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Humor at first sight: The Role of Positive Humor in Human-Robot Interactions in Groups

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CIÊNCIAS SOCIAIS
E HUMANAS

Department of Social and Organizational Psychology

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Although most children – and perhaps some adults – are most certain of what they want to be when they grow up, by the time I became an adult and I had to decide, I had long forgotten what I wanted to be as a child. As fate would have it, I discovered on an expedition to one of those awful automatic coffee machines in Edifício 2, that what I really wanted was to become a research scientist. This changed the course of my life in quite a radical way. For this – and for starting me in research, I need to thank Patrícia Arriaga and Ana Paiva.

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Resumo

O humor desempenha um papel fundamental nas nossas vidas, afetando o nosso bem-estar, a nossa maneira de lidar com o stress e a percepção das pessoas ao nosso redor. Esta tese procurou investigar de que forma é que a introdução de humor verbal em interações com robôs sociais poderia melhorar essas interações e promover maior aceitação desta tecnologia. Para alcançar este objetivo, seguimos uma abordagem segmentada em quatro etapas. Primeiro, realizamos revisões de literatura sobre o i) uso de humor em interações entre robôs e humanos (capítulo 5), ii) o papel de variáveis hedônicas na aceitação de tecnologia (capítulo 4), iii) e a relação entre humor e saúde (capítulo 3). De seguida, avaliamos as propriedades psicométricas de instrumentos de avaliação relevantes, como o RoSAS (Robotic Social Attributes Scale) e o HSQ (Humor Styles Questionnaire, capítulo 6). Na terceiro etapa, conduzimos um estudo online para avaliar como o humor afeta a percepção e aceitação de robôs sociais (capítulo 7). Finalmente, realizamos um estudo em laboratório, onde os participantes interagiram com robôs sociais no contexto de um jogo de cartas humorístico (capítulo 8). Os nossos resultados destacam a importância do humor para a saúde e enfatizam sua relevância no desenvolvimento de robôs sociais. Também contribuímos para a literatura ao adaptar e avaliar escalas de humor e aceitação de tecnologia junto de amostras Portuguesas, além de explorar as características do humor escrito e verbal, e criar um jogo para interações entre humanos e robôs sociais, que pode ser útil em investigação futura.

Palavras-chave: robótica social; modelo de aceitação da tecnologia; estilos de humor; entretenimento

Abstract

Humor plays a pivotal role in our lives, influencing our well-being, our coping mechanisms for stress, and our perception of those around us. This thesis aimed to investigate how the introduction of verbal humor in interactions with social robots could enhance these interactions and foster greater acceptance of this technology. To achieve this objective, we followed a four-step approach. First, we conducted literature reviews on i) the use of humor in interactions between robots and humans (Chapter 5), ii) the role of hedonic variables in technology acceptance (Chapter 4), and iii) the relationship between humor and health (Chapter 3). Subsequently, we assessed the psychometric properties of relevant measurement tools, such as the Robotic Social Attributes Scale (RoSAS) and the Humor Styles Questionnaire (HSQ) (Chapter 6). In the third stage, we conducted an online study to evaluate how humor influences the perception and acceptance of social robots (Chapter 7). Finally, we conducted a laboratory study where participants interacted with social robots within the context of a humorous card game (Chapter 8). Our findings underscore the significance of humor in health and emphasize its relevance in the development of social robots. Additionally, we made contributions to the literature by adapting and evaluating humor and technology acceptance scales for Portuguese samples, exploring the characteristics of datasets of humorous written material, and creating a game for interactions between humans and social robots, which may prove valuable in future research endeavors.

Keywords: social robots; technology acceptance model; humor styles; entertainment

PsycINFO Codes: 2360 Motivation & Emotion; 4010 Human Factors Engineering; 4140 Robotics.

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List of Acronyms

ANOVA: Analysis of Variance. 150
AVE: Average Variance Extracted. 112, 128

BP: Blood Pressure. 4, 43, 45, 46, 47, 48, 49, 50, 51, 53, 54, 55, 56, 60, 61, 62, 63, 193

CASA: Computers are Social Actors. 84, 103, 175, 176
CFA: Confirmatory Factor Analysis. 109, 112, 113, 116, 117, 122, 128, 129
CFI: Comparative Fit Index. 112, 121, 128, 129, 131

DBP: Diastolic Blood Pressure. 46, 53, 54, 55, 56, 60, 61

EFA: Exploratory Factor Analysis. 129, 130
EM: Expectation Maximization. 112, 128
ETAM: Extended Technology Acceptance Model. 72

HCI: Human-Computer Interaction. 84, 85
HF: High Frequency. 47, 54, 58, 60, 182, 184, 186
HMI: Human-Machine Interaction. 4, 80
HR: Heart Rate. 47, 187
HRI: Human-Robot Interaction. 6, 82, 84, 85, 86, 89, 91, 99, 100, 101, 103, 106, 107, 108, 117, 119, 139, 154, 155, 156, 158, 159, 186, 188, 192, 193, 196, 197, 198, 199, 200, 201, 202, 203
HRV: Heart Rate Variability. xvi, 4, 43, 46, 47, 48, 49, 50, 54, 56, 58, 59, 61, 62, 63, 178, 182, 185, 186
HSQ: Humor Styles Questionnaire. 6, 106, 120, 122, 123, 124, 129, 131, 132, 135, 136, 141, 142, 144, 145, 147, 150, 194, 195

IBM: International Business Machines Corporation. 112, 128

JB: Jokebox. 4, 160, 176, 195, 200, 202

KMO: Kaiser–Meyer–Olkin. 112

LF: Low Frequency. 47, 54, 58, 60, 61, 184, 186
LII: Laughter-Inducing Interventions. 4, 43, 44, 47, 48, 51, 53, 54, 55, 56, 60, 61, 62, 63

MCR: Missing Completely at Random. 112, 128

MSD: Mean Difference Between Successive RR Intervals. 47

NARHT: Negative Attitudes Towards Robots with Human Traits. 110, 111, 116, 117, 118, 178

NARS: Negative Attitudes Towards Robots. 108, 109, 110, 111, 116, 117, 118, 178

NATIR: Negative Attitudes Towards Interaction with Robots. 110, 111, 116, 117, 118, 178

NFI: Normed Fit Index. 128, 131

PANAS: Positive and Negative Affect Schedule. 124, 125, 261

PEU: Perceived Ease of Use. 139, 179, 184, 186

PU: Perceived Usefulness. 139, 179, 184, 186

RMSEA: Root Mean Square Error of Approximation. 112, 128, 131

rMSSD: Root Mean Square of Successive Differences. 54, 56, 57, 58, 60, 182, 184, 186

RoSAS: Robotic Social Attributes Scale. 6, 106, 107, 108, 109, 110, 111, 113, 116, 117, 118, 119, 146, 178, 194

SBP: Systolic Blood Pressure. 46, 53, 54, 55, 56, 60, 61

SDG: Sustainable Development Goals. 4, 192

SDNN: Standard Deviation of the Inter-Beat-Intervals of Normal Sinus Beats. 47, 54, 56, 57, 58, 60, 61, 62

SEM: Structural Equation Modelling. 112, 118

SIgA: Secretory Immunoglobulin A. 45

SR: Social Robots. 3, 4, 5, 6, 76, 80, 81, 82, 84, 86, 90, 96, 98, 100, 103, 106, 107, 108, 110, 116, 117, 118, 139, 145, 146, 147, 148, 152, 153, 154, 155, 156, 158, 159, 175, 185, 186, 187, 188, 189, 192, 194, 195, 197, 198, 199, 200, 201, 202, 203

SRMR: Square Root Mean Residual. 112, 128, 131

TAM: Technology Acceptance Model. 5, 67, 71, 72, 73, 74, 75, 76, 77, 81, 82, 139, 155

TIB: Theory of Interpersonal Behavior. 67, 70, 74

TIPI: Ten-item Personality Inventory. 124, 126

TLI: Tucker-Lewis Index. 128, 131

TPB: Theory of Planned Behavior. 67, 68, 69, 70, 72, 74, 75, 76

TRA: Theory of Reasoned Action. 67, 68, 69, 70, 71, 72, 74, 75, 76

ULF: Ultra-Low Frequency. 47

UTAUT: Unified Theory of Acceptance and Use of Technology. 72, 73, 74, 75, 76, 77, 82, 139

VLF: Very Low Frequency. 47, 61

WoZ: Wizard of Oz. 93, 94, 96, 99

CHAPTER 1

General introduction

Humor has always stood out as a unique and puzzling psychological phenomenon and the scant attention it has received from psychologists does them little credit. If any of the famous explorers of old had caught sight of a strange geological formation, seemingly unlike anything else within their territory, they would surely have made straight for it, ignoring everything else within sight until they had examined it and perhaps scaled it in the hope of surveying the whole country from a matchless vantage point. Compared with these adventurers, psychologists do not cut out impressive figures. Our Freuds may equal their intrepidity and their sense of priorities but not their rigorous surveying techniques. Most others refuse to venture outside familiar cabbage patches of proven fertility. An increasing number, impatient of the restrictions imposed on the surveyor and the horticulturist alike, turn their eyes away from the landscape and toward the clouds.

Berlyne, D., 1972 (p. 43)

Though psychologists remain divided on the precise definition, role, and origin of humor, nearly all people - including psychologists - acknowledge that humor and laughter are omnipresent, ineluctable, and essential components of the human experience. As such, for many years, humor has been posited as a vital ingredient for one's well-being, impacting and reflecting various aspects of one's interpersonal relationships and health. The ubiquity of humor in human interactions attests to its significance and is readily apparent as *"(...) we find laughter and humor occurring almost wherever we find people engaged in social interaction"* (McGhee & Goldstein, 1983, p. v).

Indeed, it is no mere coincidence that many individuals dedicate a substantial portion of their lives to pursuing or participating in humorous exchanges with others. From the earliest stages of infancy, laughter emerges as a universal social behavior, serving to strengthen the connection between child and caregiver (Gervais & Wilson, 2005; Srofe & Waters, 1976), convey excitement (Rothbart, 1973), and elicit positive emotions (Kret, Venneker, Evans, Samara, & Sauter, 2021).

But the allure of merriment and mirth does not dissipate in early childhood. For most, it blossoms into a lifelong pursuit of enjoyment that is intertwined with many significant aspects of one's existence- including how one contends with problems (Abel, 2002; R. A. Martin, Kuiper, Olinger, & Dance, 1993), settles conflicts (Sampietro, 2014; Smith, Harrington, & Neck, 2000), and interacts with others (Lehmann-Willenbrock & Allen, 2014; Ziv, 2010).

Moreover, it also appears that both scholars and laypeople share a common appreciation for the salubrious effects of humor, recognizing that humor not only *feels good*, but that it also *does good*. For instance, in relation to interpersonal relationships, research indicates that humor can promote the development of fulfilling relationships by facilitating the creation (and bolstering the quality) of positive social connections (Hall, 2017). Additionally, humor serves a crucial function in the establishment of relationships, as it increases attraction and serves as a social lubricant (McGee & Shevlin, 2009).

In regards to psychological health, humor has been consistently linked to numerous beneficial outcomes. For instance, research has found that positive humor styles are positively associated with well-being, and that this association seems to be stable across cultures and different age groups (Jiang, Lu, Jiang, & Jia, 2020). Similarly, recent literature has also emphasized how the use of humor as an effective strategy to cope with problems can lead to better psychological outcomes (Marziali, McDonald, & Donahue, 2008). In terms of physical health, humor also seems to play a role, being associated with overall greater longevity and positive changes in key variables related to heart activity (Yoder & Haude, 1995; L. R. Martin et al., 2002; Kreibig, 2010).

It follows, thus, from the acknowledgment of its many beneficial effects, that humor is something that should be incentivized and cultivated in people's lives. In this context, prior research has endeavored to create and examine a variety of humor-based applications that can effectively exploit the benefits of humor and laughter. Among them are therapeutic interventions that utilize humor to promote better health, as well as others that employ humor to promote healthy development, adjustment and coping skills for both children and adults on a variety of different contexts that include schools, organizations, and care facilities, among others (Foot, 2017; McGhee & Frank, 2014; Duncan, Smeltzer, & Leap, 1990).

More recent applications have included the use of technology to leverage the benefits of humor for increasing user adoption of new technologies, promoting healthy behavior and incentivizing improved learning experiences (Shoda & Yamanaka, 2021; Y. Wang, 2020; L. C. Lee & Hao, 2015), thus seeking to fulfil the general goal of using humor to improve both individual, interpersonal and technology-related outcomes.

In this work, we sought to identify one promising avenue to attain that goal that has emerged in the last few decades: socially embodied technology. This emerging type of technology has provided both a novel platform and form of communication, opening the doors to new forms of interactions not only among people, but also between people and machines (Giger, Piçarra, Alves-Oliveira, Oliveira, & Arriaga, 2019). Theories of technology perception - specifically those directed at technological objects with the ability to display emotions and communicate with their users- have put forward the idea that we apply many of the mental schemas that we develop to map our interactions with people, to Social Robots (SR) (Nass, Steuer, & Tauber, 1994; Nass, Fogg, & Moon, 1996; Fong, Nourbakhsh, & Dautenhahn, 2003; Breazeal, 2004).

In this context, a question has been raised as to if (and how) the benefits observed for psychological, physical and interpersonal relations that have been widely associated with the use of humor among humans can be translated to the field of interaction with social machines (and in particular, SRs); and if yes, how they can be leveraged to improve the interaction between humans and SRs by contributing towards more engaging, enjoyable and productive interactions between the two.

SRs provide a particularly interesting avenue to explore this question, as they are forms of technology that can communicate (both verbally and non-verbally) with their users in ways that are similar to the ways humans communicate with one another (Giger et al., 2019; Nass et al., 1994, 1996).

However, besides being scarce and often considered a curiosity, the existing research is limited in many important aspects. Namely, it has been mostly conducted in a theoretical void offering little contributions towards the development of a consistent approach to humor in the field of technology perception and acceptance. Additionally, it lacks in quality due to poor adherence to scientific reporting standards, lack of validation of the humorous material used and overall, small and unrepresentative sample sizes that provide an obstacle to generalization efforts.

A focus on situations or interaction scenarios that revolve around problem-solving formal tasks- as opposed to a focus on entertainment situations, in which at least a part of the interaction is motivated by hedonic factors- also presents a limitation in the sense that it fails to gauge the effects of the different aspects involved in each one of those situations. This seems to be a general limitation shared by general models of technology acceptance, which tend to emphasize utilitarian - rather than hedonistic- aspects of Human-Machine Interaction (HMI) (Hornbæk & Hertzum, 2017; X. Wang & Goh, 2017; Heijden, 2004).

As such, we sought in this thesis to contribute towards the closing of those gaps by exploring the role of humor in group entertainment scenarios involving humans and robots. Our intentional focus on multi-party interactions - as opposed to the traditional focus on dyadic interactions between one human and one robot- adds one layer of complexity that is intended to reflect that of the real world, as many robots are being introduced in contexts that call for group interactions (Woo, LeTendre, Pham-Shouse, & Xiong, 2021; Tonkin et al., 2018; Triebel et al., 2016).

More specifically, we aimed to investigate how humor could contribute to greater intentions to interact with SRs in the future by (a) improving users' perceptions of warmth, competence and discomfort of the robots, (b) increasing the users' perceived ease of use and usefulness of the robots, (c) increasing the users' perceptions of emotional, social and societal value of the robots and (d) increasing the user's enjoyment of the robots and their interactions with them.

As such, this thesis mirrors the contributions and insights (and hopefully also contributes to) several scientific disciplines, more notably, social psychology, computer science and affective computing. It also seeks to contribute to wider Sustainable Development Goals (SDG) by offering contributions in the domains of good health and well-being (SDG 3) and industry, innovation and infrastructure (United Nations General Assembly, 2015, SDG 9).

To achieve the aforementioned goals, we devised a humor-based entertainment game which could be played together by human and robotic players simultaneously, and which we named Jokebox (JB). We used this game as a group interaction scenario in which each participant interacted with two robots (one displaying humor and one not).

The remainder of this thesis is thus organized as follows (see fig. 1.1):

In **chapter 2**, we explore and reflect on the psychological study of humor throughout history, as well as the main challenges that have accompanied it. This is done to provide a broader understanding of the topic of humor and its theoretical underpinnings in the study of human behavior.

In **chapter 3**, we explore the association between humor and laughter and indicators of physical health and well-being by conducting two independent studies with a systematic review of the literature design. The first systematic review and meta-analysis; chapter 3) focus specifically on the association between humor and Laughter-Inducing Interventions (LII) on Blood Pressure (BP), HRV and overall longevity. The second systematic review (chapter 3) summarizes the existing literature investigating the relationship between different humor-related concepts and social, psychological and physical well-being.

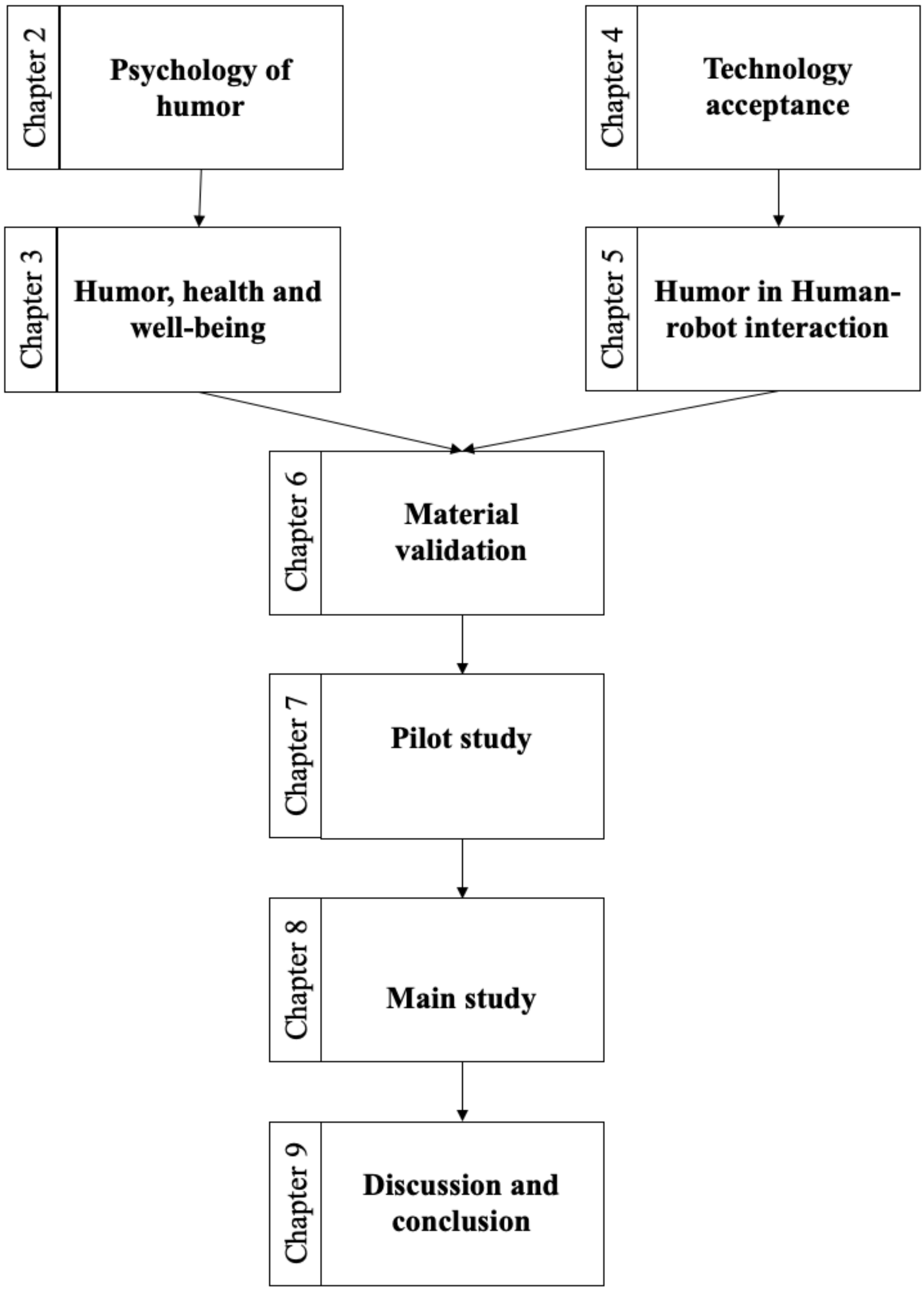


FIGURE 1.1. Overview of the present thesis.

In **chapter 4**, we address the main theoretical underpinnings of this work by addressing the Technology Acceptance Model (TAM) and its many iterations (particularly related to the role of hedonic motivations in increasing user's acceptance of interactive systems). We follow this, by providing a more specific systematic review of literature regarding the application of humorous features in SRs in **chapter 5**, in which we investigate the effects of the introduction of humor in users' interactions with SRs.

In **chapter 6**, we present the psychometric evaluation of the instruments that were used in the following chapters of this thesis. Namely, we report the translation and

Table 1.1. List of publications associated with this thesis.

Chapter	*Publication*
3	**Oliveira, R.**, & Arriaga, P. (2022). A systematic review of the effects of laughter on blood pressure and heart rate variability. *HUMOR: International Journal of Humor Research, 35* (2), 135-167. https://doi.org/10.1515/humor-2021-0111
	Oliveira, R., Arriaga, P., Barreiros, J. & Paiva, A. (2023). The role of humor in social, psychological and physical well-being. *HUMOR: International Journal of Humor Research, 35.* https://doi.org/10.1515/humor-2022-0072
5	**Oliveira, R.**, Arriaga, P., Axelsson, M., & Paiva, A. (2021). Humor–Robot interaction: A scoping review of the literature and future directions. *International Journal of Social Robotics, 13* (6),1369-1383. https://doi.org/10.1007/s12369-020-00727-9
6	**Oliveira, R.**, Arriaga, P., Stroessner, S. J., & Paiva, A. (2021). Preliminary validation of the European Portuguese (2021). Preliminary validation of the European Portuguese version of the Robotic Social Attributes Scale (RoSAS). *Human Behavior and Emerging Technologies, 3*(5), 750-758. https://doi.org/10.1002/hbe2.311
	Oliveira, R., Arriaga, P. & Lins, S. (Submitted to HUMOR). European Portuguese Validation of the Humor Styles Questionnaire (HSQ-EP).
7	**Oliveira, R.**, Arriaga, P. & Paiva, A. (Under review). The role of humor styles on robot perception, value and acceptance. Submitted to Computers in Human Behavior.
8	**Oliveira, R.**, Arriaga, P., Batina, I., Prada, R. & Paiva, A. (Under review). The role of humor in users' perceptions, evaluations, physiological responses and future intention to interact with social robots . Submitted to International Journal of Human-Computer Studies.

evaluation of the European Portuguese version of the Robotic Social Attributes Scale (RoSAS) and of the (Humor Styles Questionnaire (HSQ)).

In **chapter 7**, we bring together the research on humor and the research on social robotics and technology acceptance by conducting an online study in which we use a between-subjects study to investigate how humor has an impact on users' perception, evaluation and future intention to interact with SRs. In this study, we used text-based vignettes to exemplify an interaction between one robot and one person in a work-related context and we manipulated both the humorous actor (human vs. robot) and the style of humor displayed (affiliative, self-enhancing or self-defeating).

In **chapter 8**, we present a user study in which we re-examined the role of humor in Human-Robot Interaction (HRI) specifically in an entertainment-based interaction scenario. In this study, participants played a card-game with two robots (one displaying humor and the other not). Physiological, behavioral and self-reported data were collected and analyzed.

In **chapter 9**, we provide a general discussion of the main findings of the work composing this thesis and integrate them in the existing literature. Additionally, we also outline some of the limitations of this work, and identify future avenues of research.

The work conducted for this thesis has resulted, over the course of the previous four years, in the list of publications presented in table 1.1; and the general structure in which they are organized in this thesis is shown in fig. 1.1.

CHAPTER 2

The Psychology of Humor

There is a species of primate in South America more gregarious than most other mammals, with a curious behavior. The members of this species often gather in groups, large and small, and in the course of their mutual chattering, under a wide variety of circumstances, they are induced to engage in bouts of involuntary, convulsive respiration, a sort of loud, helpless, mutually reinforcing group panting that sometimes is so severe as to incapacitate them. Far from being aversive, however, these attacks seem to be sought out by most members of the species, some of whom even appear to be addicted to them.

...the species is Homo sapiens (which does indeed inhabit South America, among other places), and the behavior is *laughter* [emphasis added].

Dennet, D., 1991 (p. 62)

Abstract

In this chapter, we provide a broad overview of the main theories of humor in Psychology, while placing them in the historical context of how the word *humor* came to attain the meaning it has today. In particular, we focus first, on the etymological roots and history surrounding the social perception of humor. Second, we focus on an analysis of the main psychological and philosophical theories of humor that have been proposed over the decades, paying particular attention to the broad range of definitions for humor that have been put forwards by scholars, and how those definitions imply the centrality of different psychological mechanisms in the analysis of humor. Finally, we frame the study of humor within the context of different sub-fields of psychology, focusing more specifically on social psychology; and we outline some of the main challenges that have been associated with the academic study of humor. This chapter is intended for audiences interested in the concept of humor and it is included in this thesis with the goal of providing a general overview of humor as an academic pursuit situated in (and shaped by) a broader social, political, and historical environment.

2.1. Introduction and overview

Humor is a notoriously difficult concept to define, and the many definitions that have been proposed for it over the years bear witness to that fact. Not surprisingly, this wealth of different definitions has posed both many different challenges and opportunities for the academic study of humor within the field of Psychology. In this chapter, we seek to shed some light on how those challenges and opportunities have helped shape our lay and academic notions of humor, and how these evolved together over time to give rise to the exciting field of humor studies.

To achieve that goal, we start by presenting a brief review of the main classic theories of humor categorized according to the emphasis they put on different psychological mechanisms thought to explain humor. Additionally, we also provide a brief historical account of humor research in Psychology and Philosophy starting from the 4^{th} century B.C. and ending in modern times. This is done with the goal of framing the societal backdrop against which those theories were developed, as well as to inform on how those conditions shaped the concept of humor as we know it today.

As a result of the many challenges inherent to the study of humor, which will be made evident throughout the rest of this work, we must note that often times the term "theory" is employed loosely. Many accounts put forward over the years by academics, although interesting, tend to focus on identifying conditions under which humor occurs or the individual and social correlates of humor, rather than *explaining* humor (Keith-Spiegel, 1972). Others, yet, anchor themselves around assumptions or concepts that defy operationalization, and thus remain little more than anecdotal accounts or historical curiosities that have failed to live up to the rigorous standards of empirical testing (Keith-Spiegel, 1972).

Similarly, the categorization schema that we impose below on humor theories is merely one of many possibilities. Other classification schemes for humor theories and conceptualizations have been proposed and shown to be useful (Sully, 1902; Brill, 1911; Keith-Spiegel, 1972; Roeckelein, 2002; Attardo, 2017; R. A. Martin & Ford, 2018), but similar to the one we advance here have also been pointed out to be imperfect or incomplete as *"...many theories can fall into more than one category, whereas others seem inappropriate for classification"* (Keith-Spiegel, 1972) (p. 4).

With this in mind, we begin by summarizing the historical and etymological roots of humor in section 2.2, and then we explore the many definitions and theories of humor that have been proposed over the years in section 2.3. Further, we frame the study of humor in Psychology (section 2.4) and we outline some of the main challenges that have underlined humor research (section 2.5), discussing their wider implications and relation to this thesis in section 2.6.

2.2. History

In etymological terms, humor finds its roots - quite aptly- in the Latin word *humorem*, meaning liquid or fluid (Zucker & Le Feuvre, 2021). Its' association with health -which is nearly as old as the word itself- dates back to the 4^{th} century B.C., when, Hippocrates, considered today the father of medicine, proposed that good health depended on the balance of four *humors*: blood, phlegm, black bile and yellow bile (R. A. Martin & Ford, 2018; Morreall, 2012; Roeckelein, 2002).

However, it was only in the 2^{nd} century A.D., that the notion that the balance between these four fluids was related to psychological factors was advanced by the Greek physician Galen, thus introducing the still enduring notion of humor as a trait and a temporary mood. This conceptualization of humor still shapes the way that the word humor is used today, having served as the basis upon which many popular expressions involving the word humor were coined (eg., *"she is good-humored"* or *"she is in a bad humor"*) (Wickberg, 1998; R. A. Martin & Ford, 2018).

Nonetheless, although valued for its beneficial associations with good health, the term *humorem* held little to no resemblance to the meaning we currently attribute to the word *humor*. Laughter and ridicule -terms which are often conflated with humor in early literature, but are more representative of the current meaning of the word- were mostly frowned upon by society in general, with most of the contemporaneous scholar's writings expressing negative stances on the acceptability and desirability of this type of behaviors (Keith-Spiegel, 1972; Roeckelein, 2002; Morreall, 2012; R. A. Martin & Ford, 2018).

Take for instance Plato's assertions about the admissibility of laughter and humor in the public sphere (as reprinted in Plato, Hamilton, Cairns & Jowett, 1997), coupled with Aristotle's warning and description of wit as a form of educated insolence (as reprinted in Broadie & Rowe, 2002):

> "No composer of comedy, iambic or lyric verse shall be permitted to hold any citizen up to laughter, by word or gesture, with passion or otherwise"

(Plato, Hamilton, Cairns, & Jowett, 1997)

> "Most people enjoy amusement and jesting more than they should ... a jest is a kind of mockery, and lawgivers forbid some kinds of mockery—perhaps they ought to have forbidden some kinds of jesting."

(Broadie & Rowe, 2002)

These clearly negative stances towards humor (with little distinction being placed between *laughing with* and *laughing at* someone) derived mostly from the widely held perception that all laughter arose from mockery, ridicule or scorn (Keith-Spiegel, 1972).

Plato and Aristotle were not alone in these views, either. Great thinkers, for centuries after them, advised others to the perils of humor and laughter: *"Let not your laughter be loud, frequent, or unrestrained"* (Epictetus as cited in Morreall, 2012). These negative connotations assigned to humor later found their way into the writings of Christian thinkers, and became an ingrained part of European and Middle Eastern culture. This is evidenced in many religious texts, including the bible, in which laughter and humor are consistently used in a derogatory, scornful manner:

> The kings of the earth stand ready, and the rulers conspire together against the Lord and his anointed king... . The Lord who sits enthroned in heaven laughs them to scorn; then he rebukes them in anger, he threatens them in his wrath

Psalm 2:2–5

Influenced by these writings, laughter and humor became synonymous with laziness and moral flaws in one's character in popular writings:

> Laughter often gives birth to foul discourse, and foul discourse to actions still more foul. Often from words and laughter proceed railing and insult; and from railing and insult, blows and wounds; and from blows and wounds, slaughter and murder. If, then, you would take good counsel for yourself, avoid not merely foul words and foul deeds, or blows and wounds and murders, but unseasonable laughter itself.

Schaff, 1889 as cited in Morreall, 2012

Born out of a place of social stigma and negative connotations, and despite its initial relation to physical health, and later its association with psychological traits and states, the 16^{th} century witnessed a transformation in the meaning of the word humor (Wickberg, 1998).

In English, the word humor (borrowed from the French *humeur*) was used to describe a person who was perceived to have an unbalanced temperament and whose behaviors deviated from social norms. Given that such people were often seen as odd or eccentric, thus being the worthy target of laughter, the word soon evolved to be associated with comedy and funniness (Wickberg, 1998; Morreall, 2012; Roeckelein, 2002).

It was in the brink of this shift in meaning and social connotation that some of the earliest theories of humor emerged. Most notably, it was at this time that Thomas Hobbe advanced his superiority theory. The notion of humor as a form of ridicule that served the psychological purpose of enhancing one's self-perceived status, thus originating feelings of superiority appears to be rooted in some of the historical negative stances on humor. These roots, however, flourished - at least in parts - into a view of humor that emphasized its *social* role like few theories did before. Humor was a way to scorn or ridicule others, yes. But it was more than that too. It was a way of communicating that leveraged *ad hominem* attacks in an *amusing* manner to an audience.

This performative aspect of humor quickly became a central piece of its' definition and social use. Laughter, in its most aggressive form turned into ridicule, became a popular form of communication (often observed, for instance, in debates where it was used as a strategy to undermine an adversary by making them seem laughable in the eyes of an audience); but also as a talent or art form valued for its entertaining use (Keith-Spiegel, 1972; Wickberg, 1998; Morreall, 2012; Roeckelein, 2002).

As the second meaning of humor, i.e., humor as an acceptable and desirable art form became increasingly more popular, its association with emotional superiority over a laughable target was gradually replaced by an association to the intelligence and wit that were perceived as being necessary to craft clever retorts or to identify novel or incongruous relationships between ideas that were perceived as being humorous (Keith-Spiegel, 1972; Wickberg, 1998; Morreall, 2012; Roeckelein, 2002).

These dichotmous perceptions of humor - one that emphasized its *emotional* component and the other that framed it in *intellectual* or cognitive terms - became a frame for many of the later conceptualizations of humor and reminiscences of it can still be observed in many of the current theories on humor.

In particular, the distinction between wit (associated with an intellectual frame) and humor (associated with more emotional aspects), typically made in the daily use and perceptions of those words, began to permeate the fabric of work of early academics. Sigmund Freud, followed by many of his contemporaries, made this distinction between humor as healthy and desirable psychological trait, and wit as an aggressive and detrimental trait in many of his works (O'Connell, 1960; O'connell, 1969).

In this context, wit referred mostly to intellectual comedy, whereas humor was perceived as designating a type of comedy that could be used to facilitate interpersonal relationships due to its emotional and congenial nature. Wit, which was often aggressive, comprised sarcasm and comedy intended to downplay others' status and was seen as elitist. Humor on the other hand, was perceived as being the *"... combination of the laughable with an element of love, tenderness, sympathy, warm-heartedness, or affection"* (Wickberg, 1998, p. 65).

It was only during the course of the 20^{th} century that the distinction between wit and humor gradually began to fade, with humor increasing its proeminence as an umbrella term to designate all things funny. This final conceptualization of humor was the result of a remarkable process of evolution, "*...shifting from the aggressive antipathy of superiority theory, to the neutrality of incongruity theory, to the view that laughter could sometimes be sympathetic, to the notion that sympathy is a necessary condition for laughter.*" (R. A. Martin & Ford, 2018; Wickberg, 1998, p. 11).

Around this time, during the course of the 18^{th} and 19^{th} centuries, English philosophers began using the term *senses* to refer to individuals' refined abilities or proclivities to discern the quality of certain things. This resulted in the adoption of terms such as *sense of decency*, *moral sense*, *common sense* and, more importantly in the context of this thesis, *sense of the ridiculous*, which was later replaced in common language for *sense of humor*.

Over the course of the 20^{th}, the notion of sense of humor as a trait or quality that one possesses that is greatly appreciated in interpersonal interactions became an increasingly popular one. And, although that is still the case today, an argument can be made that a sense of humor is better defined in its absence, in other words, during this period, "*(...) what it meant to have a sense of humor came to be defined in large part by what it meant not to have one*" (R. A. Martin & Ford, 2018, p. 12).

In lay terms, accusing someone of not having a sense of humor often was a way of saying that person was excessively serious, fanatical or easily offended. Similarly, the notion that a lack of sense of humor was detrimental to good mental health became commonplace, with the absence of this trait being a defining characteristic of some forms of mental illness, including schizophrenia (Roeckelein, 2002; R. A. Martin & Ford, 2018).

These evolving conceptualizations of humor and their relationship with one's personality, well-being and relationships with others transcended the realm of lay thinking about the subject, permeating the fabric of the academic study of humor. As such, and in reflection of the variety of lay meanings and associations with humor, academics over the centuries have produced a wealth of theories about humor, laughter and their role in intrapersonal and interpersonal variables.

2.3. Theories and Definition(s)

2.3.1. Relief theories

Relief theory posits that people engage in humor as a way to escape built-up states of intense emotional tension or arousal (Wilkins & Eisenbraun, 2009; Shurcliff, 1968; R. A. Martin & Ford, 2018; Freud, 1961). Much like a pressure relief valve for a steam pipe, which is set to open up when gases and or fluids drive the pressure up, thus, providing a complementary route for their release, humor provides a complementary route for built-up nervous energy to escape the body (Shaftesbury, 1744; R. A. Martin & Ford, 2018).

Theories of humor focused on tension relief appear in the literature as far back as the beginning of the 18^{th} century, being among one of the first types of formal theories on humor to exist and representing some of the first instances of the word humor being used with the meaning that we know for it today (Morreall, 2012).

Reflecting what was known at the time about the human nervous systems, the earliest relief tension theories of humor employ hydraulic metaphors for its functioning based on the assumption that nerves, which connect the brain to the muscles and organs, could carry gases and bloods (known to contemporaries as "animal spirits"[1]). Laughter, thus, served the important function of releasing these animal spirits.

This idea that laughter and humor released tension continued to be a central tenant of the theories of humor that emerged in the following two centuries, even as the knowledge behind the biological processes of tension release and of the functioning of the central nervous system was updated (Morreall, 2012).

Most notably, Herbert Spencer and Sigmund Freud both advanced theories that described humor as a form of physical emotional tension relief (see table 2.1). Following his psychoanalytical theory of the mind, Freud advanced several propositions about humor, arguing, for instance, that humor is created by letting repressed ideas and feelings into the conscious mind (in particular those of sexual or aggressive nature, thus explaining, the general propensity for this type of jokes).

However, later studies analyzing joke preference demonstrate that the individuals who enjoy and engage in these types of humor are not those who tend to repress such feelings or topics; but actually those who choose to express them (Eysenck, 1972). In addition to this, relief theories also significantly failed to account for several important aspects of joke appreciation, including why some jokes are considered to be funnier than others and, more importantly, failed to propose a mechanism for the release of tension that could be tested and analyzed under the scrutiny of the scientific method (Eysenck, 1972; Morreall, 2012; R. A. Martin & Ford, 2018).

TABLE 2.1. Different definitions of humor offered in the literature

Source	Definition	Central psychological mechanism or goal
Descartes (1649; p.35)	"As for the laughter [...] it seems to result from the joy we get from seeing that we can't be harmed by the evil that we are indignant about, and from finding ourselves surprised by the novelty of the evil or by our unexpected encounter with it."	Superiority

[1]For an example of the use of this expression in writings from the 18^{th} and century, see Shaftesbury (1744) or Locke (1948).

Hobbes (1650; p. 3)	"[T]he passion of laughter is nothing else but sudden glory arising from some sudden conception of some eminency in ourselves, by comparison with the infirmity of others, or with our own formerly"	Superiority
Beattie (1779; p. 318)	Laugther "...seems to arise from the view of things incongruous united in the same assemblage"	Incongruity
Kant (1790; sec. 54)	"Laughter is an affection arising from the sudden transformation of a strained expectation into nothing."	Incongruity
Dewey (1894; p. 558)	"[Laughter] marks the ending [...] of a period of suspense, or expectation [...], [being a] sudden relaxation of strain, so far as occurring through the medium of the breathing and vocal apparatus [...]. The laugh is thus a phenomenon of the same general kind as the sigh of relief."	Tension relief
Spencer (1911; p. 303)	"(...) a release of nervous energy"	Tension relief
Freud (1928; p. 2)	"... the essence of humor is that one spares oneself the affects to which the situation would naturally give rise..."	Tension relief
Eysenck (1942; p. 307)	"...laughter results from the sudden, insightful integration of contradictory or incongruous ideas, attitudes, or sentiments which are experienced objectively."	Incongruity

Schultz (1972; p. 457)	”The expectations are violated as the subject discovers the simultaneous presence of the other, unexpected element. To the extent that the two context's of occurrence have been non overlapping in the subject's past experience or imagination, he will be surprised or cognitively aroused at the discovery of the incongruity. This arousal can be reduced if he can explain or resolve the incongruity, i.e., if he can discover some justification for the simultaneous presence of the incongruous elements or glean some new meaning from their co-occurrence.”	Incongruity
Svebak (1974: p. 99)	”Humor is a strategem [sic] for relating the collective social reality of a group of persons (the rational world) to their personal imaginations of alternative social worlds, meanings, or identities (the irrational world)”.	Interpersonal relations
Jung (2003; p. 245)	“laughter is a signal that facilitates cooperation by transfer of information on the laugher's empathy with attributed mental states and his sympathy levels for others.”	Interpersonal relations
Peterson and Seligman (2004; p.530)	One ”(...) who is skilled at laughing and teasing, at bringing smiles to the faces of others, at seeing the light side, and at making (not necessarily telling) jokes ”	Interpersonal relations
Martin and Ford (2018; p. 3)	”Humor is a broad, multifaceted term that represents anything that people say or do that others perceive as funny and tends to make them laugh, as well as the mental processes that go into both creating and perceiving such an amusing stimulus, and also the emotional response of mirth involved in the enjoyment of it.”	–
Phillips et al. (2018; p. 270)	“a statement made with the intent to make others in the room laugh or react positively and to which a positive response is elicited”	Interpersonal relations

2.3.2. Superiority theories

Superiority theories encompass a collection of humor theories positing that humor is essentially a manifestation of aggression stemming from a sense of triumph or superiority over others. While the notion of humor and laughter as forms of aggression, particularly when associated with attitudes like scorn or mockery, can be traced back to ancient times, its more contemporary formulation emerged through the works of philosophers in the 17^{th} century, such as Hobbes and Descartes.

The modern heirs to Hobbes and Descartes' conceptions about humor and superiority went on to propose theories of humor that revolved around the concept of disparagement (in particular, the vicarious superiority theory most significantly defended by La Fave (LaFave, 1972; La Fave, 1961); and the disposition theory, famously proposed by Zillmann and Cantor (Zillmann & Cantor, 1972).

La Fave's theory of humor differed from previous superiority theories of humor in the extent to which it introduced the idea that the amusement generated vicariously by disparaging humor was mediated by the enhancement on one's self-esteem that resulted from a downward social comparison with the target of humor. This social comparison, in turn, depended on something the proponents of this theory called identification class, which was defined in terms of affiliation and group membership (R. A. Martin & Ford, 2018; Ferguson & Ford, 2008). The disposition theory of humor, similar to the vicarious theory, emphasizes the social component of superiority humor, but places the emphasis on subject's attitudes towards the disparaged group rather than on group membership (Ferguson & Ford, 2008; R. A. Martin, 1998; Zillmann & Cantor, 1972).

This difference, however subtle, has some important empirical implications. First, whereas group membership (as used in the context of the vicarious theory of humor) is relatively stable, affective dispositions are not. Thus, group membership would fail to explain instances of humor directed at in-group members (e.g., friends or family). Second, explaining humor solely in terms of group membership can not account for instances of humor in which the target can not be easily placed within a broader category with which the audience can readily identify (or not) with (Ferguson & Ford, 2008).

Empirical tests of these theories seem to support that both the attitudes and the dispositions held towards a target of humor are important predictors of amusement with humorous material (Gallois & Callan, 1985). For instance, studies have consistently shown that appreciation of sexist humor (i.e., humor that disparages women) can be predicted, regardless of sex, by the attitudes held towards women by the recipient of the humor (LaFrance & Woodzicka, 1998; Butland & Ivy, 1990; Moore, Griffiths, & Payne, 1987; Henkin & Fish, 1986).

2.3.3. Incongruity theories

To the best of our knowledge, the first use of the word incongruous in the context of humor literature dates back to the 18^{th} century, and comes, not from Psychology, but from Philosophy, by the hands of author James Beattie (Morreall, 2012; Beattie, 1779).

This set of theories argued that humor did not arise from the relief of tension, nor from feelings of superiority, but from the perception of something that is incongruous, i.e., something that violates mental models or expectations (R. A. Martin & Ford, 2018; Morreall, 2012; Keith-Spiegel, 1972; Koestler, 1964; Beattie, 1779).

This notion was later significantly developed by Koestler (1964), who introduced the concept of "bissociation" to refer to the presence of different frames of references within a joke that create incongruity. In other words, in order to be perceived as funny a statement must first evoke a frame of reference, and then present a punchline, which introduces a second and contradictory or incongruent frame of reference. This abrupt transition between the two incongruous frames of references is at the core of what humor is (R. A. Martin & Ford, 2018; Keith-Spiegel, 1972; Koestler, 1964).

Soon, however, debate was started as to whether incongruity alone was sufficient for humor to occur (J. Suls, 1983; Shultz, 1972; J. M. Suls, 1972; Jones, 1970). This was in light of the fact that there is no shortage of incongruous occurrences that do not spark humor.

This notion that an incongruity must be present and that it must be resolved as necessary condition for humor to occur, attributed a puzzle-like (sometimes referred as problem-solving (R. A. Martin & Ford, 2018; J. Suls, 1983; J. M. Suls, 1972)) facet to the process of humor appreciation, thus placing an emphasis on the cognitive aspects of humor that had not been central in previous conceptualizations.

Shultz (1972), for instance, argued that a central process of humor appreciation involved the listener going back, after listening to the punch line of the joke, to search for ambiguous terms used in the set up of the joke and then resolving them in light of the information comprised in the punch line.

Other contemporary authors proposed more complex formal models to explain the process of humor appreciation. For example, Suls (1972, 1983) proposed a two-stage model that defined detection and resolution of incongruity as the central processes involved in humor appreciation (see fig. 2.1).

2.3.4. Linguistic and computational theories

Linguistic theories are partly derived from incongruity theories, but differ from the latter due to the focus they put on the *structural* and linguistic qualities of the humorous material. Notably, many of the main proponents of linguistic theories of humor sought to identify *laws* of humor that would allow one to *control* funniness, positing that:

> When we ultimately are able to make humorless people funny entertainers, or turn sarcastic types into benevolent whimsical jesters, we have ultimate proof that we *control* humor behavior.
>
> (Ruch & Raskin, 2008, p.17)

To achieve this goal, Attardo and Raskin (1991) famously proposed the General Theory of Verbal Humor-one of the most influential theories of linguistic humor- as an extension

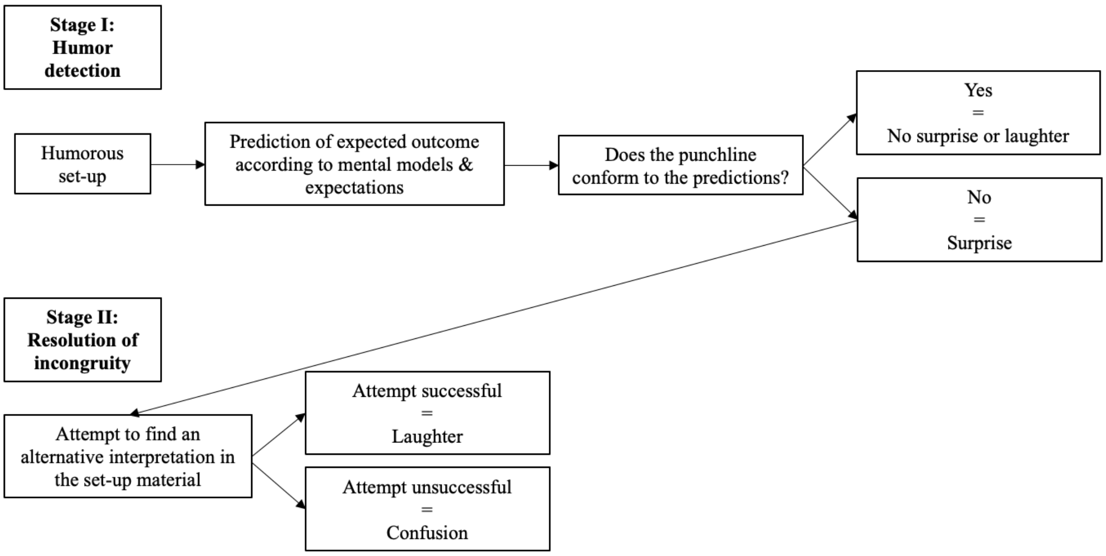


FIGURE 2.1. Two-stage model of humor appreciation proposed by Suls (1972).

and revision of Raskin's script-based semantic theory of humor and Attardo's five-level joke representation model.

This theory identified knowledge resources that informed joke taxonomy (with different jokes differing from one another mostly in regard of these resources). The six knowledge resources identified included script oppositions, logical mechanisms, situations, targets, narrative strategy and language, and these were organized on a set hierarchy of factors that served as the basis for their general theory of verbal humor (Attardo, 2010; Attardo & Raskin, 1991).

The preceding script-based semantic theory, in contrast, relied on the concept of scripts (in other words, representation schemes of a target concept), and claimed both that each joke can be interpreted according to at least two overlapping scripts and that these scripts must be opposed in some way (Raskin, 2008).

This concept of script opposition clearly influenced the general theory proposed by Attardo, becoming one of the six important knowledge resources. As this script opposition invariably introduces some degree of incongruity to the text, logical mechanisms (another theorized knowledge resource) are necessary to fully or partially explain that incongruity (Raskin, 2008; Attardo, Hempelmann, & Maio, 2002).

However, in order to make sense of the joke and take notice of the incongruity that it introduces, knowledge about the situation is necessary. As such, the knowledge resource related to the situation includes all sub-textual knowledge about the concepts involved in a joke (e.g., if a joke involves some situation at a put, the listener of the joke must be aware of some basic facts about pubs, such as that they serve drinks, are a place for social interaction, etc) (Raskin, 2008). Similarly, the joke must also present a target that is a participant of the events depicted in the joke.

The remaining knowledge resources, namely the narrative strategy and language, relate to more formal aspects of the joke. In particular, they seek to chategorize and distinguish between different genres of jokes (e.g., riddles, question and answer) and between jokes in regards to their actual lexical, synthatical and phonological characteristics (Raskin, 2008; Attardo et al., 2002; Attardo & Raskin, 1991).

2.3.5. Evolutionary and play theories

Evolutionary and play theories of humor are perhaps some of the most recent type of theories to emerge on this subject, and depart significantly from all of the previous ones due to their overall positive conceptualization of humor and laughter.

Put simply, the fundamental tenet of these theories is a rather simple one: *"Nothing in biology makes sense, except in the light of evolution"* (Dobzhansky, T. cited in Mayr, 2001, p. 39). As the cognitive ability to produce and recognize humor is a biological process - in other words, a cognitive phenotypic trait-, it follows that this ability is based on a corresponding neurobiological substrate ingrained in our genotype (Polimeni & Reiss, 2006).

The evolutionary survival of this ability, which has been present in humans for thousands or even millions of years, must thus be one that presents some type of evolutionary advantage (Panksepp, 2007; Deacon, 1997). This evolutionary argument is further strengthened by considering the complexity and universality of humorous exchanges (Polimeni & Reiss, 2006; Deacon, 1997).

Namely, as a linguistic resource and a cognitive process, the production and understanding of humor represent complex problems. Verbal humor, in particular, often relies on different techniques and delivery characteristics (e.g., irony, voice tone) that create complex ambiguous meanings and that make use of shared social representations (Polimeni & Reiss, 2006). Evolutionary theorists argue that this process is, thus, too complex to be learnt or assembled without the support of specific neural pathways or cognitive modules.

Similarly, the fact that humor tends to be considered a universal behavior lends further credence to the idea that it must have been consistently shaped by (or at least, not selected against) evolutionary forces (Polimeni & Reiss, 2006; Deacon, 1997).

In light of these assumptions, evolutionary theories of humor are particularly geared towards answering questions about the specific ways in which humor enhances fitness, the evolutionary vehicles through which it does so, and what (if any) human contemporary cognitive abilities have been exapted from the neural mechanisms of humor.

In an attempt to answer these questions, many theories have been proposed over the years. A review of those theories is presented in table 2.2.

This set of theories, taken as whole, present a shift in academic conceptualizations of humor translated by their emphasis of the place occupied by humor in the complex dynamics of human interaction. This idea is thus, a departure from more essentialist approaches to humor, traditionally preoccupied in highlighting *what* makes something funny (e.g., Linguistic and incongruity theories (Polimeni & Reiss, 2006).

TABLE 2.2. Overview of the central tenets of the main evolutionary theories of humor

Main proponents	***Main preposition***
Alexander (1986)	The main benefits of humor include: (1) raising one's status, (2) lowering the status of other individuals, (3) raising the status of designated listeners, thus increasing social cohesion among the joke teller and said designated listeners.
Weisfeld (1993)	The main function of humor is to provide social information. Laughter, in turn, provides pleasurable feelings to the joke teller and audience, which serve to reinforce this type of behavior.
Ramachandran (1998)	The main function of humor is to signal others that some type of incongruity or anomaly detected is harmless or trivial.
Barrett, Dunbar & Lycett (2002)	Given some similarities in terms of the release of endogeneous opiates, laughter is argued to be a replacement for social grooming (observed in primates).
Jung (2003)	The main function of humor is to facilitate collaboration. The fundamental property of humor is that it requires listeners to be able to attribute mental states to others.
Vettin & Todt (2005)	The primordial function of humor and laughter was to signal play.
Wood & Niedenthal (2018)	The main functions of humor are (1) to reward and reinforce the behaviors of others, (2) to dissipate tension and signal affiliation, and (3) punish undesirable behaviors by others by signaling superiority.

It is also in the context of these conceptualizations of humor, that the concept of *humor as social play* is introduced (Boyd, 2004; Todt & Vettin, 2005; Polimeni & Reiss, 2006). This conceptualization further emphasizes the social nature of humor by stating that its main functions revolve around the signaling of certain interactions as a form of play to others (Todt & Vettin, 2005), thus diffusing tension and reinforcing or punishing behaviors perceived as being desirable or undesirable by others (Wood & Niedenthal, 2018).

2.4. Humor in Psychology

Although many theories have been proposed on humor; many would still argue that the space occupied by humor in the Psychology literature remains void of general rules of humor. Scanning the brief overview of humor theories presented above, it should not be difficult to understand why that is the case. In fact, analyzing the extensive list of definitions that have been offered for humor presented in table 2.1, one must ask: What is the common denominator?

Some common threads seem to trespass the borders of different schools of thought (as is the case, for instance, of superiority and incongruity), to interweave a complex tapestry of ideas that presents a clearer image of some facets of humor. Reconciling these different threads into a clear image of humor, however, is still an ongoing effort.

The difficulty of this effort can be attributed in large part to the different approaches to humor that underlie each set of theories. For instance, linguistic and incongruity theories of humor tend to adopt an *essentialist* approach, being concerned mostly with answering the question of *what makes something funny.* In both of these cases, the answer appears to be incongruity, but where linguistics focus only on verbal humor, proponents of the incongruity theory expand that focus to other types of humor and add consideration of other aspects geared more towards the social component of humor (e.g., social norms, attitudes towards the target of the joke).

Relief theories (similar to superiority and evolutionary theories) differ from the previous as they are steered towards answering an entirely different question about humor. These theories seek to answer the question of *why we engage in humor.* Relief theorists will answer this question by stating that we engage in humor in order to release pent up tension - thus focusing on mostly intrapersonal mechanisms.

Superiority theorists, however, will go a step forward when answering this question. Proponents of this theory will argue that we engage in humor because it allows us to release tension and aggression outwardly by inflating our own social status or decreasing another's. This places the focus on interpersonal mechanisms rather than on intrapersonal ones.

This shift towards more social and interpersonal aspects of humor culminates in the answers given to the question of why we engage in humor by proponents of evolutionary theories of humor. The answer here being that we do so because humor presents (and has consistenly presented throughout our evolutionary path) important social advantages that include a greater sense of affiliation with others, a form of signaling play and a tool for regulating other's behaviors (either by reinforcing them or punishing them).

It is this wealth of definitions and approaches that make defining humor a daunting task. However, and although it is not our goal in this work to define humor, and many books could be -and in fact, have been- written in that attempt, we must here, for practical purposes, propose a *working definition.*

In this context, we define humor as a *form of communication* intended particularly to transmit social signs (either by rewarding desirable behaviors (easing tension and increasing affiliation) or by punishing undesirable ones (by signaling one's superiority)). This form of communication relies on (and distinguishes itself from other types of communication through) a set of linguistic foundations (that include lexical, syntactical aspects, phonological and delivery factors) that are particularly employed in humor production with the goal of achieving purposefully ambiguous communication. This ambiguous facet allows for the exercise of incongruity which is the content quality that provides humor its amusing quality, and is allowed in social terms, by a set of shared knowledge about the objects and artifacts of the joke. These processes are, at a biological level sustained by specific mechanisms and present specific outward (e.g., laughter) and inward (e.g., mirth) signs of expression.

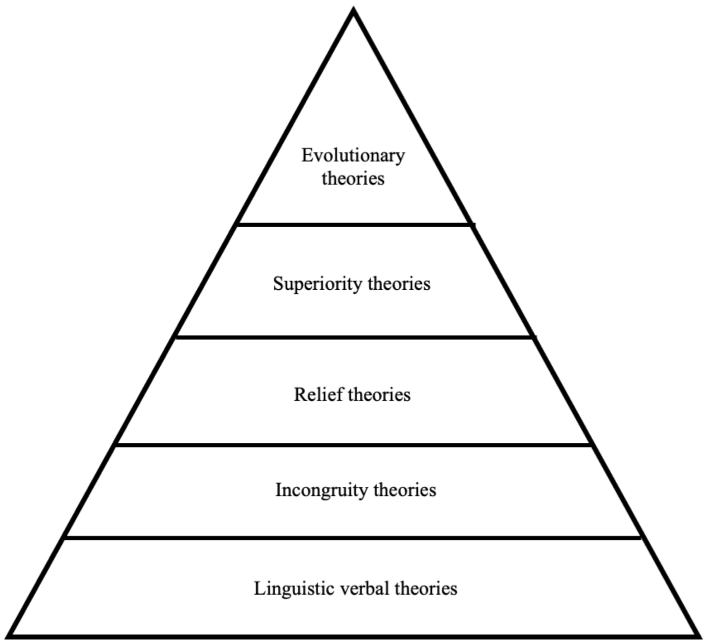


FIGURE 2.2. Overview of humor theories in terms of their scope and essentialist (bottom) or constructionist (top) approach to humor.

2.5. Challenges in humor research

Enough has - hopefully- been written thus far to convince the reader that the process of evolution of what humor *is* and *means*, as well as its specific framing within Psychology, has been a fascinating one. So much so, that the criticisms advanced by Berlyne at the beginning of this chapter, although at points harsh, might begin to seem justified.

Indeed, it was my own experience during the course of my Ph.D. to often find amusement and surprise from members of the academia and the lay public alike when disclosing that my academic studies are related to *humor*. Not that that surprise seemed to me to have any negative connotations - in fact, it was frequently followed by positive utterances expressing interest or originality-, but its mere existence indicated to me a certain instinct to perceive humor as a topic outside of science. Otherwise, why would the academic study of humor be worthy of surprise in the first place?

This realization was quickly followed by an understanding that, even in the academic context, humor was often considered to be at periphery of other more "important" aspects of social and psychological functioning. If on one hand, it is almost uncontested that humor is a desirable trait and a necessary ingredient for well-being and good mental health; on the other, it clearly lacks the type of systematical approach and popularity devoted to other psychological phenomena in the literature.

My conclusion that humor was the victim of some form of *"...enduring and persistent old prejudice"* (Roeckelein, 2002) (p.3) in mainstream psychology, however, was in no way novel or original (Ruch & Raskin, 2008), and support for it can be found in the work of several authors.

Roeckelein (2002), for instance, presented an interesting analysis of the psychological study of humor during the late 19^{th} and 20^{th} centuries. This author points out that in the first three volumes of *Psychological Abstracts*, published between 1927 and 1929, each one containing thousands of citations of psychological studies, only eleven references related to humor can be found. An analysis of those eleven references reveals, in turn, a profound lack of empirical and experimental focus of early psychological research on humor (Roeckelein, 2002).

Although this reality did not remain unchanged for long, as drastic increases in the production of humor research were observed in the following decade with noticeable further explosions in the 70's and 80's, humor remained conspicuously absent from Psychology textbooks published during the 20^{th} century. A review of 136 Psychology textbooks published between 1885 and 1996, yielded only three references to the subject of humor (Roeckelein, 2002).

This quiet absence of humor in early Psychology[2] literature screams, perhaps, to the challenges that its academic pursuit carries. Being difficult to define, also means that humor is often difficult to operationalize in a way that conforms to scientific standards.

For instance, one prevalent limitation found in many empirical studies aimed at investigating humor is the lack of consistent control or analysis over the comedic content, which is frequently generated and categorized by the researchers themselves, albeit with good intentions.

Similarly, others have pointed out that the hedonic nature of humor offers, by itself, a roadblock to experimental endevours:

> Typically, many human activities lend themselves readily to experimental research where individuals respond because they are aroused by hunger, anger, sex, or anxiety, but humor—in contrast—relates to the environment in nondrive or nondeprivation ways where one's cognitive and interpersonal competence skills and activities are focal points
>
> Roeckelein, J. (2002, p. 1)

Furthermore, while the aforementioned definitions of humor (refer to Table 2.1) may seem abundant, it is important to note that in numerous cases, particularly in earlier works, authors only briefly addressed humor as a constituent of a broader subject of inquiry, namely human nature. This circumstance was further compounded by the limited inclination of earlier philosophers and intellectuals to engage in empirical investigations, resulting in many of the assumptions they made—thus significantly shaping subsequent theoretical endeavors—remaining obscured or unexamined.

The resulting maze of definitions, conceptualizations and speculations on the psychological and physical correlates of humor, thus, became very hard to navigate. Although

[2] It is important to note here that this is not a specific criticism of Psychology in general; as similar criticisms have been raised in other social sciences, such as Anthropology (Apte, 1985) and Sociology (M. S. Davis, 1995).

this did not provide an encouraging start, some psychologists, however, were not dissuaded by it and went on to produce a wealth of literature that explored the concept of humor in the context of many different sub-fields of Psychology.

Those efforts eventually made this thesis possible.

2.6. Conclusion

As we conclude this second chapter, it is essential to underscore the following point: while the criticisms articulated earlier regarding humor research accurately portray the current state of the field, it is equally important to recognize the significant advancements that have been achieved in recent years. It would be remiss of me not to acknowledge that this thesis itself is bolstered by a substantial body of literature and empirical investigations focused on humor. Although certain limitations exist, these scholarly contributions, in my view, reflect an increasing interest in psychological phenomena encompassing creativity, curiosity, and hedonic motivations.

The limitations highlighted within the broader context of research presented in this chapter serve two purposes: first, they provide a comprehensive overview of psychological investigations on humor, and second, they justify the deliberate emphasis placed on implementing methodological safeguards (as detailed in Chapter 4) and the substantial investment of time in organizing research concerning the influence of humor on psychological and physical well-being (as discussed in Chapter 3), before delving into the applied perspective of technology acceptance and perception.

It has also been made clear thus far how the concept of humor evolved through time, adopting new meanings and connotations in the eyes of academics and lay people alike. I can not determine, with any quantitative degree of accuracy, the extent to which these early views and social conceptions of humor and laughter influenced the thinking of early academics; but it seems clear, nonetheless, that such influences are present in the writings of contemporary thinkers.

Neither can I speak as to the why of the shift towards a more favourable perception of laughter that started to take place in the past three centuries- the one we are familiar with today -; except to say that it did (Wickberg, 1998; Carrell, 2008).

In fact, there is no shortage of extraordinary claims about the healing powers of humor and laughter in scientific and non-scientific literature - however these claims often appear to be exaggerated with thin empirical support. It was for this reason I chose to take the extra step to carefully and systematically review the existing literature on the effects of humor and laughter in physical health and well-being (as described in chapter 3).

A more in-depth exploration of how humor (and other hedonic variables) connects to theories on technological acceptance is developed in chapter 4, presenting a bridge between the topics of humor, technology acceptance, and social robotics.

This journey along the path that connects humor research to technology acceptance and perception culminates in two main studies, devised particularly to investigate our hypotheses regarding the beneficial impact of humor on technology acceptance.

CHAPTER 3

Is humor the best medicine?

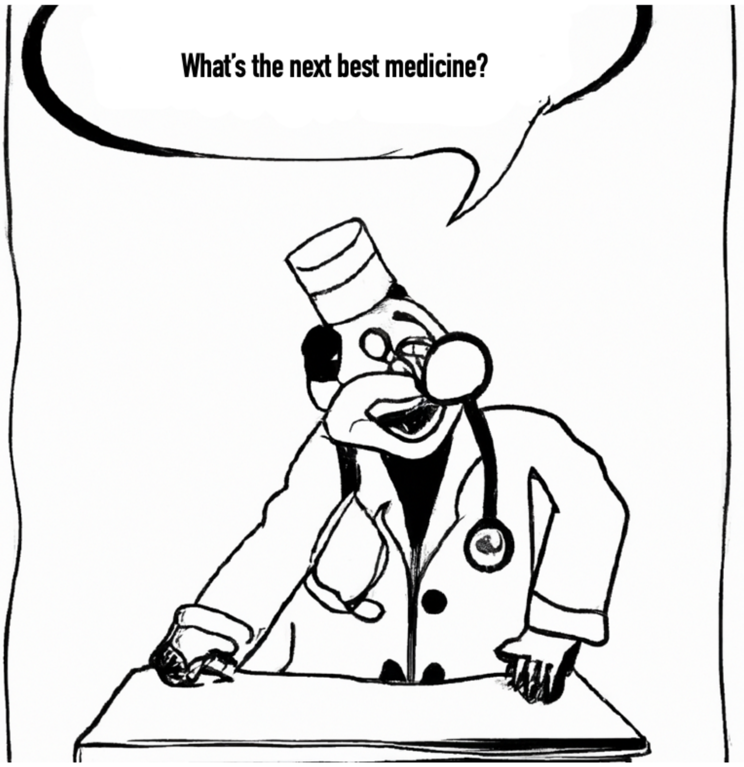


Image generated using DALL-E 2 (https://openai.com/dall-e-2), on August 2023, depicting a clown doctor wondering "What's the next best medicine?".

Abstract

In this chapter, we present two systematic reviews conducted with the goal of gaining a better understanding about the effects of humor on health and well-being. The first of those reviews focused on exploring the association between different humor conceptualizations and well-being. The second review focused on exploring the association between humor-based and laughter-based interventions on indicators related to cardiovascular health (namely, blood pressure, heart-rate variability, and longevity). In terms of cardiovascular health, although some benefits were observed in within-subjects comparisons of individuals who participated in laughter-inducing interventions, those benefits dissipated entirely when analyzing the results of between-subjects controlled studies. This review also found a pattern of decreases in both time and frequency-domain indicators of heart activity, coupled with a positive association with overall longevity. In terms of well-being, our review found a consistent positive association between different humor conceptualizations and psychological well-being. Overall, the findings of these reviews offer mixed support for the hypotheses that humor is positively associated with good health.

3.1. Humor and social, psychological and physical well-being

Although it is not yet clear what are the evolutionary origins of laughter, and the exact nature of its relationship with humor (Gervais & Wilson, 2005), previous studies have emphasized its social component as a core attribute (Wood & Niedenthal, 2018). For example, we are approximately 30 times more likely to laugh when in the company of others than when we are alone (Provine, 2004; Provine & Emmorey, 2006), and observational studies examining interpersonal conversations indicate that laughter occurs very frequently (at an approximate rate of 5 laughters per 10 minutes of conversation; (Vettin & Todt, 2004)).

In addition to its social ubiquity, humor and laughter have been associated with several positive outcomes that span from strengthening social bonds (Wood & Niedenthal, 2018), to improving mental (J. Yim, 2016; Savage, Lujan, Thipparthi, & DiCarlo, 2017) and physical health (Mora-Ripoll, 2011). As a reflection of the recognition of its importance, researchers have proposed and developed several models that emphasize both the individual and interpersonal facets of humor.

As an individual trait, research on sense of humor has focused on how different individuals behave, experience, engage, perceive and feel about amusing and humorous situations in general (Ruch & McGhee, 2014). Similarly, humor orientation has been defined as the extent to which individuals present *"...differences in the[ir] disposition to enact humorous messages"* (Booth-Butterfield & Booth-Butterfield, 1991, p. 32).

Both sense of humor and humor orientation have been suggested to produce or be associated with intra (such as reducing anxiety, (Yovetich, Dale, & Hudak, 1990); fewer headaches (Curran, Janovec, & Olsen, 2021)) and interpersonal beneficial effects (lower levels of loneliness (Curran et al., 2021); increased satisfaction and cohesion in a relationship (Maki, Booth-Butterfield, & McMullen, 2012)).

The extent to which individuals use humor as a coping mechanism (i.e. a strategy to deal with adversities) has also accrued a lot of academic attention, in particular regarding its association with positive personal (such as, decreased burnout (Talbot & Lumden, 2000), and stress (Abel, 2002)) and social outcomes (including, time spent with others, perceived pleasurableness and confidence in interactions with others, (Nezlek & Derks, 2001).

Similarly, a more recent conceptualization of humor as a character strength (i.e., *"[a] unipolar and unidimensional strength (...) [that] is subsumed under the virtue of transcendence"*, Müller & Ruch, 2011, p. 368), identifies humor as being one of the highest endorsed character strengths (N. Park, Peterson, & Seligman, 2006) and one of the character strengths that shows a higher correlation with subjective well-being and life satisfaction (C. Peterson, Ruch, Beermann, Park, & Seligman, 2007; N. Park, Peterson, & Seligman, 2004). Besides being an individual character strength, other authors have focused on the more social aspects of humor by considering individual differences on how people use humor in their daily lives (i.e., humor styles).

These styles of humor organize humor usage in four dimensions according to the valence (positive or negative) and the target (oneself or others) of the humor, resulting in four humor styles: affiliative (positive and directed at others), self-enhancing (positive and directed at oneself), aggressive (negative and directed at others) and self-defeating (negative and directed at oneself). Positive styles of humor have been extensively linked to positive outcomes, including greater self-esteem, well-being and social support (R. A. Martin, Puhlik-Doris, Larsen, Gray, & Weir, 2003).

Comic styles, unlike humor styles, focus on the lower-level aspects of humor (i.e., its content, form, structure, modality and degree of refinement), and are based on classical literature on humor (Ruch & Raskin, 2008). The eight comic styles include fun, humor, nonsense, wit, irony, satire, sarcasm, and cynicism, and have, as other facets of humor, been observed to have positive relations with several character strengths (Ruch, Heintz, Platt, Wagner, & Proyer, 2018), well-being and decreased worry (Dionigi, Duradoni, & Vagnoli, 2021).

3.1.1. Humor and well-being

The concept of well-being has been notoriously difficult to define due to its *"intangible and amorphous"* nature (Kiefer, 2008, p. 244). In general, well-being has been broadly defined as an umbrella term which encompasses factors related to psychological, physical and social well-being (Kiefer, 2008).

The psychological component concerns how people evaluate and judge the quality of their lives (Keyes, 2007). According to Ryff (1989), one of the main theorists on well-being, it includes dimensions such as self-acceptance, positive relations with others, autonomy, environmental mastery, purpose in life, and personal growth. However, other authors have extended this definition by arguing for the importance of variables such as self-esteem (Solomon & Kernis, 2006), life satisfaction (Vladisavljević & Mentus, 2019; Diener, Oishi, & Lucas, 2002) and happiness (Hills & Argyle, 2002).

The physical component concerns the ability to perform physical activities, as well as social roles not hindered by physical limitations and experiences of bodily pain, and it can also comprise biological health indicators like overweight and chronic illness status (Capio, Sit, & Abernethy, 2014; Doll, Petersen, & Stewart-Brown, 2000).

Finally, the social component focuses on the quality of the relationships with other people and society, like the perceived social support from family and friends (Canty-Mitchell & Zimet, 2000) and social adjustment/functioning (McDowell, 2006). It includes dimensions such as extension of the social network, provision of instrumental support, and perception of support adequacy (Canty-Mitchell & Zimet, 2000).

The idea that humor has beneficial effects in one's health is neither new nor obscure. Over the years, a lot has been speculated regarding the relationship between humor, laughter and well-being (Gonot-Schoupinsky & Garip, 2018). In particular, in the context of positive psychology, which is the field of psychology dedicated to investigating how *"(...) positive subjective experience, positive individual traits, and positive institutions promise(s) to improve quality of life and prevent the pathologies(...)"* (Seligman & Csikszentmihalyi, 2014, p.5). Several theories have been proposed to explain the mechanisms through which positive emotions and states (such as humor) contribute to improving well-being and improving individual's lives (for an overview, see table 3.1).

Although these theories differ in many important aspects, the idea that positive states, emotions or values are positively associated with well-being and with desirable outcomes for individuals seems to be common ground among them (Seligman & Csikszentmihalyi, 2000). This, in turn, is congruent with findings from past research on the beneficial effects of humor and laughter.

For instance, in accordance with the hypotheses based on the Broaden-and-Build theory (Fredrickson, 2001, 2004, 2013), humor has indeed been linked consistently to improved social outcomes, such as greater relationship satisfaction (Butzer & Kuiper, 2008; Cann & Collette, 2014; Hall, 2017), and to improved psychological outcomes such as stress reduction (Abel, 2002).

However, each theory also requires different conceptualizations of humor. Indeed, as with the conceptualization of well-being, a consensual definition of humor is also difficult by its amorphous and multifaceted nature. Humor has been conceptualized as a coping mechanism (Nezlek & Derks, 2001), a character strength (K. R. Edwards & Martin, 2014), an individual trait (Wrench & McCroskey, 2001) and as a specific situational response (R. A. Martin & Lefcourt, 1984).

In addition, due to its complexity, humor also involves different responses and mechanisms, including specific cognitive (e.g., humor detection and appreciation), emotional (e.g., mirth) and behavioral (e.g., laughter) responses and processes. Despite, or perhaps

Table 3.1. Summary of positive psychology theoretical approaches to the relation between positive emotions and states, and well-being based on Oades & Mossman (2017).

Theory & Main premise	**Main proponents**	
Broaden-and-build theory	Positive emotions and states increase people's thought-action repertoires and thus promote exploration and discovery of creative ideas, actions and social bonds, which in turn contribute to building an individuals' personal resources (physical, social, psychological).	Fredrickson, 2001, 2004, 2013
Psychological well-being theory	Psychological well-being goes beyond the absence of having something negative, rather it depends on the presence of positive qualities, namely growth, positive relationships, autonomy, purpose, and environmental mastery.	Ryff, 1989; Ryff & Keyes, 1995
PERMA theory	There are five main pathways to well-being: positive emotions, engagement, positive relationships, meaning and accomplishment.	Seligman, 2018
Character strengths theory	Individuals have a set of character strengths that are associated with subjective well-being.	Park, Peterson & Seligman, 2004; Peterson & Seligman, 2006

due to this complexity, literature still lacks an integrative and comprehensive model that connects these different facets and mechanisms of humor. The conciliation of these different facets of humor is, however, particularly important when considering efforts devoted to systematically mapping its effects on individual variables, such as well-being.

3.1.1.1. *The Present Review* The scant attention given to laughter and humor within positive psychology, as well as a pattern of limitations (e.g., insufficient sample sizes, inconsistent operationalizations, lack of control of potential confounds) in studies investigating these phenomena, as noted in previous systematic reviews (Gonot-Schoupinsky & Garip, 2018), leave an important gap in our understanding of them. With this review, we seek to contribute to bridge that gap by investigating and systematically summarizing primary evidence regarding the association between laughter, humor and well-being. We argue that this contribution is an important step in fomenting future research.

In this context, some reviews and meta-analyses have already been conducted with the goal of investigating the relation between humor (and its different components) and well-being. More specifically, a recent meta-analysis has suggested that positive styles of humor (namely, self-enhancing and affiliative) are positively associated with subjective well-being, whereas negative styles of humor (self-defeating and aggressive) are negatively associated with that variable (Jiang et al., 2020; R. A. Martin et al., 2003).

This review also showed that these relations between humor styles and subjective well-being are not moderated by either age or culture. Our review seeks to confirm and extend the findings of this review by looking at different measures of humor, and by considering the potential effects of humor on different facets of well-being.

Furthermore, one review has also been conducted with the goal of investigating the effects of laughter and humor interventions on well-being on an elder population (Gonot-Schoupinsky & Garip, 2018). This review found beneficial impacts associated with the interventions in at least one of the metrics of well-being employed in all of the studies included. Our review extends this work by considering a wider population of individuals in terms of age and also by investigating the associations of other concepts related to humor, such as sense of humor and styles of humor.

3.1.2. Goals

The goal of this review is twofold. First, we seek to investigate the pattern of association between humor and social, psychological and physical well-being in adult individuals (i.e., $<$ 18 years old). Second, we aim to systematically review studies on the effects of laughter-inducing-interventions in social, psychological and physical well-being.

3.1.3. Method

3.1.3.1. *Search strategy* Our search was conducted in the following databases: PubMed, Scopus, Web of Science (WoS), PsycARTICLES, Science Direct (SD) and Google Scholar. After the relevant articles were identified through this search, we also analyzed potential relevant references within each article. In congruence with our aforementioned goals, we used the following keywords and boolean operators in our search:

> (Humor* OR Jok* OR laughter OR sense of humor OR humor style*) AND (well-being OR wellbeing) AND (mental OR psycholog* OR social* OR physical). The search and extraction was conducted by two independent individuals and was last conducted on June, 14th, 2021.

3.1.3.2. *Inclusion and exclusion criteria* We included only peer-reviewed articles published in journals or scientific conferences, in English, Spanish or Portuguese, until january 2021. In addition, we only considered publications that reported the results of original empirical research related to our goals, involving human adult participants (i.e. ¿18 years old). We excluded extended abstracts, "work-in-progress", study protocols and workshop presentations.

3.1.3.3. *Data collection, extraction and coding* Data collection, extraction and coding were conducted by two independent individuals. The coding schemes and analysis strategy were discussed and defined a priori among all the authors, and later disagreements between reviewers were resolved through joint discussions.

After all the articles returned by the search query were extracted, the two coders scanned all the titles and abstracts and removed all articles that did not fit the exclusion criteria and duplicates.

Then, all of the remaining articles were randomly divided between the two reviewers, who analyzed each one according to the coding scheme developed. This coding scheme included the following information regarding the extrinsic characteristics of each study: (a) title, (b) year of publication, (c) abstract, (d) country (as inferred by the affiliation of the first author), (e) approval by an ethics committee), as well as the intrinsic characteristics: such as (f) type of study (e.g., experimental), (g) type of study design (between/within-subjects), (h) presence of a control group and details about the control and experimental group's activities or interventions (including a description of said activities, duration, frequency, human or technology-based delivery), (i) independent and (j) dependent variables, (k) the metrics used, (l) demographic characteristics of participants (age (M, SD), health status), and (m) summary of the main findings.

One third of the articles coded by each reviewer was then randomly selected and assigned to the other reviewer for an agreement evaluation. The process of data collection and extraction can be consulted in fig. 3.1. After disagreements were resolved, the final database of articles was completed and we proceeded to conduct quality, bias and certainty in evidence evaluations according to PRISMA guidelines (Page et al., 2021).

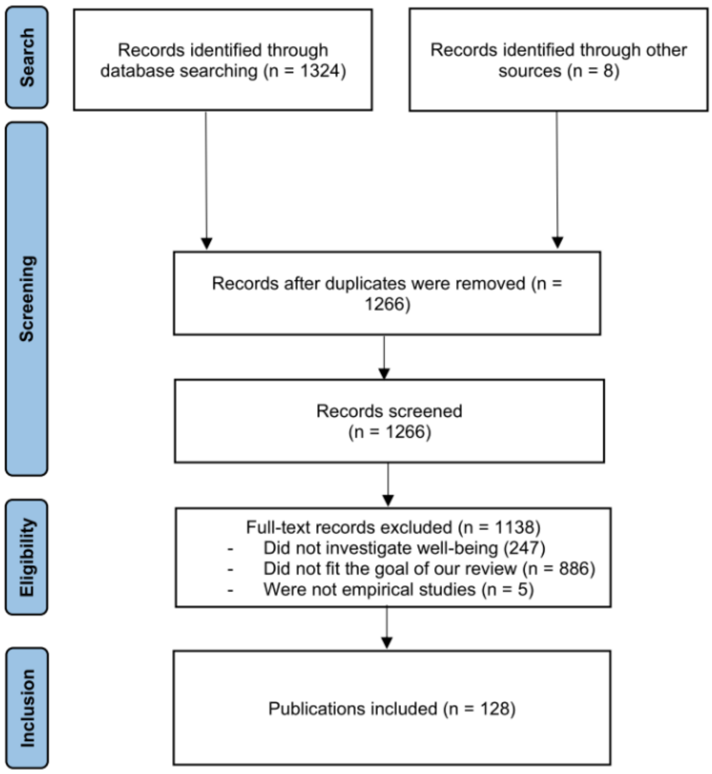
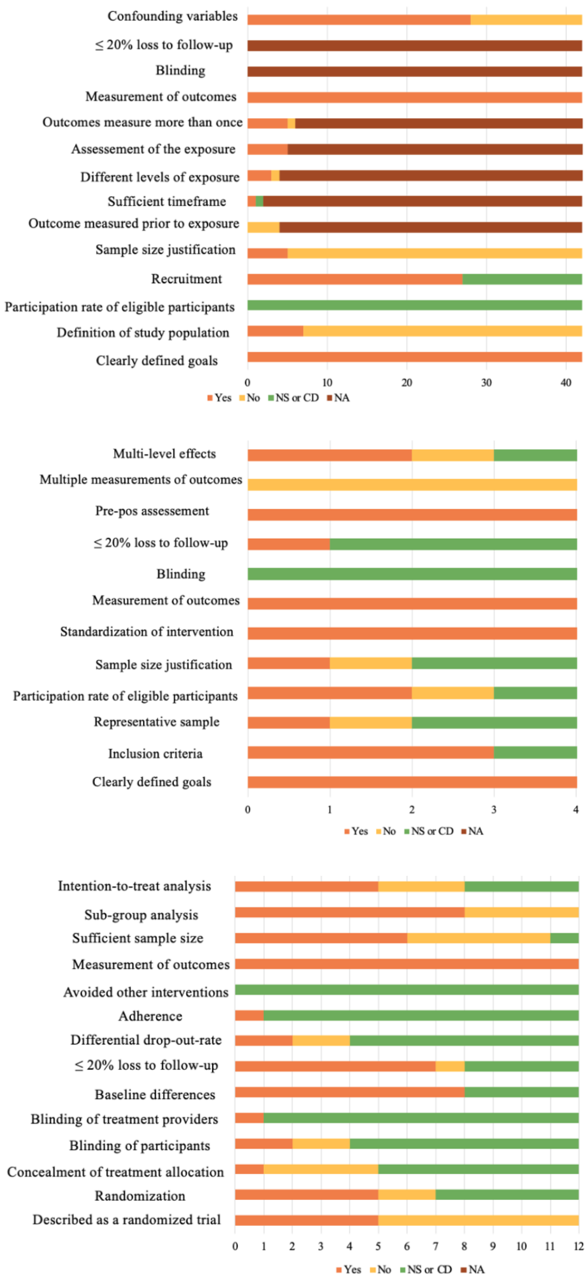


FIGURE 3.1. PRISMA diagram detailing the search and inclusion process.

3.1.3.4. *Quality assessment* Quality assessment was conducted using the study quality assessment tools developed by NHLBI (National Heart, Lung and Blood Institute). This toolbox includes different quality assessment instruments specific to certain study designs. As such, and based on our goals, the studies collected were divided into three main clusters according to their design: (1) experimental and quasi-experimental, (2) pre-post comparisons without a control group and (3) cross-sectional. For each cluster of studies, the appropriate quality assessment tool was used. The outcomes of this assessment are presented in figure 3.2.

FIGURE 3.2. Summary of the quality assessment of studies involving (a) correlational, (b) pre-post without a control group (c) and pre-post with a control group design.



3.1.3.5. *Risk of Bias* Risk of bias was assessed using the RoB 2 tool (randomized trials), the ROBINS-I tool (non-randomized intervention studies) and the categories proposed by Wang et al. (2006) for the non-randomized studies. Visualizations of the outcomes of the assessment are presented in figure 3, and were produced using the robvis tool (McGuinness & Higgins, 2021).

FIGURE 3.3. Results of the risk of bias assessment for randomized studies (organized alphabetically).

3.1.4. Data Analysis

According to our goals, the results will be presented separately for each outcome, and for each facet of humor being considered. Different variables related to well-being were extracted from each study and then grouped together into clusters according to their relation to psychological, physical, social and general well-being, and their classification of them made by each study's author. The clusters of variables and their respective composition are presented in figure 3.4.

Regarding the different facets of humor explored in the 43 correlational studies included, the majority included humor styles ($k = 26$), sense of humor ($k = 7$) and humor as a coping mechanism ($k = 4$). Two studies looked at humor as a character strength, one study looked at comic styles, another at humor orientation, and another two involved more than one facet (sense of humor and coping humor). This smaller subset of studies was included in the analysis in an attempt to provide a more comprehensive overview of the research on the link between humor and well-being. The remaining studies (pre-post comparisons with and without control groups) investigated the impact of humor ($k = 11$) or laughter ($k = 5$) interventions on well-being.

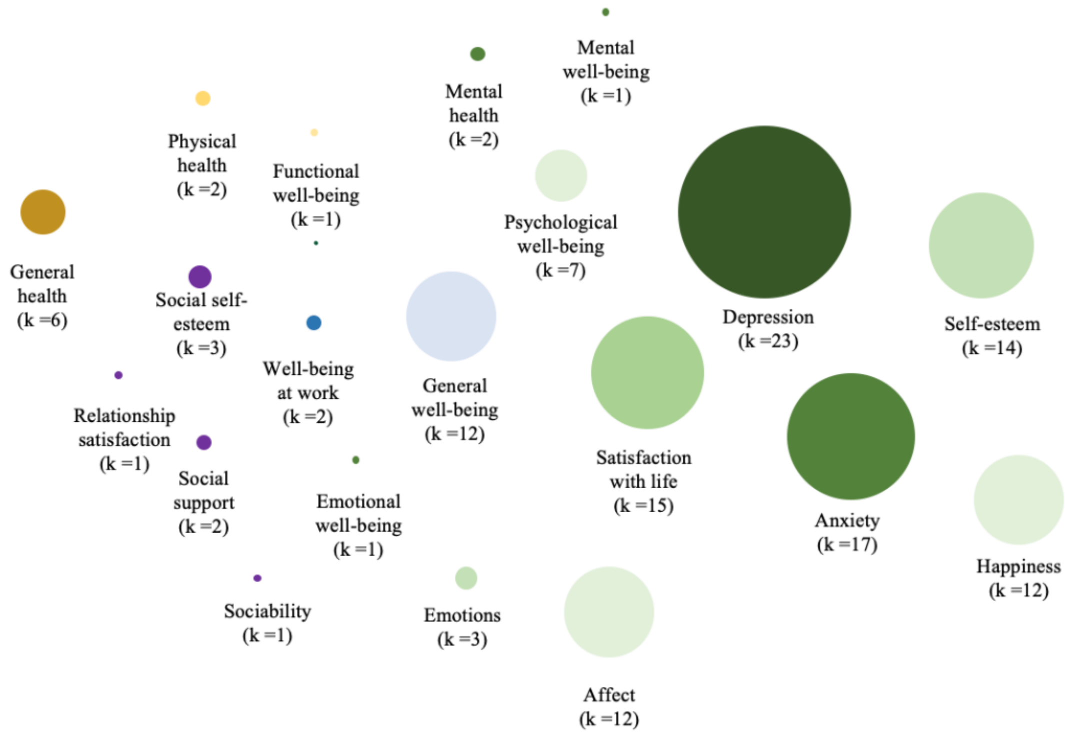


FIGURE 3.4. Distribution of studies according to main independent variables.

When one article reported results for more than one independent group of individuals (e.g., hospitalized individuals and their parents/spouses), the findings for each group were considered separately. Because of the variety and diversity of measures used in each study, a meta-analysis was not conducted. Instead, we labeled each main outcome of interest in each study as supporting, partially supporting (mixed), or not supporting the link between humor and well-being. Statistically non-significant results were also recorded and included in the analysis.

3.1.5. Results

3.1.5.1. *Descriptive analysis of Extrinsic Characteristics* The studies included originated mostly from Western countries (specifically from North American and European continents; see fig. 3.5).

A detailed reporting of the socio-demographic characteristics of the participants in the studies included can be consulted in table 3.2.

3.1.5.2. *Humor Styles and Well-being* Most of the studies reported a positive relation between positive humor styles (i.e., affiliative and self-enhancing) and psychological, social, and general well-being, with psychological well-being being the most predominantly explored category ($k = 21$; see fig. 3.4).

In addition, the studies suggest a relationship between self-enhancing humor and well-being ($k = 3$), but offer poor support for a link between any of the other humor styles

FIGURE 3.5. Heat map of the geographic distribution of the studies included (as inferred from the affiliation of the first author)- the color scheme denotes the number of studies from each region.

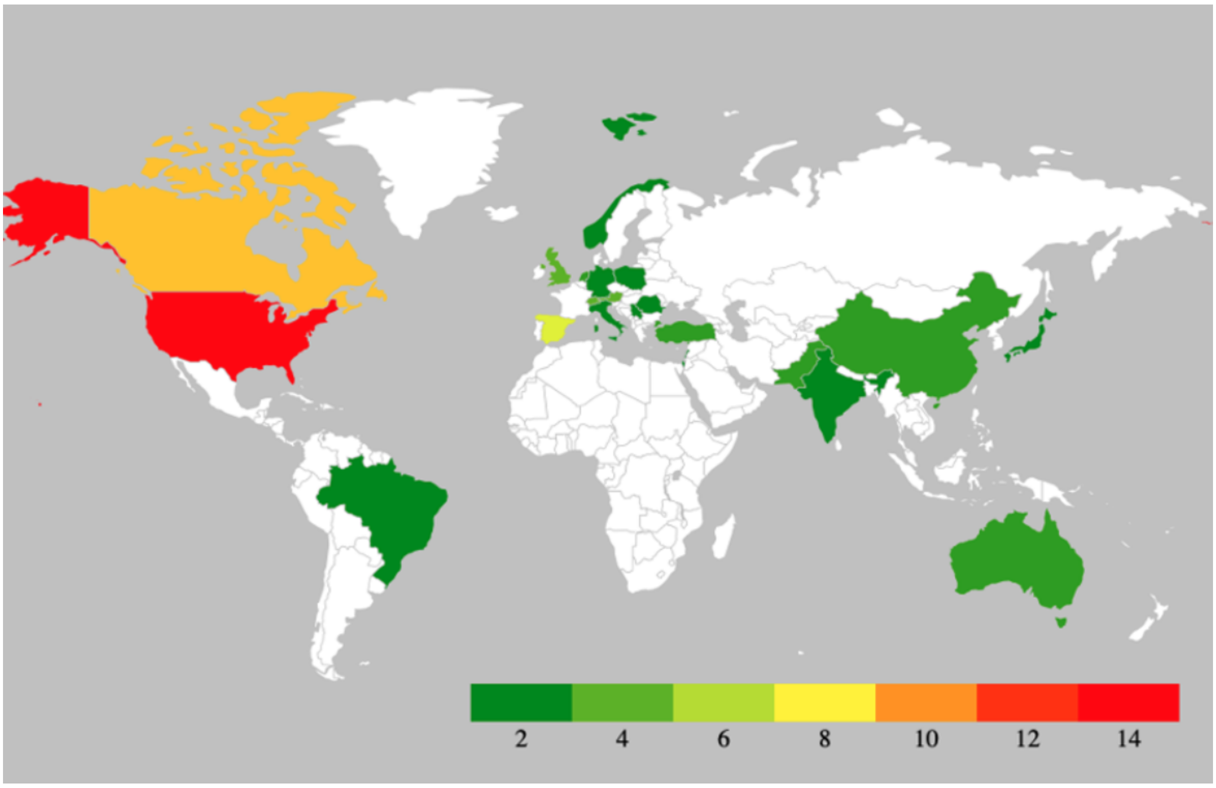


TABLE 3.2. Sociodemographic characteristics of participants.

		M ± SD		
Age		37.85 ± 17.70		
		Number of studies	Number of participants	Percentage
Age range	18-29	23	7901	45%
	30-39	9	1714	10%
	40-49	11	5172	29%
	50-59	8	517	3%
	<60	5	570	3%
	Unclear	NA	1667	10%
Sex	Female	NA	9953 (at least)	57%
	Total	58	17541	100%

and well-being. Aggressive humor does not seem to be significantly associated with any of the dimensions of well-being explored. However, self-defeating humor was observed to be negatively correlated with psychological well-being in most of the studies included.

3.1.5.3. *Sense of humor* Most of the studies considered psychological well-being, and found evidence that supports a positive link between sense of humor and that variable. Notably, none of the studies investigated the relation between sense of humor and physical, social, emotional and general well-being. Humor as a coping mechanism Humor as a

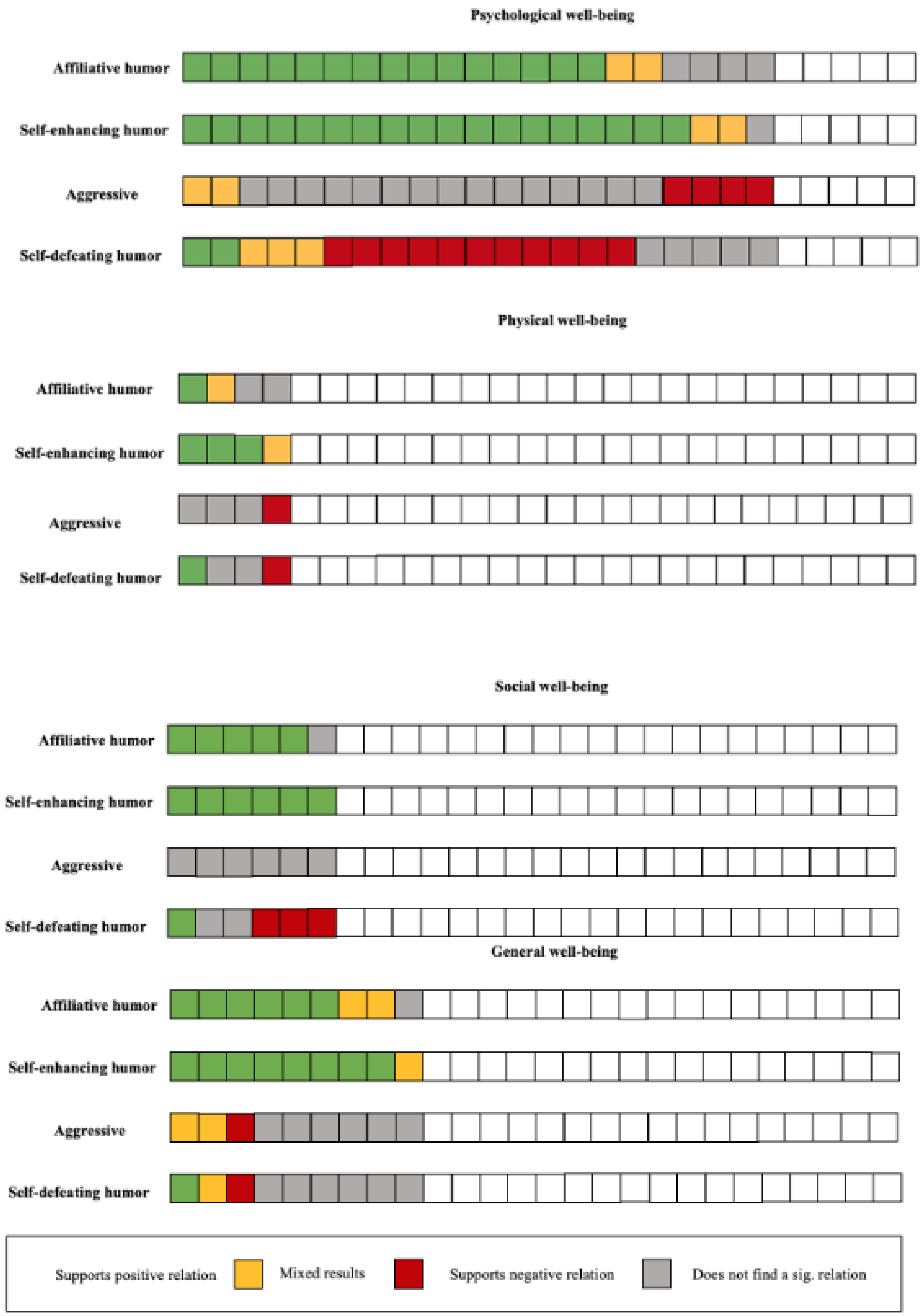


FIGURE 3.6. Summary of the evidence, supporting, not supporting or providing mixed evidence on the association between humor styles and psychological, physical, social and general well-being.

coping mechanism has been observed to have beneficial effects on psychological well-being, and in general well-being to a lesser extent. Evidence of the effects of humor in emotional well-being suggest a mixed or negative relation between the two. Similar to what was observed for sense of humor, we found a lack of studies investigating the relationship between the use of humor as a coping mechanism and physical and social well-being.

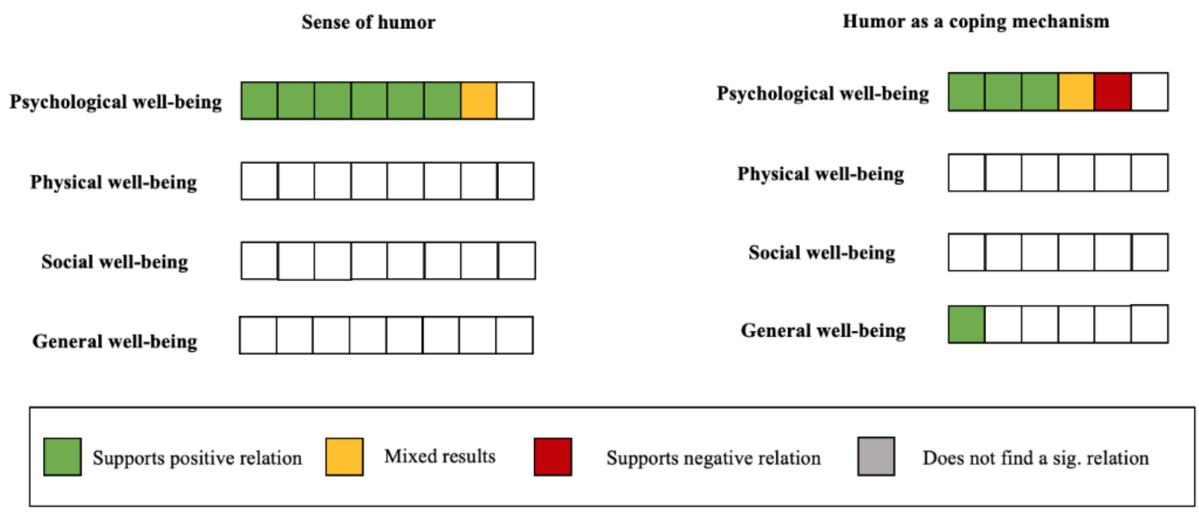


FIGURE 3.7. Summary of the evidence, supporting, not supporting or providing mixed evidence on the association between sense of humor and humor as coping mechanism and psychological, physical, social and general well-being.

3.1.5.4. *Humor as a character strength* As a character strength, the studies included suggest either a positive ($k = 1$) or mixed ($k = 1$) relation between humor and psychological well-being. No associations with other types of well-being were apparent in the literature analyzed.

3.1.5.5. *Comic styles and humor orientation* The study included for comic styles reports a positive relationship between the use of specific comic styles and psychological and general well-being. Humor orientation was positively correlated with psychological well-being. No other relations with other types of well-being were found for these variables.

3.1.5.6. *Laughter and humor interventions* Both humor and laughter interventions were found to be associated with predominantly positive effects in psychological well-being. One study found that laughter interventions were linked to improved physical well-being, but no studies were found investigating the relationship between humor interventions and physical well-being. Both humor and laughter interventions were found to be linked to social well-being in one study each. Laughter interventions were associated with improved general well-being in one study. Humor interventions were found to be positively associated with general well-being in three studies, and mixed evidence was found in one study. Two studies found no significant link between participation in humor interventions and general well-being.

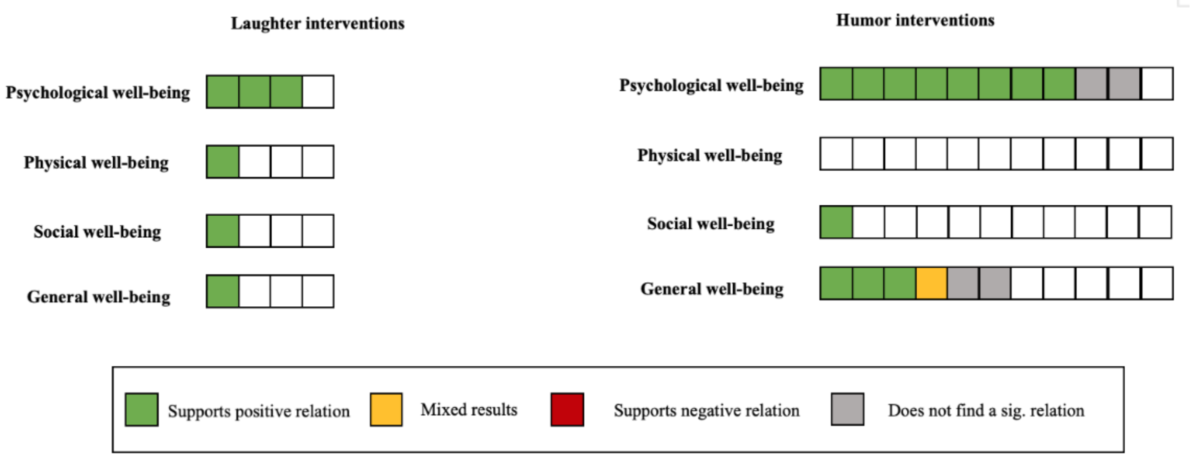


FIGURE 3.8. Summary of the evidence, supporting, not supporting or providing mixed evidence on the association between laughter and humor interventions and psychological, physical, social and general well-being.

3.1.6. Discussion

Humor is a pleasurable and inescapable way to interact with others and with the world around us. However, its common, pervasive and malleable nature, as evidenced by research and by our daily experiences with it, do not lend humor the simplicity of straightforwardness that one might need when attempting to comprehend it and track its effects and associations.

This review largely confirmed previous findings regarding the existence of an association between some components of humor and psychological well-being. In this sense, of all the components of humor analyzed here (sense of humor, humor orientation, humor as a coping mechanism, humor as a character strength, humor styles and comic styles), humor styles seems to be the most extensively studied, with results supporting the thesis that positive styles of humor (affiliative and self-enhancing) are positively associated with psychological well-being.

In addition, most of the studies analyzing the associations between sense of humor, and humor as a coping mechanism with psychological well-being also supported a positive relation between these variables (although these variables were much less well-represented in the literature when compared to humor styles). Similarly, social well-being and general well-being were found to be positively associated predominantly with positive humor styles. Regarding the effects of humor in physical well-being - which out of all the components of well-being, was the least predominant in the literature analyzed-, results suggest that positive styles of humor (in particular, self-enhancing humor) have a positive association with greater well-being. No consistent association between any other styles of humor and physical well-being was observed; and no other studies regarding other components of humor with this variable were found.

Both laughter and humor-based interventions yielded largely positive results across all dimensions of well-being analyzed. Similarly to what described above for the humor components, the research analyzed focused mostly on the association between these interventions and psychological well-being.

3.1.6.1. *Limitations and future work* There are many challenges inherent to the scientific study of humor. Most evidently, the lack of validated material that can be applied consistently across different samples hinders the generalizability of the results observed in some of the studies included. This issue is aggravated by a lack of methodological fail-safes, such as the implementation of manipulation verifications and the assessment and control of individuals' perception of the humorous material used. Moreover, among the studies included in this review, we found that sharing the materials used through its inclusion in the supplementary materials or by using open science platforms was not a common practice. This limitation emphasizes the importance of developing and evaluating datasets of humorous material, that allow humor researchers a greater degree of control over their experimental settings.

In addition, most studies included did not control for other important state variables that were likely to affect individuals' responses and perceptions of humorous materials (e.g., mood, Yoon, 2018). Given that most studies relied on convenience samples (as opposed to probabilistic samples), the potential effects of confounding variables (such as mood) need to be better understood or controlled for in future studies.

As evidenced by the geographical distribution of the studies included in this review (see fig. 2), and as noted in previous publications (Jiang et al., 2020; Elshakry, 2010), the existing research reflects mostly a Western and European perspective. Although a previous review could not find a moderating effect of culture on the association between humor (in particular, humor styles) and well-being (Jiang et al., 2020), there are important aspects to consider before discarding a possible cultural influence.

Firstly, we must consider the possibility of an ambivalent perspective on humor in Eastern cultures explained by the contradictory views on humor of two of some of the most common philosophical and religious beliefs (i.e., Confuncian philosophy and Taoist and Buddhist teachings; (Jiang et al., 2020), and the possibility that the disproportionate distribution of studies looking at the relationship between humor and well-being (favoring Western perspectives) might itself complicate the task of investigating a potential moderating role of culture (Jiang et al., 2020).

Second, and looking beyond humor styles, we must consider that there are several studies that suggest potential cultural differences in other facets of humor such as sense of humor (G. N. Martin & Sullivan, 2013), as well as the existence of different perceptions on humor itself (X. Yue, Jiang, Lu, & Hiranandani, 2016). This fact raises two particularly important questions. The first regards the ability of current instruments to adequately reflect, and hence gauge, subjective factors related to humor, and originates from the recognition of the fact that many of the most prominent humor scales are developed and tested with Western populations. The second regards the importance of specific cultural values and their interaction with specific humor-related components. In particular, although it is assumed that humor is a universal type of behavior or trait, some would argue that its meaning is not universal (Suoqiao, 2007). The extent to which these differences in meaning relate to different levels of desirability and understanding of different conceptualizations of humor (e.g., humor as a coping mechanism, sense of humor), however, still warrants further research

Humor in all its shapes is beneficial for psychological well-being; however the question of if and how it positively affects physical, social and general well-being is still far from resolved. Through this review, we identified many gaps in the literature that can provide interesting avenues for future research, and benefit our understanding of humor both by increasing its span and quality. Firstly, we would like to call for more research examining the potential association between humor components and physical and social well-being. Previous research has shown that humor has both physiological substrates (Scott, Lavan, Chen, & McGettigan, 2014) and consequences (Oliveira & Arriaga, 2022), that can be leveraged to improve the health and well-being of individuals in a cost-effective way, that is straightforward to implement and with few negative side effects in clinical settings.

Although the studies presented limited evidence (due to their limited scope and quantity), some positive associations between some humor components and interventions and social and physical well-being were still observed. More research is needed to confirm and further explore these positive associations.

Finally, we would like to emphasize the need for more research that takes a more holistic approach to the effects of humor, both by analyzing more extensively the association between other (than humor styles) components of humor and well-being, but also by attempting to model how (and if) different components of humor contribute in different ways (or through different mechanisms) to well-being.

3.2. Humor and physical health

Positive psychology is a sub-field of psychology that is concerned with identifying, developing and evaluating interventions aimed at improving well-being and health (Carr et al., 2021; Seligman & Csikszentmihalyi, 2000). Positive psychology interventions can impact well-being through diverse pathways, including enhancing relationships, promoting meaning and purpose and promoting positive and enriching experiences (Carr et al., 2021; Seligman & Csikszentmihalyi, 2000). In this context, humorous interventions have been shown to have a small to medium positive effect on well-being and reducing depression symptoms, and a large effect on increasing character strengths and reducing anxiety and stress (Carr et al., 2021).

Congruently, it has also been theorized that intense emotions, despite their content, lead to activation of the sympathetic nervous system (Bennett & Lengacher, 2008). In a study conducted by (Averill, 1969), the author observed that while sad and humorous stimuli led to an increase in galvanic skin responses, only sad stimuli were associated with increased blood pressure, suggesting that humor could help buffer some of the negative effects associated with sympathetic intervention.

Other theories have also, more generally, stressed the beneficial impact of positive emotions on physical health. In this context, positive emotions are thought to improve health by reducing the duration of negative emotional states, which due to their association with heightened and prolonged cardiovascular activation, have been implicated in the emergence of heart disease (Blascovich & Katkin, 1993; Fredrickson, Mancuso, Branigan, & Tugade, 2000; Garland, Gaylord, & Fredrickson, 2011).

Similarly, the broaden-and-built theory argues that better recovery is a central pathway connecting positive affect to improved well-being (Fredrickson & Joiner, 2002). In this context, studies comparing the amount of time required to return to resting levels of cardiovascular function between participants who smiled during stressful situations and non-smiling participants, observed that smiling participants recover more quickly than their non-smiling counterparts (L. Fredrickson & Levenson, 1998), even when their smile was simulated (Kraft & Pressman, 2012).

Previous reviews about the effects of positive emotions on physical health have supported theoretical claims about their beneficial effects on different variables, including immune system response (Howell, Kern, & Lyubomirsky, 2007) and inflammation (Steptoe, O'Donnell, Marmot, & Wardle, 2008), being associated with an overall decrease in mortality (Chida & Steptoe, 2008). This beneficial effect of positive emotions on physical health is thought to be explained by people's own perceptions of their social relationships, which lead to improved vagal tone, and contribute to the creation of an upward-spiral dynamic (Kok et al., 2013).

However, there are still few reviews that have been conducted to investigate the specific effects of humor and laughter on health variables, which is important to determine given the growing implementation of laughter or humor-based therapies in clinical settings, their wide appeal to the lay public (Bennett & Lengacher, 2008) and the aforementioned claims regarding their effectiveness in improving physical health. With this review and meta-analysis, we seek to contribute towards closing that gap by investigating the effects of laughter on BP and HRV.

In this context, we should acknowledge that humor and laughter have been linked to improved health both by the lay public and by researchers alike. Some researchers have argued that LIIs and humor-based interventions can function as an adjunctive therapy to improve conditions like depression and anxiety (Dogan, 2020; van der Wal & Kok, 2019). These interventions offer low-risk, cheap and scalable options to deliver those benefits. However, it is important to fully understand the physical health effects of LIIs before implementing them. To the best of our knowledge, this is the first systematic review specifically aimed at analyzing the impact of LII on cardiovascular health (namely, BP and HRV).

In this context, we analyzed the results of studies involving LII published until 2020, involving more than 20,000 participants from different geographical backgrounds and with different socio-demographic characteristics. In addition, we sought to add value by analyzing and comparing results obtained from studies employing different study designs, so we could offer a more comprehensive view of the effects of LII in different groups of people.

The results of this review offer a first systematic glance at the effects of LII on the cardiovascular system. Although definitive conclusions cannot yet be drawn, we expect that this review stimulates further research and offers new insights and avenues of development for the creation, evaluation and implementation of LII.

3.2.1. The Present Review

The use of humor as a therapeutic tool has grown significantly over the last decades. However, academic research on the effectiveness of this approach has taken up a much slower pace (Gelkopf, 2011). Previous meta-analytical reviews about the positive effects of humor and laughter on mental health suggest that positive styles of humor (i.e., affiliative and self-enhancing) are positively correlated with mental health in young adults (Schneider, Voracek, & Tran, 2018). Furthermore, the use of positive humor in organizational settings also seems to be associated with improved health, work performance, decreased burnout and work withdrawal (Mesmer-Magnus, Glew, & Viswesvaran, 2012). In romantic relationships, studies have reported that positive humor has a beneficial effect on the level of satisfaction with the relationship (Hall, 2017) and is a central factor in interpersonal and social attraction (Bressler, Martin, & Balshine, 2006; Cann, Calhoun, & Banks, 1997; McGee & Shevlin, 2009; Murstein & Brust, 1985).

However, despite its importance in central aspects of our social life, humor has been a particularly difficult concept to grasp, and hence to define and manipulate in the context of academic research. In particular, humor has been generally defined as a multi-faceted concept, which can include anything that a subject does or says that is perceived by others as being humorous, as well as the cognitive processes that contribute to the recognition and creation of the humorous stimuli and the emotional responses that people assign to them (R. A. Martin & Ford, 2018).

Specifically, in terms of the emotional responses, mirth has been defined as *"…the distinctive emotion that is elicited by the perception of humor"* (R. A. Martin & Ford, 2018) (p. 6), and is typically expressed outwardly through laughter. This emotion has been characterized by subjective feelings of amusement, cheerfulness, and pleasure, and like other emotions, it has been associated with specific physiological changes (Carbelo & Jáuregui, 2006; R. A. Martin & Ford, 2018).

In this context, although humor, mirth and laughter are tightly interconnected, often happening together, they are separate phenomena (van der Wal & Kok, 2019). In particular, laughter can be elicited as a response to humorous external events (i.e., spontaneous laughter) or by oneself voluntarily (i.e., simulated laughter; (van der Wal & Kok, 2019)).

However, little research has been conducted on the different effects that spontaneous and stimulated laughter can have on individuals' health, but a recent review suggested that simulated laughter seems to be more effective than spontaneous laughter at improving depressive symptoms (van der Wal & Kok, 2019).

Similarly, another review conducted by (Mora-Ripoll, 2011) concluded that both spontaneous and simulated laughter have positive impacts on health compared to control groups (both including waiting lists and no intervention, as well as active control groups who engaged in other activities, e.g., exercise therapy).

In terms of the effect of laughter on physical health, some authors have argued that it can have a positive effect on variables such as blood pressure (BP) regulation, Secretory Immunoglobulin A (SIgA) (Secretory Immunoglobulin A) production (Ryu, Shin, & Yang, 2015) and pain tolerance (Lapierre, Baker, & Tanaka, 2019). However, the mechanisms through which humor and laughter exert this positive influence are still unclear (L. R. Martin et al., 2002). Some argue that laughter has a direct influence on health; whereas others adopt the view that the effects of humor on health are mostly of an indirect nature.

Proponents of the first viewpoint, argue that laughter induces a set of physiological changes in various systems of the human body which can have positive effects on health (L. R. Martin et al., 2002). Authors who argue that humor has an indirect effect on health, generally place the emphasis on humor as a trait or emotion (as opposed to focusing on laughter) as mediating or moderating variables that increase the beneficial effects associated with positive emotional states and serve as a buffer for the negative effects associated with stress (L. R. Martin et al., 2002; Carbelo & Jáuregui, 2006; Chinery, 2007; Crawford & Caltabiano, 2011).

As a result of the belief in the positive effects of laughter in physical and psychological health variables, many programs involving the use of humor or laughter as a therapeutic tool have emerged. Associations like the Laughter Association UK or the Laughter Yoga International[1], promote the use of laughter-inducing interventions to improve health and well-being and train professionals to deliver these types of interventions. However, although the effectiveness of laughter-inducing interventions has been confirmed in improving conditions such as depression (van der Wal & Kok, 2019), little is known regarding its effects on psychophysiological variables.

The link between laughter and the cardiovascular system has been, for a long time, a subject of interest for researchers in the medical and social sciences (Lefcourt, Davidson-Katz, & Kueneman, 1990). In this context, laughter seems to be integrated in a wider category of activities that involve the exercise of muscles crucial to the respiratory activity (e.g., coughing), and that display reciprocal influences in some aspects of cardiovascular functioning, such as BP regulation (Miller & Fry, 2009).

[1]For more information see: https://laughteryoga.org/ and http://www.laughterassociation.com/ [Last consulted on October, 11th, 2022]

The production of laughter is characterized by rapid contractions of the intercostal muscles, resulting in ample, quick, exhalations, which vocalization involves supra-laryngeal structures (Scott et al., 2014).

In addition, the neural control of laughter involves two cortical systems that act on the midbrain and brainstem motor structures involved in the production of voluntary or learned (lateral premotor and motor areas) and involuntary (anterior cingulate and supplementary motor areas) vocalizations associated with laughter (Scott et al., 2014).

Because laughing involves such a complex array of muscles and systems, vigorous laughing is believed to relax muscles, improve respiration and circulation, and decrease the production of stress-related hormones in the brain (L. R. Martin et al., 2002).

Mirthful laughter has also been found to induce the release of β -endorphins, which due to its affinity for $\mu 3$ opiate receptors are thought to lead to a direct release of NO (Nitric Oxide). NO, in turn, is known to affect smooth muscle relaxation, vessel dilation and might reduce vascular inflammation (Miller & Fry, 2009).

3.2.1.1. *Blood pressure* BP refers to the pressure measured within the arteries during the contraction of the heart (systolic blood pressure; Systolic Blood Pressure (SBP)) and between heart contractions (diastolic blood pressure; Diastolic Blood Pressure (DBP)). BP can typically be measured using a standard sphygmomanometer, stethoscope, or a digital automated unit. Normal levels of BP tend to be between 90 and 120 for SBP and 60 and 80 for DBP in healthy adults (Pickering et al., 2005).

BP changes can be induced by a myriad of factors that are normal in our day-to-day lives. For instance, emotions directly impact biological pathways, such as the sympathetic nervous system and the hypothalamic–pituitary–adrenal axis, which in turn influence other biological processes involved in the regulation of BP (Trudel-Fitzgerald, Tworoger, Poole, Williams, & Kubzansky, 2016). In addition, as detailed above, the act of laughter involves the exercise of muscles directly involved in the regulation of the respiratory activity, which, as demonstrated by other similar behaviors (e.g., coughing; (Criley, Blaufuss, & Kissel, 1976)) can impact cardiac activity in general, and BP in specific.

Positive emotions, in specific, and psychological well-being in general, are thought to be protective factors for cardiovascular disease, and to be positively associated with biological function and restorative health behaviors, and negatively associated with potentially harmful behaviors (e.g., smoking; (Boehm & Kubzansky, 2012)). Previous reviews suggest that BP changes are associated with the experiencing of positive emotions (in specific, amusement), but the variability of the results reported for this variable does not allow us to stipulate a concise judgement on the nature of such changes (Kreibig, 2010).

3.2.1.2. *Heart rate variability* The human heart beats to a non-regular rhythm, due to the influence of the two branches of the autonomic nervous system on the heart (Shaffer & Ginsberg, 2017). As such, heart rate variability (HRV), in general, is a measure of the oscillations in length of the intervals between heartbeats and can be a valuable indicator of the sympathetic and parasympathetic functions of the autonomic nervous system (Shaffer & Ginsberg, 2017).

The measurement of HRV can include frequency, time-domain, and non-linear indices. Frequency-domain indices allow the determination of the HRV four frequency bands (more specifically, high (High Frequency (HF)), low (Low Frequency (LF)) and very-low (Very Low Frequency (VLF)) and ultra-low frequency (Ultra-Low Frequency (ULF)) bands); whether time-frequency domain indices allow for the quantification of the variability of inter-beats intervals (Shaffer & Ginsberg, 2017).

HF and LF can be calculated from short-term (2–5 min) or long-term recordings (24h), are measured in absolute values of power (milliseconds squared) and vary according to autonomic modulations of heart period. The physiological explanation of VLF, on the other hand, is much less understood and thus its interpretation must be done with caution (Electrophysiology, 1993).

Non-linear indices attempt to quantify the unpredictability of a series of inter-beat intervals. In addition, each of these indicators provides clues regarding the activity of different branches of the autonomic nervous system (Shaffer & Ginsberg, 2017). For instance, HF is associated with parasympathetic activation given that it reflects the vagus nerve activity, whereas LF reflects sympathetic activity (Shaffer & Ginsberg, 2017).

A previous review has shown that different emotions are associated with different patterns of autonomic system activation. In particular, amusement (manipulated in the studies included mostly by exposing participants to comedic material/films) is usually associated with increased *"...vagal control, vascular α-adrenergic, respiratory, and electrodermal activity, together with sympathetic cardiac β-adrenergic deactivation..."* (Kreibig, 2010) (p. 406).

Studies examining the physiological manifestation of amusement, as indexed by heart rate (Heart Rate (HR)), have shown inconsistent results, with some studies reporting an increase, others reporting a decrease, and others reporting no change in HR as a result of exposure to amusement-inducing material (Kreibig, 2010). However, a previous review suggested an increase in HRV, as indicated by time-domain measures, such as Standard Deviation of the Inter-Beat-Intervals of Normal Sinus Beats (SDNN) (standard deviation of the inter-beat-intervals of normal sinus beats) and Mean Difference Between Successive RR Intervals (MSD) (mean difference between successive RR intervals; (Kreibig, 2010)), as a common response pattern to amusement-inducing stimuli. Frequency-domain measures, such as LF/HF, tended to remain unchanged in the studies included in that review (Kreibig, 2010). CO (cardiac output), which is the product of heart rate and stroke volume, decreased after exposure to amusement-inducing stimuli (Kreibig, 2010).

3.2.2. Goals

The objective of this review is to analyze the effects of LII on BP regulation and HRV at two levels: (a) intraindividual (pre-post comparisons) and (b) interindividual (active vs. control group comparisons). In interindividual comparisons, we seek to compare LII to active (e.g., writing exercises) and passive control groups. In addition, we seek to identify and summarize the results of longitudinal studies involving the effects of laughter or humor in the cardiovascular system and general health.

3.2.3. Methods

3.2.3.1. *Eligibility criteria* Studies published until August 2020 examining the effects of LII (for a review on different types of LII, see (Ruch & McGhee, 2014)) on BP and HRV, including pre–post comparisons, controlled trials, and longitudinal designs that spanned for more than one-year, were eligible. These interventions can include any type of laughter-inducing intervention, including both interventions involving simulated laughter (i.e., non-humorous, e.g., laughter yoga) or spontaneous laughter (i.e., humorous, e.g., clown interventions).

Studies were included if they provided enough information regarding the BP levels indifferent conditions, or for pre–post assessments for at least one type of BP measurement (systolic or diastolic). If such information was not present a qualitative summary of the results was presented instead. Given the wide variability of parameters that can be employed to assess HRV, we provided a qualitative summary of the results of the studies included for this variable. For both outcomes, if a sufficient number of homogeneous studies was found, a statistical meta-analysis was conducted to quantify the effect sizes.

Peer-reviewed articles presenting an abstract and written in English were preferred, but for reasons of achieving wider inclusivity of non-Western literature, translations of relevant articles were procured when possible. Approved theses (master's degree or PhD) were also included in the review. No other exclusion criteria were defined.

3.2.3.2. *Data collection, search procedure, and study selection* Studies were identified using appropriate digital libraries in medical and social sciences. The databases searched were PubMed, Web of Science, ScienceDirect, and Scopus. To reduce the chance of publication bias, parallel searches were conducted in thesis repositories (OTAD; Open Access Thesis and Dissertations) and other platforms likely to host grey literature or preprint manuscripts (Open Science Framework; arXiv), as well as in other scientific repositories (Academic Google, Microsoft Academic, ResearchGate). The search was last conducted in February 2021, and included papers published between January 2000 and August 2020.

The search terms used included the following keywords (humor OR laughter) AND (blood pressure OR heart rate variability) anywhere on the title, abstract, or keywords of a paper. At this stage, we purposefully did not narrow the search by including more restrictive search terms to avoid missing potentially relevant papers. The study selection procedure is detailed in figure 3.9.

After achieving a first selection of the relevant papers, the reference section of each was thoroughly analyzed in search of other potential papers that could fit our inclusion criteria. This process was repeated in the newly identified papers until all new references were exhausted, and the search process was terminated.

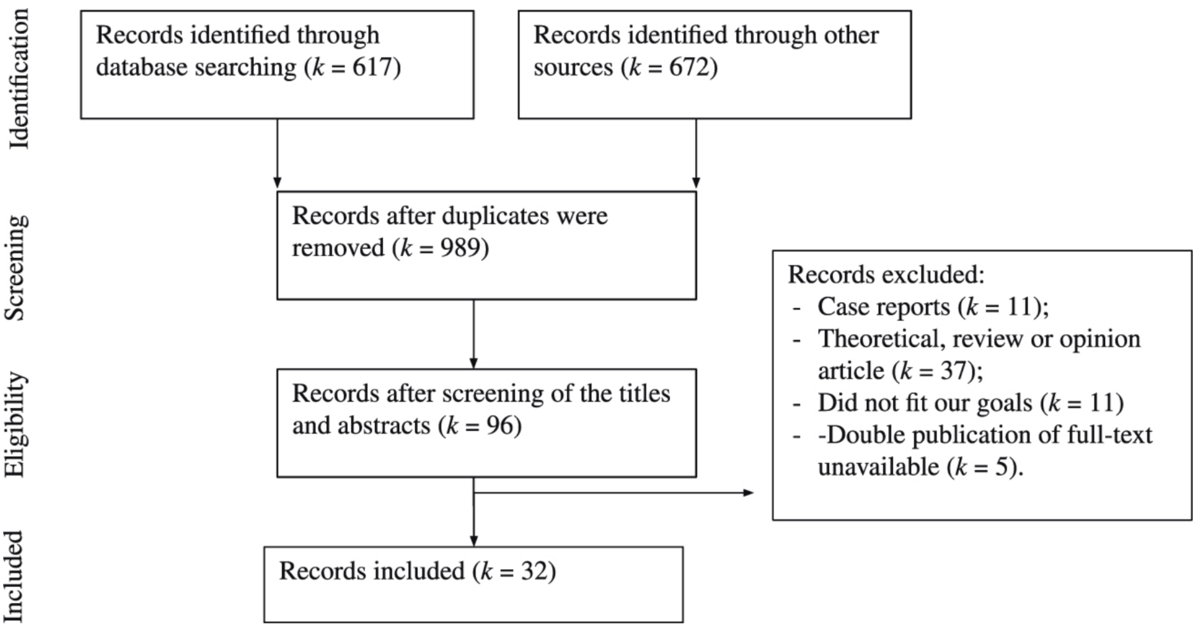


FIGURE 3.9. PRISMA diagram detailing the study screening and selection process.

The information retrieved from the selected papers included both extrinsic and intrinsic characteristics. In terms of extrinsic characteristics, we collected information regarding the (1) title, (2) publication year, (3) author list, (4) country of origin (as inferred from the affiliation of the first author), (5) disclosure of funding sources, and (6) conflict of interests. For intrinsic information, we collected data regarding (7) sample size, (8) demographic characteristics of the sample, (9) type of intervention (simulated vs. spontaneous) and implementation (frequency, number of sessions, duration, activities included), (10) study design, (11) BP levels, (12) type of HRV indicators measure, and (13) summary of the main findings of each study.

The information extraction (and the initial screening of records) was conducted by the first author and by an external examiner, who also contributed to the quality of the appraisal process. Both reviewers worked independently and solved disagreements by discussing them during joint meetings. A third reviewer and the main author independently conducted the risk of bias appraisal and the same disagreement resolution method was adopted.

When translation of articles was necessary (in our case, for articles written in Iranian and South Korean), two native speakers of those languages were asked to assist independently in the translation. Their translations were then read and integrated by the first author and doubts regarding the content of the translation were answered in joint meetings.

3.2.3.3. *Extrinsic characteristics and quality appraisal* The 32 studies included in this review originated from varied geographic backgrounds, with Japan (k = 6; (Hayashi et al., 2016; Ikeda et al., 2021; Sakurada et al., 2020; Sakuragi, Sugiyama, & Takeuchi, 2002; Nasir et al., 2005; Sugawara, Tarumi, & Tanaka, 2010); the USA ($k = 4$; (Berger, Wilson, Potts, & Polivka, 2014; Dolgoff-Kaspar, Baldwin, Johnson, Edling, & Sethi, 2012; Boone, Hansen, & Erlandson, 2000; Rizzolo, Zipp, Stiskal, Simpkins, et al., 2009); India ($k = 4$; (Nagoor & Dudekula, 2015; Jemmi Priya, 2016; Rampalliwar, Rajak, & Singh, 2016; Salomi, Varanasi, & Balananda, 2018), South Korea ($k = 2$; (Yu & Kim, 2009; Yun, Kim, & Jung, 2015), Iran ($k = 2$; (Eshg, Ezzati, Nasiri, & Ghafouri, 2017) (Jalali, Kheirkhah, Ahmadi, Seifi Zarei, et al., 2008), Taiwan ($k = 2$; (C. Chang, Tsai, & Hsieh, 2013; Y.-C. Wang et al., 2020), and the UK ($k = 2$, (Harrison et al., 2000; Kanji, White, & Ernst, 2006) being the most predominant contributors. The other studies originated from Finland (Kerkkänen, Kuiper, & Martin, 2004), Turkey (Hasan and Saritas 2020), Brazil (Alcântara et al. 2016), Slovenia (Krebs et al. 2014), Australia (Ellis et al. 2017), Spain (Ruiz-Padial & Ibáñez-Molina, 2018), Indonesia (Kasenda and Jael 2016), Austria (Lackner, Weiss, Hinghofer-Szalkay, & Papousek, 2014), Greece (Vlachopoulos et al. 2009), and New Zealand (Law et al. 2018; all $k = 1$). With the exception of one thesis (Jemmi Priya, 2016), all the other papers were published in peer-reviewed journals.

Quality appraisal was conducted using the quality assessment tool for quantitative studies developed by the Effective Public Health Practice Project (2012). Because treatment allocation was obvious (i.e., participants allocated to an experimental condition involving a laughter activity would be very aware of the manipulation and dependent variables), due to the nature of the intervention and measures collected, this item of quality assessment was not coded (van der Wal & Kok, 2019).

Overall, most of the studies included were evaluated as being weak ($k = 16$). The main factors contributing to this evaluation were related to selection bias (namely the lack of sample representativeness and the lack of information regarding the percentage of individuals that agreed to participate in the study), the lack of information about possible relevant confounder variables and intervention integrity (namely, lack of control or information about the consistency of the interventions, and lack of control about possible co-interventions or activities that might have influenced the results). This latter factor, intervention integrity, was also present in other studies which were classified as providing evidence of moderate strength ($k = 10$). However, these studies were evaluated as presenting more information regarding possible selection biases, confounders, and consistency of the applied intervention.

The remaining studies were evaluated as providing strong evidence ($k = 6$) due to the overall quality of the study design, statistical analysis and quality of the evaluation, and reporting of the study procedure and possible confounder variables.

Regarding the quality assessment of studies per variable, we found that 14 studies involving BP measurements were evaluated as providing weak evidence; 10 were evaluated as providing moderate strength evidence and the remaining 6 were evaluated as providing strong evidence. Of the studies included for HRV, we found that 2 provided strong evidence and 2 provided moderate strength evidence.

In terms of the laughter-inducing activities, we found three main clusters. The most predominant way to induce laughter in the studies included was through the presentation of humorous films or video clips ($k = 13$). These videos could be short clips of stand-up comedians performing, popular late-night programs, movies, or short compilations of humorous clips.

The second most prominent cluster of laughter-inducing activities included studies that analyzed laughter therapy ($k = 10$) and laughter yoga ($k = 2$). These activities generally include breathing exercises and the production of simulated laughter; and might or might not include other relaxation exercises that are performed concomitantly.

Third, some of the studies included induced laughter through exposure to clown interventions, and other silly activities (e.g., dressing up in costumes, putting on funny make-up; $k = 3$). One study induced laughter through giving laughter-inducing commands to participants.

Approximately half of the non-longitudinal studies employed multiple-sessions of laughter-inducing activities ($k = 15$); whereas the other half included a single session. The average number of sessions for the studies involving multiple-session interventions was 8, with the average total duration (sum of the duration of each individual session) of said intervention being 339 min ($SD = 298.90$; ranging from 60 to 1,040 min).

For the studies involving single-session interventions, the average duration of the intervention was approximately 23 min ($SD = 22.37$; ranging from 3 to 71 min).

3.2.3.4. *Risk of bias* According to recommendations, risk of bias was assessed using ROBINS-I (Sterne et al., 2016) for non-randomized intervention studies and ROB 2 (Sterne et al., 2019) for randomized intervention trials. Visualizations of the outcomes of the risk of bias assessment were produced using the robvis tool (McGuinness & Higgins, 2021) and are presented in figures 3.10 and 3.11.

3.2.4. Data analysis

3.2.4.1. *Blood pressure* We included in this review 28 studies involving BP and cardiovascular health in general. Eighteen studies employed pre-post comparisons levels of BP, seven studies involved controlled trials, and four longitudinal studies explored the effects of frequency of laughter and sense of humor in BP or overall cardiovascular health. The remaining articles ($k = 4$) analyzed BP changes related to LII, however, because they did not present the mean BP values (or presented it in graphical form only), we can only provide a qualitative summary of these results. These four articles used a repeated measures design (Harrison et al., 2000; Vlachopoulos et al., 2009; Dolgoff-Kaspar et al., 2012; Lackner et al., 2014; Genç & Saritas, 2020).

Congruently with our goals, data analysis of the articles included in this review will be organized according to the type of comparisons conducted within each paper (pre–post comparison, active vs. control and longitudinal). Some overlap of the articles included in terms of the type of comparison group employed was observed, with some studies reporting both pre–post and active versus control group comparisons ($k = 5$), resulting

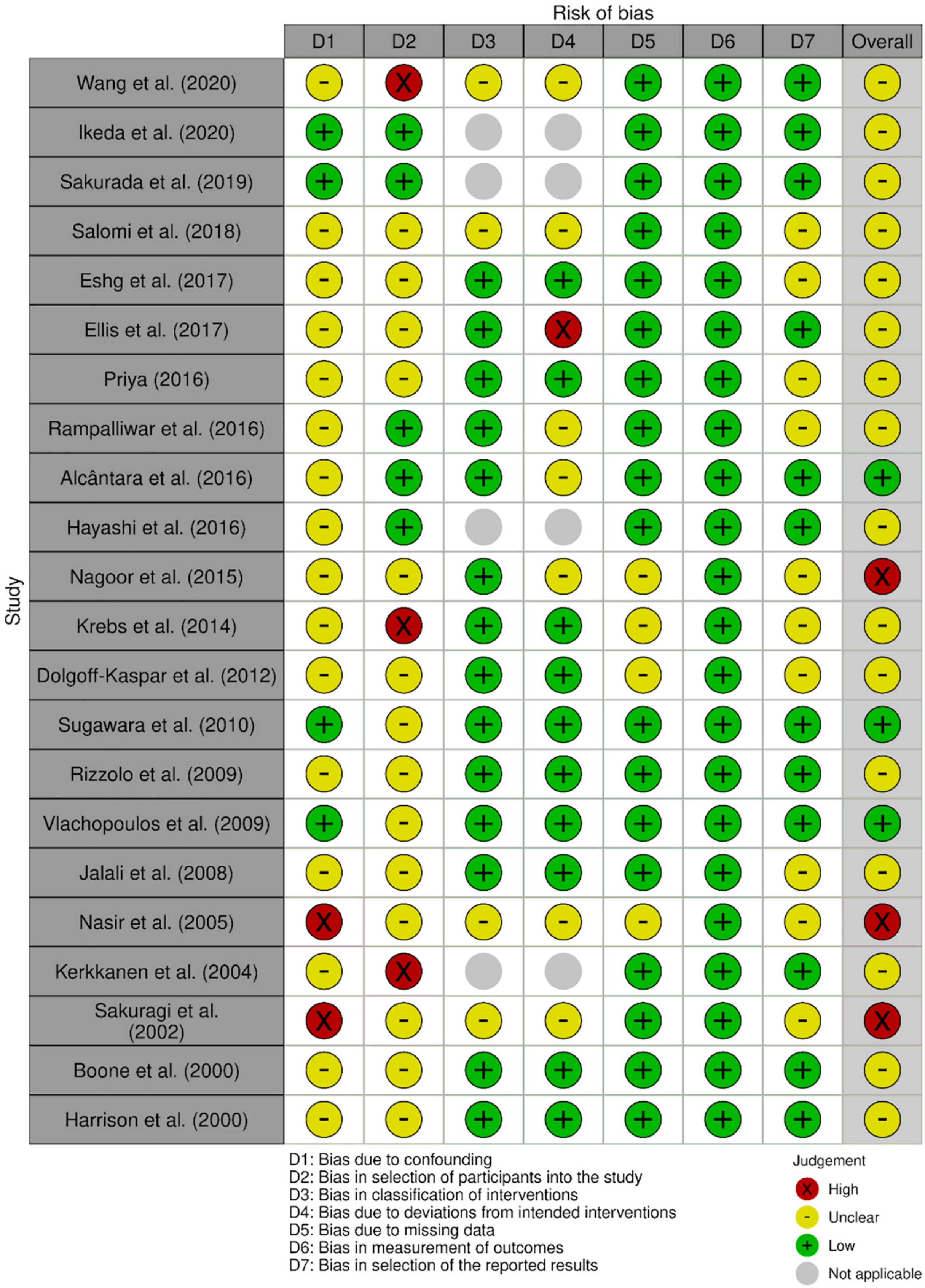


FIGURE 3.10. Risk of bias assessment for pre-post and longitudinal comparisons studies using ROBINS-I.

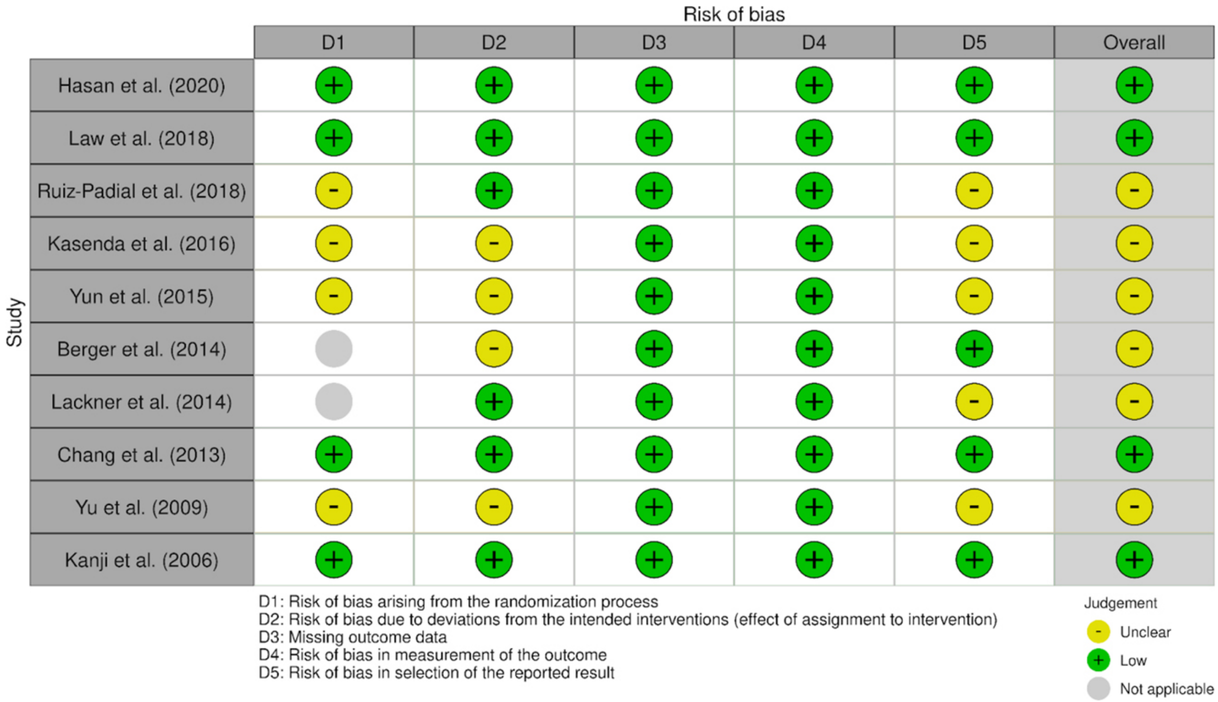


FIGURE 3.11. Risk of bias assessment for randomized or controlled trials using RoB 2.

in a total sum of 28 individual articles included (Kanji et al., 2006; C. Chang et al., 2013; Berger et al., 2014; Yun et al., 2015).

Data analysis of the BP scores for the studies including pre–post comparisons will be merely descriptive. Although methods for calculating effect sizes in studies involving dependent groups exist (e.g., Morris and DeShon 2002), its interpretability and susceptibility to bias has been noted recently (Cuijpers et al. 2017). In addition, the majority of the studies included in this category did not present correlation values between pre–post measures, which would be necessary to calculate effect sizes, and no reliable estimates for this correlation are present in previous literature, to the best of our knowledge.

Furthermore, this type of comparison is potentially subject to a number of known effects, such as regression to the mean and the Hawthorne effect. The effects of regression to the mean have been specifically studied in regard to BP measurements, demonstrating that baseline measurements of BP tend to decrease in comparison to follow-up measures (Moore et al. 2019). This potential effect of potential bias is aggravated in this case by a lack and overall inconsistency of the demographic and health-related characteristics reported for participants in each study, that might affect the full comprehensibility of the results reported.

Two meta-analyses were conducted for the effects of LII: one for SBP and another for DBP. In all studies, BP was measured in units of millimeters of mercury (mmHg). Assuming an overall effect size of 0.5, and an average number of 25 participants per condition (experimental and control) and the nine individual comparison groups included, the estimated statistical power for the meta-analysis varied between 0.99 (low heterogeneity) to 0.75 (high heterogeneity).

Hedge's g was calculated to compare the standardized effect sizes between active and control groups, considering the small sample sizes observed in the majority of the studies included in this category. Sub-group analysis was not conducted due to the small number of studies included in the meta-analysis, and the relatively high level of heterogeneity observed (as measured by I^2). The common interpretation of heterogeneity scores as provided by I^2 is that higher values of this statistic indicate higher levels of within-subgroup heterogeneity.

According to statistical recommendations, Egger's test was used to assess publication bias, instead of the more common fail-safe N method (Higgins et al. 2019). Analyzes were conducted using Jeffreys's Amazing Statistics Program (JASP) software (version 0.12.2). In accordance with common practice, a p value inferior to 0.05 will be considered evidence to reject the null hypothesis.

3.2.4.2. *Heart rate variability* Seven articles involving the analysis of HRV changes associated with LII were identified (Y.-C. Wang et al., 2020; C. Chang et al., 2013; Dolgoff-Kaspar et al., 2012; Lackner et al., 2014; Law, Broadbent, & Sollers, 2018; Ruiz-Padial & Ibáñez-Molina, 2018; Sakuragi et al., 2002).

Some of the studies included for this variable also presented measurements of BP. Therefore, there is some overlap between the studies already included in the section above. The results for HRV were considered separately from the results of BP measures. The studies included used different measures of time-domain (Root Mean Square of Successive Differences (rMSSD) and Standard Deviation of the normal-to-normal intervals, SDNN) and of frequency-domain HRV (LF/HF, LF, HF), with the most frequently reported being rMSSD (k = 4), LF/HF, LF or HF (k = 4), and SDN (k = 3).

Due to the variability in the measures reported in each study, and the lack of consistency regarding the measures reported in the studies included as whole, a statistical analysis of the effect size of the reported effects was not possible. Instead, the results for these studies will be summarized qualitatively by analyzing the main conclusions of each study.

3.2.5. Results

3.2.5.1. *Blood pressure* A summary of the studies included for BP is presented in table A.1.

A net reduction of 3.97 and 3.14% in SBP and DBP, respectively, was observed when comparing pre-post BP measurements for individuals who participated in LII. When excluding the studies involving patients with hypertension (k = 2, remaining n = 648), a reduction of 3.97% and of 2.08% in SBP and DBP, respectively, was observed between pre (M_{SBP} = 121.82, M_{DBP} = 75.52) and post (M_{SBP} = 118.21, M_{DBP} = 73.95) measurements. In individuals with hypertension (n = 85), SBP decreased by 10.94% between pre-post measurements (M_{Pre} = 148.21; M_{Post} = 132.00), whereas DBP decreased by 10.29% in pre-post measurements ($M_{Pre} = 90.61$, $M_{Post} = 81.29$).

When considering only the studies for which no diseases were reported ($k = 10$; $n = 434$), the results suggest a 3.70% and a 3.66% drop in SBP and DBP, respectively, between pre ($M_{SBP} = 122.04$, $M_{DBP} = 77.15$) and post ($M_{SBP} = 117.52$, $M_{DBP} = 74.33$) measurements. In children (< 18 years old; $k = 3$; $n = 118$), participating in LII was associated to a reduction of 0.51% in SBP ($M_{Pre} = 115.38$, $M_{Post} = 114.77$); and to an increase of 4.62% in DBP ($M_{Pre} = 70.84$, $M_{Post} = 74.27$).

In studies involving simulated laughter ($k = 7$; $n = 393$), the overall reduction in SBP ($M_{Pre} = 130.81$, $M_{Post} = 123.15$) and DBP ($M_{Pre} = 83.65$, $M_{Post} = 75.34$), corresponded to 5.86 and 9.94% decrease. In studies analyzing the effects of spontaneous laughter ($k = 11$, $n = 340$), the corresponding reduction observed was 3.54% for SBP ($M_{Pre} = 123.47$, $M_{Post} = 119.10$). For DBP, an increase of 0.39% was observed ($M_{Pre} = 75.05$, $M_{Post} = 75.34$).

In studies involving multiple-session interventions, the overall decrease in SBP was 5.94% ($M_{Pre} = 130.09$, $M_{Post} = 122.36$), and of 5.19% for DBP ($M_{Pre} = 80.87$, $M_{Post} = 76.67$).

For single session-interventions, the corresponding reduction was of 0.95% for SBP ($M_{Pre} = 116.02$, $M_{Post} = 114.92$); and of 0.32% for DBP ($M_{Pre} = 71.95$, $M_{Post} = 71.72$).

The four studies that did not report BP values, or did so in graphical form, presented inconsistent results, with three not reporting changes in DBP, two not reporting changes in SBP and one reporting increases in SBP ranging from 3 to 23% after the intervention.

The pooled effect size of LII for SBP was 0.05 ($z = 0.32$, $p = 0.75$, $I2 = 65.85$) and -1.36 for DBP ($z = -1.75$; $p = 0.08$, $I2 = 47.41$; see Figure 4).

Significant publication bias was found for findings on SBP, as evidenced by the Egger's test ($z = -5.99$; $p < 0.001$); however, no significant risk was found for the findings involving SBP ($z = -0.19$; $p = 0.85$).

We identified four longitudinal studies evaluating the link between laughter or humor and BP. The first study was published in 2004 by Kerkkanen and colleagues, and described a longitudinal prospective study involving 34 Finnish police officers, with an initial collection of data taking place in 1995 and with a follow-up in 1998 (Kerkkänen et al., 2004). The authors were interested in evaluating the association between sense of humor (as measured by the Multidimensional Sense of Humor Scale; MSHS; (Thorson & Powell, 1993)) and a series of physical health and workplace wellbeing measures (including cardiovascular health, and in particular, BP). The MSHS measures sense of humor in terms of (a) humor generation, (b) amusing humor, and (c) coping humor.

The authors found no correlation between sense of humor and BP (systolic and diastolic) in either the data collected in 1995 or in 1998. Furthermore, they found that sense of humor was not a good predictor of BP changes between those two periods of time. Across the different analysis conducted for these two variables, the mean absolute correlation value observed was of 0.08 for SBP and of 0.11 for DBP.

The second longitudinal study (Ikeda et al., 2021) analyzed the link between frequency of laughter and BP in a sample of 1,441 Japanese individuals without a history of cardiovascular diseases, between 2010 and 2014 (with yearly follow-ups). Ikeda et al. (2020) found no overall difference in BP according to the frequency of laughter at baseline measurements; and no overall longitudinal differences in BP in women (Ikeda et al., 2021).

In middle-aged men, infrequent laughter (1–3 times a month, or almost never) was associated with increased SBP and DBP over the 4-year period, when compared to men who reported laughing frequently (1–5 days a week, or almost every day), and this effect was *"... confined to current drinkers... " (p. 5) and to men who were not on hypertensive medication.* In this study, only 12.99% ($n = 72$) of men and 8.05% ($n = 116$) of the total sample reported laughing infrequently.

A third study ($n = 20,934$) found that, even after controlling for risk and other factors (e.g. hyperlipidemia, hypertension, depression, body mass index), the prevalence of heart diseases was superior among participants who reported laughing infrequently versus those who reported laughing frequently (Hayashi et al., 2016); however, the causal direction of this relation is unclear.

Fourthly, in another study (2019; $n = 17,152$) it was found that the incidence of cardiovascular disease (as well as mortality) was significantly higher in individuals who reported low frequency of laughter (Sakurada et al., 2020).

3.2.5.2. *Heart rate variability* A summary of the studies included for HRV is presented in table 3.3. All of the studies included for HRV included pre-post comparisons. Overall, the studies presented mixed results with approximately half of the studies included ($k = 3$) reporting no significant changes in measures of HRV between pre–post measurements. The other studies present incoherent results, with some reporting an increase in rMSSD (Dolgoff-Kaspar et al., 2012), and others reporting a decrease (Y.-C. Wang et al., 2020). In the majority of the studies that investigated changes in SDNN associated with LII, it was found that the value of this variable increased (Dolgoff-Kaspar et al., 2012; Lackner et al., 2014; Y.-C. Wang et al., 2020). However, in the study by (Lackner et al., 2014), this variable only increased for participants who rated their amusement with the comedic material shown as being high.

TABLE 3.3. Summary of studies analyzing the effects of laughter-inducing interventions in HRV.

Study	***Demographic characteristics***		***Intervention characteristics***		***Results***
	Sample size (n female)	***Age (M ± SD)***	***Type of laughter***	***Number of sessions & duration (min)***	***Summary***
Dolgoff-Kaspar, Baldwin, Johnson, Edling & Sethi (2012)	3 (N/A)	59.83 ± 7.05	Simulated	3 & 60	Prior to the intervention, participants presented rMSSD and SDNN values below normal. After participation, participants presented rMSSD and SDNN values within or close to the normal range.
Wang, Chiang, Chiang, Huang, Gao & Chang (2020)[a]	48 (21)	42.15 ± 20.31	Simulated	1 & 30	Regular practitioners presented higher SDNN after a single session.
Wang, Chiang, Chiang, Huang, Gao & Chang (2020)[b]	52 (31)	34.00 ± 10.13	Simulated	1 & 30	Participants who irregularly participated in a laughter therapy program presented lower rMSSD after the intervention.

Law, Broadbent & Sollers (2018)	72 (24)	24.15 ± 1	Spontaneous & Simulated	1 & 6	There were no sig. changes either in rMSSD or In-rMSSD associated with spontaneous laughter. Simulated laughter led to a decrease in rMSSD.
Ruiz-Padial & Ibáñez-Molina (2018)	21 (7)	20.8 ± 1.4	Spontaneous	1 & 5	When exposed to a comedic video, participants presented higher HRV than when watching a neutral video or a fear-inducing video.
Lackner, Weiss, Hinghofer-Szalkay & Papousek (2014)	48 (48)	21.00 ± 2.7	Spontaneous	1 & 3	Viewing humorous clips was associated with increased SDNN, SD2/SD1, TOT, LF, LF/HF, but only when the subjective amusement reported by participants was high.
Chang, Tsai & Hsieh (2013)	67 (33)	n/a[1]	Simulated	8 & 360	No changes were observed for the experimental group.

Sakuragi, Sugiyama & Takeuchi (2002)	10 (10)	n/a	Spontaneous	1 & 50	Although there were changes in HRV during laughter, no sig. differences in this variable were found when comparing pre-post measurements.

[1] Participants are reported to be school children.

[2] Participant's ages ranged between 20 and 22 years old.

Taken together, the studies that analyzed changes in rMSSD, and from which we could retrieve numerical information ($k = 5$) indicate an average increase of 0.75% in this variable between pre-post measurements. For SDNN, an increase of 7.01% was reported ($k = 2$) and for LF/HF a net increase of 7.42% was found ($k = 3$).

3.2.6. Discussion

The view that laughter has positive effects in health is a popular one, both among academics and the general public alike. However, the relationship between these two variables is not as straightforward as it might appear at first glance. Previous meta-analyses have suggested that laughter has positive effects in some factors related to mental health, such as anxiety, depression, and perceived stress (van der Wal & Kok, 2019). However, when it comes to the effects of laughter or humor in physiological variables, the evidence becomes scarcer.

In this review, we found that the overall decrease in BP observed in individuals after participating in LII was of approximately 4.5% for SBP and of 4% for DBP. The highest percentage decrease in BP in the pre–post measurements was observed in patients with hypertension, corresponding to approximately 11 and 10% in SBP and DBP, respectively.

Congruent with what was reported in the meta-analysis conducted by (van der Wal & Kok, 2019), interventions using non-humorous laughter were reported to be associated with higher relative decreases in BP, when compared to humorous laughter, for the studies included in this review. However, when we consider studies in which the authors employed a control group, the effect of LII appeared to be non-significant.

In addition, although longitudinal studies analyzing BP dealt with different aspects of humor (laughter and sense of humor), taken together, they seem to provide some evidence in favor of the impact of laughter and humor on BP and cardiovascular health. However, these studies were not without limitations that might have impacted the results observed.

For instance, the study involving sense of humor not only involved a small sample size ($n = 34$) but also failed to control for other health and lifestyle variables that might impact cardiovascular health and included only men (Kerkkänen et al., 2004). Although they collected information regarding Body Mass Index (BMI), smoking and cardiovascular risk index (based on BP levels, blood serum cholesterol levels and drinking habits), other variables, such as frequency of exercise practice, eating habits, and daily levels of stress, have an effect in cardiovascular health and endothelial function and that were not measured or controlled for in this study (Toda & Nakanishi-Toda, 2011; de Pascual-Teresa, Moreno, & García-Viguera, 2010; Low, Salomon, & Matthews, 2009; Myers, 2003).

The second study found no evidence to support a relation between frequency of laughter at baseline and BP levels but found that infrequent laughter (in comparison to frequent laughter) was associated with increased BP in men who reported drinking at the beginning of the study, over a 4-year period. The changes in BP observed for this group of participants, although significant, was rather small, corresponding to a total decrease of 3.35% in SBP ($M_{Pre} = 129.8$, $M_{Post} = 134.3$) and of 4.07% in DBP ($M_{Pre} = 75.4$,

$M_{Post} = 78.6$; (Ikeda et al., 2021)). These values are close to the net changes in SBP and DBP reported in our review for pre–post comparisons.

The two other longitudinal studies focused more specifically in cardiovascular health and both found that frequent laughter seems to be associated with improved health and lowered mortality (Hayashi et al., 2016; Sakurada et al., 2020).

Overall, it appears that the effect of LII is not universal, being dependent both on the characteristics of the interventions and those of the participants. In particular, interventions involving simulated laughter (e.g., laughter therapy, laughter yoga) seem to be associated with a larger decrease in BP. However, although providing a satisfactory indicator of the effects of laughter in BP regulation, these interventions do not allow a definitive indicator given that they usually involve other breathing and relaxation exercises.

In addition, we also hypothesize that this difference might be partially due to the amount of laughter produced in each type of intervention. One study directly comparing the effects of simulated versus spontaneous laughter found that participants in the simulated laughter condition produced significantly more laughter than participants in the genuine laughter condition, although this factor alone did not explain all differences in terms of the participant's cardiovascular responses to humor (Law et al., 2018). However, further studies are needed to investigate this hypothesis as most of the studies included in this review did not control or report the amount of laughter produced by participants.

Another factor that might have influenced participants' cardiovascular responses is their level of amusement by the activities included in the LII in which they participated. Specifically, although we observed greater effects in BP for participants who engaged in LII which involved simulated laughter, at least one study involving HRV seems to indicate that participants' amusement with the comedic material has a positive effect in mediating the effects of laughter on cardiovascular responses (Lackner et al., 2014). This finding might suggest that LII and humor might influence different aspects of cardiovascular activity differently and warrants further research.

Other individual factors, such as personality and sense of humor have also been found to influence the effectiveness of humor-based interventions, both in the short and long-term (Wellenzohn, Proyer, & Ruch, 2018); however, most of the studies included in this review did not account for these factors. As such, it remains unclear whether they might also modulate or influence the physiological responses associated with LII.

For HRV, the studies also present inconsistent results. The most consistent finding appears to be that exposure to LII seems to be associated with increased SDNN. The SDNN is the "gold standard" for categorization of cardiovascular risk (when measured for a period of at least 24h) and is an important predictor of morbidity and mortality (Shaffer & Ginsberg, 2017). It is subject to the influence of both the sympathetic and parasympathetic nervous systems, and is usually highly correlated with VLF, LF and total power, although this relationship highly depends on the conditions in which the measurements are conducted (Shaffer & Ginsberg, 2017).

In the studies included in our review exploring HRV, the data collection period was brief (all under 1 h to the best of our knowledge). In these cases, it seems that the primary source of variation is the parasympathetic nervous system. However, previous studies have argued that SDNN is more accurate when calculated over longer periods of time (at least 24h), providing more precise information about cardiorespiratory regulations and central nervous system activity, among others (Shaffer & Ginsberg, 2017).

The results observed for HRV seem to be in line with those reported by (Kreibig, 2010) regarding the increased SDNN. For BP, our results suggest some fluctuations associated with participation in LIIs, while in the review conducted by (Kreibig, 2010), BP is reported to remain unchanged. This difference might be explained by the fact that our review included more articles involving the effects of LIIs in BP, and by the fact that the previously mentioned review focused more broadly on amusement (as opposed to laughter; (Kreibig, 2010)).

Situating laughter in the context of its associated emotional response (i.e., mirth), our findings also seem to be congruent with past research that suggests a positive association between positive emotions and HRV (in particular, cheerfulness and calmness; (Geisler, Vennewald, Kubiak, & Weber, 2010)), although these effects of positive emotions seem to be less durable than those caused by negative emotions (Brosschot & Thayer, 2003). This lack of durability might hinder experimental efforts to document the benefits of positive states (in this case, laughter) and also warrants further research to better comprehend the chronology of the physiological correlates of laughter.

Regarding the effects of laughter frequency in overall cardiovascular health, the studies included seem to support the hypothesis that there is a positive relation between these two variables. Whether this difference is due to the cumulative effects of laughter or due to other variables is still inconclusive; although this effect it is likely a combination of both.

For instance, other variables that might be positively correlated with laughter frequency such as positive psychological well-being, are also correlated to improved cardiovascular health, independently of traditional risk factors (Boehm & Kubzansky, 2012). This effect appears to be due to the fact that positive psychological well-being seems to be associated with a higher number of health restorative behaviors (e.g., meditation) and with a lower number of harmful behaviors that might impact cardiovascular health.

Taken together, the difficulty in finding consistent physiological patterns in terms of the cardiovascular system stemming from the application of LII can also be explained by the existence of large intra and interindividual variability in responses. This reasoning is congruent with a more constructivist approach to emotions and their physiological correlate, which posits that physiological responses associated with specific emotional states are often *"...neither consistent nor specific..."* (Hoemann et al., 2020).

3.2.6.1. *Limitations and future work* The quality of any systematic or meta-analytical review is largely determined by the quality of the primary sources included. Most of the evidence included in this review was evaluated as being weak or moderate and with some risk of bias, mostly due to the prevalence of small sample sizes, selection bias, and intervention integrity. Although the studies analyzed a wide range of interventions, lasting for variable amounts of time, the lack of consistency between a sufficiently large subset of studies complicates the task of withdrawing definite conclusions about important aspects, such as the adequate dosage, content, and effectiveness of LII. This was especially true for studies involving measures of HRV, which due to its smaller number, implicate a much higher level of uncertainty when attempting to extract overall conclusions. This poor quality, however, does not seem to be unique to the studies we included in our review, as it has been noted in other reviews focusing on the effects of humor and laughter on other variables (van der Wal & Kok, 2019).

Similarly, we found that many of the studies lacked the reporting of important experimental and study-related information, such as the blinding of participants and researchers to treatment allocation and important confounding variables. Notably, in most studies, we found a lack of information about individual factors that can influence cardiovascular activity, such as health habits and characteristics (e.g., smoking, BMI) and medication or drug usage.

Furthermore, the small number of studies found to be congruent with our selection criteria did not allow us to explore other potentially relevant factors that might have influenced the indirect effects of laughter on the cardiovascular system (Hoemann et al., 2020). These variables include, for example, the valence of the comedic material employed (as well as its comparison with neutral LII, such as those employing simulated laughter) and the intensity or duration of the laughter episode.

In addition, in terms of evaluating the effectiveness of LII in decreasing BP and, to the best of our knowledge, there is still a significant lack of comparative approaches that attempt to situate the effect of these interventions when compared to other non-pharmacological interventions aimed at improving cardiovascular function. Future studies should thus expand the literature by considering the relative efficiency of this type of intervention by comparing it to other methods for improving cardiovascular health.

CHAPTER 4

Adoption of new technologies

Any sufficiently advanced technology is indistinguishable from magic.

Arthur C. Clarke (1973)

Abstract

In this chapter, we present a survey of the prominent theories pertaining to technology acceptance, tracing their evolution and refinement throughout the years. We delve into the profound interplay between these theories and influential psychological and sociological frameworks, highlighting how they were crafted and adapted. Moreover, we undertake a comparative examination of these theories, illuminating not only their individual contributions to the gradual accumulation of knowledge concerning technology acceptance, but also the profound impact of technological advancements on the theoretical foundations designed to elucidate its adoption and utilization. Additionally, we delve into the identified gaps and limitations inherent in these theories, reflecting on how they can be addressed and applied in the realm of emerging social technologies, specifically social robots, which have burgeoned in recent decades. By doing so, we aim to provide a comprehensive panorama for those interested in the concept of technology acceptance. Embedded within this thesis, this chapter serves as an academic exploration, positioned within a broader social landscape entwined with the continuous development and proliferation of new technologies.

4.1. Introduction and overview

In the vast expanse of predictions of the future that have adorned the historical records of the past century, one emerges that can be distinguished by its sheer simplicity and profound implications: the unyielding advancement of technology was to revolutionize every dimension of our quotidian lives. Indeed, the tides of new technologies raised many boats that have put us on the path to different ways of interacting with each other and with the world; and although many technologies that are now commonplace were deemed to be a hopeless venture, others that were deemed a sure success have now faded into oblivion. What distinguishes the two? What makes people more likely and willing to embrace some technologies and not others?

In order to navigate the development phase of new technologies effectively, decision-makers must possess a comprehensive awareness of the factors that sway users' inclinations towards adopting a specific system (Taherdoost, 2018; Mathieson, 1991). Consequently, both practitioners and researchers have been compelled to examine the specific factors responsible for explaining individuals' acceptance of emerging technologies. This exploration is aimed at contributing to the development of enhanced methodologies, dedicated to the design and evaluation of these novel technologies, which foster their acceptance and adoption by the wider community (Taherdoost, 2018; Dillon & Morris, 1996).

Acceptance, in its essence, can be defined as the antithesis of refusal, embodying a positive determination to embrace and utilize a novel innovation (Taherdoost, 2018). In the specific field of technology acceptance, the term *acceptance* has been typically defined as a function of both subjective (attitudes towards a specific type of technology, intention to use) and objective aspects (e.g., purchase, use) that research has deemed to underlie technology adoption (Salovaara & Tamminen, 2009).

The past few decades witnessed an unparalleled technological revolution, and with it, a great number of theoretical models and empirical research aimed at predicting, explaining and documenting its introduction into the daily lives of million of people globally. Namely, the realm of technology acceptance has witnessed the application of diverse models and theories across numerous domains, encompassing areas as diverse as voting behavior (Nemeslaki, Aranyossy, & Sasvári, 2016; Choi & Kim, 2012), family planning (Sono, Meilani, Prihyugiarto, & Karyanti, 2018), blood donation practices (Torrent-Sellens, Salazar-Concha, Ficapal-Cusí, & Saigí-Rubío, 2021; Appiah et al., 2018), usage of cancer screening tools (Vilaro et al., 2021; Nadal, Sas, & Doherty, 2020), transportation mode selection (Yuen, Cai, Qi, & Wang, 2021), educational practices (Kemp, Palmer, & Strelan, 2019), consumer purchasing behavior (W.-Y. Wu & Ke, 2015), and computer utilization (Hamner, 2009).

In this context, scholars and experts within the field have endeavored to construct frameworks that evaluate the adoption of particular technologies developed and implemented within these contexts. Various models and frameworks have emerged, shedding light on the factors influencing user acceptance. In this chapter, we will review the most proeminent models of technology acceptance developed in the past few decades, including the TAM, the Theory of Planned Behavior (TPB), the Theory of Reasoned Action (TRA), and the Theory of Interpersonal Behavior (TIB). Many studies have drawn upon these traditional frameworks over the years, either individually or in combination, adapting and augmenting them with additional constructs to suit their specific research inquiries.

Considering the multifaceted nature of the subject, it is crucial to explore various theoretical approaches to gain a comprehensive understanding of its intricacies (Taherdoost, 2018). By treating these approaches as distinct entities, we can enhance clarity and conduct a thorough examination of the underlying issues. However, to fully grasp the complexities at hand, it is necessary to incorporate a diverse range of theoretical perspectives. Thus, a comprehensive survey of existing adoption models becomes indispensable. This chapter endeavors to present a variety of adoption theories and models, offering an overarching perspective that facilitates a deeper comprehension of these frameworks and theories.

4.2. Theories and definitions

4.2.1. The theory of reasoned action and the theory of planned behavior

The TRA, initially devised in 1975 by Martin Icek Fishbein and Ajzen, held prominence in sociological and psychological research as a theoretical framework intended to predict and explain people's behavior based on their individual's attitudes and subjective norms Ajzen (1980); Ajzen and Fishbein (1975).

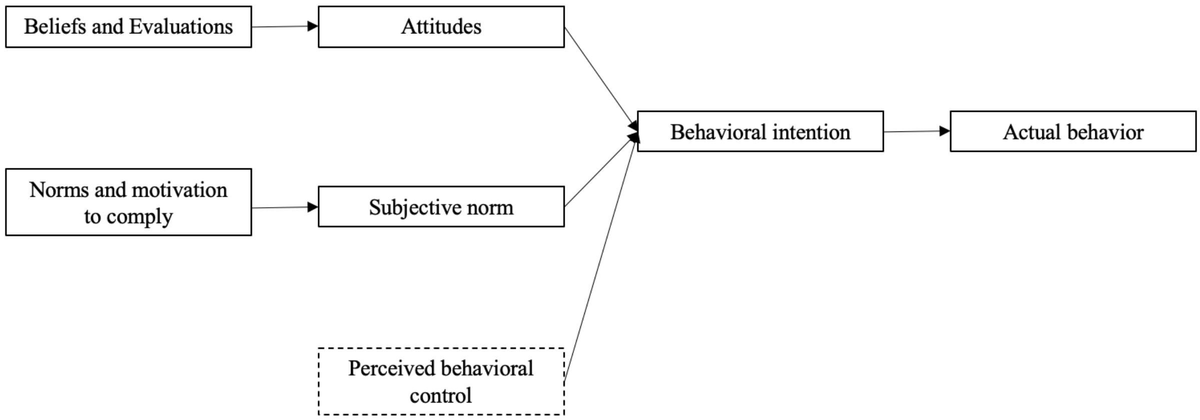


Figure 4.1. Theory of reasoned action and theory of planned behavior.

Although not initially intended to explain technology acceptance and adoption, it quickly turned into the bedrock for delving into individuals' behaviors regarding the (intention to and actual) use of new technologies (Taherdoost, 2018; Legris, Ingham, & Collerette, 2003; Ajzen, 1980; Ajzen & Fishbein, 1975). Within this conceptual framework, human behavior is proposed to be comprehended and forecasted through three pivotal elements: attitudes (reflecting personal preferences or aversions towards a specific behavior), social norms (indicating the impact of social factors on behavior), and intentions (capturing an individual's decision to either engage in or abstain from a behavior; see fig. 4.1).

The individual's attitudes, in this model, are thought to be predicted by the person's beliefs and evaluation of an object or its relation to an attribute (Legris et al., 2003). The social norms, or subjective norms, are primarily shaped by the individual's perception of the prevailing attitudes within their community towards a specific object or technology. Additionally, these norms are influenced by the individual's personal inclination to conform or deviate from the societal expectations imposed upon them (Legris et al., 2003; Ajzen, 1980).

Moreover, this model assumes that human behavior is driven by volition and systematic reasoning, defining the user of technology as a rational agent (Legris et al., 2003; Ajzen, 1980). The model, thus, includes three critical factors for assessing and examining reasoned action, which include volitional control, stability of intentions over time, and precise measurement of intentions across various dimensions such as target, time, context, action, and specificity (Sok, Borges, Schmidt, & Ajzen, 2021; Ajzen & Kruglanski, 2019).

Within this paradigm, the TRA undergoes an expansion by incorporating perceived behavioral control as a novel variable, with this extended model becoming known ad the TPB. Perceived behavioral control, in this context, derives from the interplay of available resources, opportunities, and skills, as well as the perceived significance of these elements in attaining (or refraining them from attaining) their desired outcomes (Ajzen & Kruglanski, 2019; Legris et al., 2003; Madden, Ellen, & Ajzen, 1992). Thus, while both the TPB and TRA acknowledge that an individual's behavioral intention influences their subsequent actions, the TPB uniquely utilizes perceived behavioral control to account for actions that lie beyond the realm of volitional control (Ajzen & Kruglanski, 2019; Legris et al., 2003; Madden et al., 1992).

The inclusion of perceived behavioral control not only introduces a pragmatic consideration of the limitations identified with the TRA (Ajzen & Kruglanski, 2019; Blue, 1995; Madden et al., 1992), but also engenders a factor akin to self-efficacy (Sok et al., 2021). As the initial assumption of perfect volitional control within the theory's framework proved limiting for behaviors that were challenging to carry out (either due to lack of knowledge, skill or resources), hindering individuals from acting on their intentions, a need arose to introduce a variable that could account for such barriers. For this reason, Ajzen introduced the construct of control and revised the theory, leading to the development of the TPB. In the TPB, the level of actual control over a behavior moderates the impact of intention on behavior, with higher levels of control increasing the likelihood of intention translating into action (Ajzen, 1985). Additionally, drawing on Bandura's (1977) concept of self-efficacy, Ajzen proposed that individuals' belief in their ability to perform a behavior can influence their intentions and indirectly affect behavior (Sok et al., 2021; Ajzen, 1985; Bandura, 1977). As a result, perceived behavioral control, reflecting individuals' perceptions of their capability to engage in a specific behavior, was included as a third determinant of intention (see fig. 4.1).

In their most recent conceptualization, Fishbein and Ajzen further expand upon the conceptualization of predictors for intentions within the TPB (Fishbein & Ajzen, 2010). Contrary to the unitary definition of attitude towards a behavior as a simple evaluation, empirical research has identified two distinct sub-dimensions: instrumental factors, which relate to the perceived outcomes of behavior, and experiential factors, which reflect the pleasantness or unpleasantness of behavior. Similarly, perceived behavioral control encompasses two sub-dimensions: capacity, representing individuals' perception of their capability to perform a behavior, and autonomy, referring to the extent to which individuals believe they have control over behavior (Sok et al., 2021; Fishbein & Ajzen, 2010).

Furthermore, building on the work of Cialdini and colleagues, Fishbein and Ajzen (2010) distinguish between injunctive and descriptive aspects of subjective norms (Fishbein & Ajzen, 2010, 2010; Cialdini, Van Lange, Kruglanski, & Higgins, 2012; Cialdini, Reno, & Kallgren, 1990). Injunctive norms pertain to individuals' perception of others' expectations or what is socially desirable, while descriptive norms relate to perceptions of what important others actually do. Descriptive norms provide a connection to social networks and their influence on perceptions of others' behavior. These perceptions collectively influence the perceived social pressure to engage or refrain from a behavior, known as subjective norms (Sok et al., 2021; Fishbein & Ajzen, 2010).

Over the years, despite various proposed modifications and additions to the TRA, the scholarly literature has consistently acknowledged its significant predictive power in the field of technology acceptance and adoption research. Moreover, numerous comparative

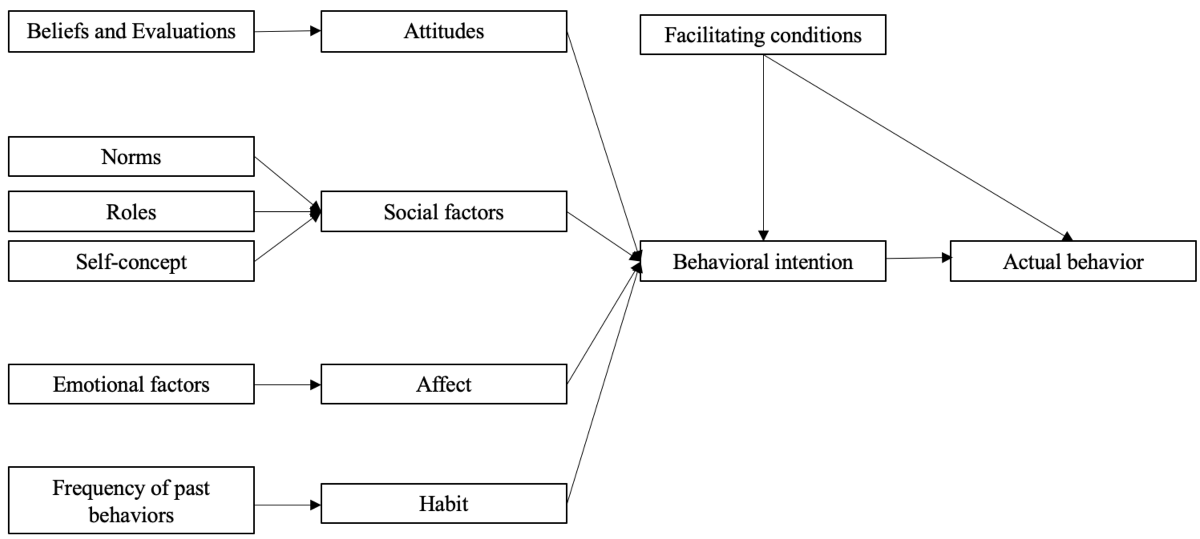


FIGURE 4.2. Theory of interpersonal behavior (adapted from Triandis, 1979).

empirical studies have demonstrated the enhanced predictive capabilities of the model following the inclusion of the perceived behavioral control variable (B. H. Yim & Byon, 2021; Sheeran & Taylor, 1999; M.-K. Chang, 1998; Madden et al., 1992).

4.2.2. Theory of Interpersonal Behavior

Few years after the initial proposal of the TRA, Triandis recognized the significance of social and emotional factors in the formation of intentions, going beyond attitudes (Triandis, 1979, 1977, see fig. 4.2). As a result, the Triandis' TIB extends the constructs of the TPB by incorporating additional factors such as social aspects, affect, habit, and facilitating conditions, that had been neglected in past theories (Gagnon et al., 2003; Triandis, 1979).

Habit, the frequency of past behavior, was identified as a mediator of behavior, along with intentions, moderated by facilitating conditions (Triandis, 1979). The social factor in the TIB encompasses norms, roles, and self-concept, whereas roles and self-concept are not considered in the TPB. Affect refers to emotional factors that can influence intentions and is distinct from rational thinking (Triandis, 1977). Facilitating conditions refer to situational constraints or opportunities for behavior performance (Gagnon et al., 2003; Triandis, 1979, 1977).

While the TPB has been widely applied, the application of the TIB has been relatively limited, even though the few comparative studies that exist demonstrate that it has better explanatory power, either alone or when combined with concepts from the TPB(Russell, Young, Unsworth, & Robinson, 2017; Pee, Woon, & Kankanhalli, 2008; Egmond & Bruel, 2007; Boyd & Wandersman, 1991).

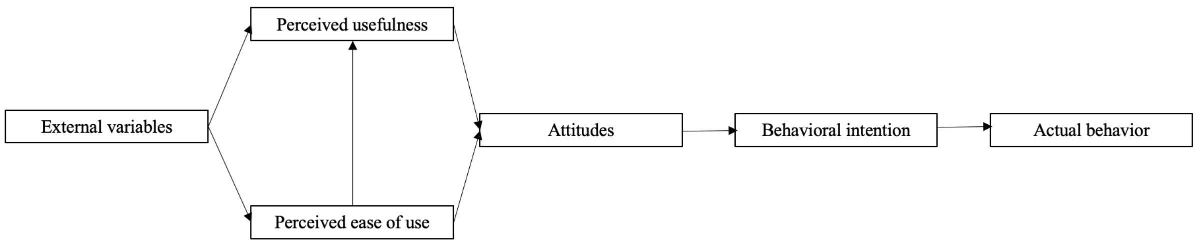


FIGURE 4.3. Original technology acceptance model (adapted from Davis, 1989).

4.2.3. Technology Aceptance Model (and its expansions)

This model, similarly to the previous one, derived from the TRA, and introduced a departure from user subjective norms while addressing the uncertain theoretical and psychometric aspects of the TRA (Taherdoost, 2018; Bagozzi, 2007). Known as the TAM, this model originally elucidated user motivation through three key factors, namely perceived usefulness, perceived ease of use, and attitude toward use, which were thought to explain behavioral intention, and consequentially, actual usage (F. D. Davis, 1989, see fig. 4.3).

Thus, the TAM encompasses not only behavioral intention (which was already present in the aforementioned theories) but also incorporates two critical beliefs, perceived usefulness and ease of use, which significantly shape the user's attitude (F. D. Davis, 1989). These factors manifest as varying degrees of favorability or unfavorability towards the system (M. S. Davis, 1995; F. D. Davis, 1989, 1985). In some cases, additional factors known as external variables, such as user training, system characteristics, user participation in design, and implementation processes, are considered within the TAM framework (Bagozzi, 2007).

Later conceptualizations of the original TAM, removed the attitudes variable after a series of studies demonstrated that both perceived usefulness and perceived ease of use had a direct effect on behavioral intention, thus eliminating the necessity of an intervening factor (F. D. Davis, 1989). Eliminating the attitudes variable also removed any direct unexplained influence from the system's characteristics, thus increasing the parsimony of the overall model (Chuttur, 2009; F. D. Davis, 1989).

During this period, the TAM continued to evolve, and even as of today, it stands as one of the most widely referenced models in the realm of technology acceptance, having garnered substantial empirical support over the past decades (Taherdoost, 2018; Chuttur, 2009; Bagozzi, 2007; King & He, 2006). However, the original TAM still possessed significant limitations, particularly in its exclusion of social influence on technology adoption, which greatly restricted its applicability beyond workplace contexts. More importantly in the context of this thesis, the TAM's focus on instrumental motivations omitted intrinsic motivations, thereby limiting its efficacy in customer-centric and non-work contexts where the acceptance and utilization of information technologies fulfill not only functional tasks but also emotional needs (Bagozzi, 2007; Legris et al., 2003).

As a response to these limitations, the Extended Technology Acceptance Model (ETAM) was devised with the intention of enriching the TAM by incorporating new factors that enhance adaptability, explanatory power, and specificity. The ETAM has emerged from two distinct studies (Venkatesh & Davis, 2000).

The first study, known as TAM2, delved into the antecedents of perceived usefulness and behavioral intention (Venkatesh & Davis, 2000). By incorporating two sets of constructs, social influence (image, subjective norms, and voluntariness) and cognitive factors (result demonstrability, job relevance, and output quality), TAM2 aimed to bolster the predictive capability of perceived usefulness (Venkatesh & Davis, 2000). Notably, TAM2 outperformed TAM in both voluntary and mandatory environments, with subjective norms being the only exception, influencing behavior solely in mandatory settings but not in voluntary ones (Venkatesh & Davis, 2000). Overall, these additions to the TAM, were responsible for approximately 40% to 60% of the variance in participant's usefulness perceptions, and for approximately 34% to 52% of the variance in their usage intentions (Venkatesh & Davis, 2000).

The second study focused on the constructs that influence perceived ease of use, and became known as TAM3 (Venkatesh & Bala, 2008). Antecedents of perceived ease of use were categorized into two major groups: adjustments and anchors (Venkatesh & Bala, 2008; Venkatesh, 2000). Anchors encompass general beliefs regarding the use of computer systems, including enjoyment and objective usability, while adjustments involve beliefs formed based on direct experiences with specific systems, encompassing external control, computer self-efficacy, computer anxiety, and computer playfulness (Venkatesh & Bala, 2008; Venkatesh, 2000). A summary of TAM2 and TAM3 is presented in fig. 4.4.

4.2.4. Unified Theory of Acceptance and Use of Technology (and its extensions)

Venkatesh and colleagues (2003) conducted a comparative analysis of eight models that originated from the fields of sociology, psychology, and communications, and were previously utilized in the context of information systems. These models include the TAM, the TRA, the TPB, model of PC utilization (Triandis, 1979, 1977, or the interpersonal Behavior theory), the diffusion of innovation model (Rogers, 2002), and the motivational model (Vallerand, 1997; F. D. Davis, Bagozzi, & Warshaw, 1992), and social cognitive theory (Compeau & Higgins, 1995; Bandura, 1986). In their work, they tailored and refined the fourteen initial constructs from these eight acceptance theories to develop the Unified Theory of Acceptance and Use of Technology (UTAUT).

The UTAUT identifies four key antecedents to the acceptance of information systems: effort expectancy, performance expectancy, social influence, and facilitating conditions. Moreover, they identified four significant moderating variables: gender, experience, age, and voluntariness of use (Venkatesh, Morris, Davis, & Davis, 2003). The result of this

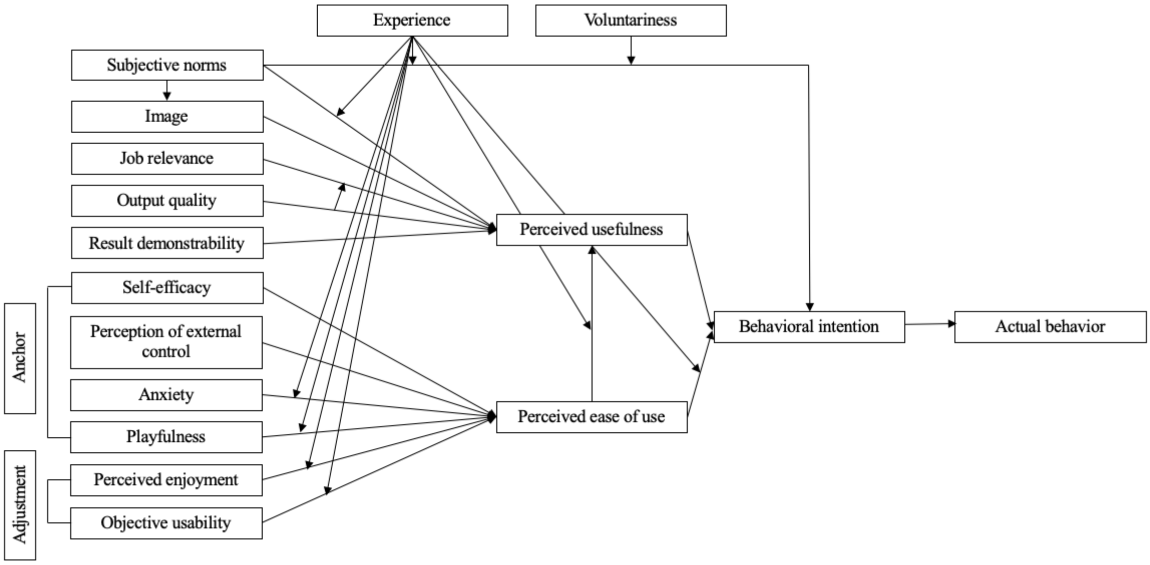


Figure 4.4. Conceptual model for the extended technology acceptance model (adapted from Venkatesh & Bala, 2008)

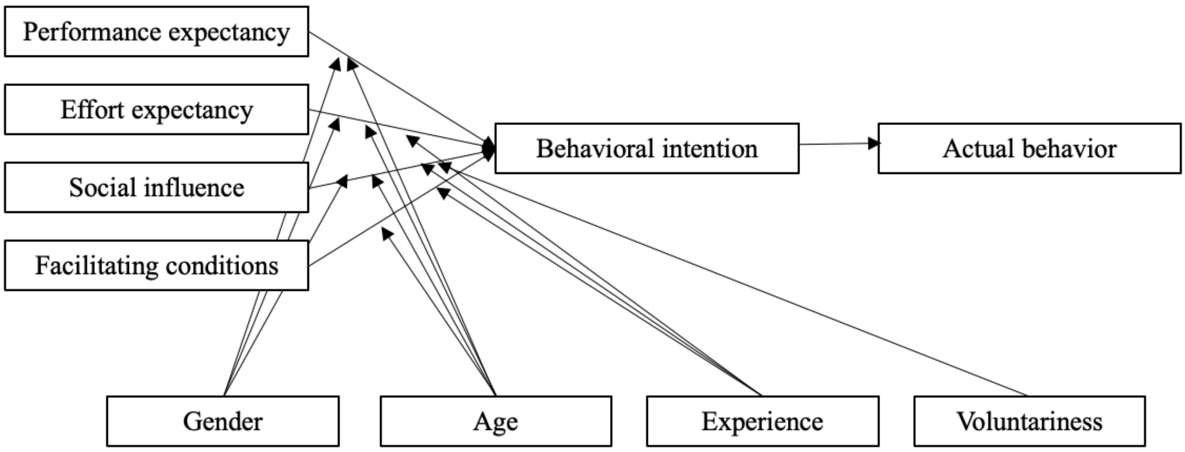


Figure 4.5. Conceptual model for the unified theory of acceptance and use of technology (adapted from Venkatesh and colleagues, 2003).

cross-theoretical integration of concepts was a model that performed better in accounting for the variance in intention to use technology (69%) than any of the eight models upon which it was based (17% - 53%), and thus became one of the most cited and widely applied models of technology acceptance (M. D. Williams, Rana, & Dwivedi, 2015). A conceptual scheme for this model is presented in fig. 4.5.

Similarly to what occurred with the TAM, and in an effort to enhance the explanatory power of the UTAUT, several modifications and extensions have been proposed over the years (A. Chang, 2012). Namely, despite the widespread acceptance of the UTAUT, Venkatesh and colleagues introduced three additional constructs, namely hedonic motivation, price value, and habit, in UTAUT2 (A. Chang, 2012; Venkatesh, Thong, & Xu, 2012).

These new introductions in the model emerged, in the context of a continuously changing technological background, that grew to emphasize the proliferation non-utilitarian technologies (such as videogames), in addition to the utilitarian (work-related) purposes that were the most common in the 70's and 80's when the first technology acceptance models were proposed. This extension significantly enhanced the explanatory power of UTAUT, with an increase in the variance explained in behavioral intention from 56% to 74% and in technology use from 40% to 52% (A. Chang, 2012; Venkatesh et al., 2012).

4.3. Challenges in technology acceptance research

The research on technology acceptance has grown and expanded hand-in-hand with technology for the last few decades. The several theoretical models that have been proposed to explain why people choose to interact or adopt a certain technology, as well as the wealth of empirical literature to evaluate and update those models is a testament of that.

The theoretical frameworks mentioned above, although just a subset of the extensive range of theories on technology acceptance, form a cohesive continuum of evolving ideas. These theories collectively contribute to the academic landscape, against which researchers have attempted to explain and predict individuals' responses, interactions, and influences when (inevitably) confronted with new technology.

In this context, the TRA remains perhaps one of the most influential theories in the field of technological acceptance, due, both to its parsimony and predictive power (Ajzen & Kruglanski, 2019; Taherdoost, 2018; Fishbein & Ajzen, 2010; Ajzen, 1985). Throughout the several adaptations and reformulations of which it was the target of since it was first used to investigate people's reactions to technology, its place on the literature was cemented by providing the initial bedrock upon many of the later theories of technology acceptance that followed were conceived (Ajzen & Kruglanski, 2019; Taherdoost, 2018).

However, despite its merits, the TRA does exhibit certain limitations. Notably, it falls short in addressing the role of habitual behaviors, cognitive deliberation processes, potential misunderstandings arising from survey-based data (pertaining to attitudes, subjective norms, and respondents' intentions), and the moral factors that may influence behavior (Ajzen & Kruglanski, 2019; Taherdoost, 2018).

Some of these limitations, however, were answered in the form of the TPB through the inclusion of perceived behavioral control, and later in the many conceptualizations of the TAM and the TIB through the consideration of factors such as habit, experience and the enjoyment that users derive out of the use of said technology.

The multiplication of different TAM versions over the years is a testament to its relevance and wide applicability (King & He, 2006). Indeed, some have argued that the primary strength of the TAM lies in its simplicity. It posits that usage behavior is influenced by intentions to use, which, in turn, are determined by perceived usefulness and perceived ease of use. This integration of intentions and usage behavior aligns TAM with the TRA and the TPB, replacing the effects of attitudes, subjective norms, and perceived behavioral control found in those models. Notably, TAM consistently surpasses the TRA and TPB in terms of explaining variance across numerous studies (Venkatesh et al., 2003; F. D. Davis, 1989).

However, the growth of this model throughout the years was done at the cost of the parsimony to which it owed its strength, and resulted in a large amount of literature that is difficult to compare and summarize as the result of using different TAM versions. The high level of heterogeneity found in TAM literature has hindered the efforts to aggregate and meta-analyze its findings, which would have otherwise contributed to its cohesiveness and explainability (King & He, 2006).

In addition, most of the endeavors to extend TAM have primarily focused on broadening TAM by introducing additional predictors for perceived usefulness, ease of use or intentions, rather than deepening the model itself. Little attention has been given to explaining the underlying mechanisms of perceived usefulness and perceived ease of use, reconceptualizing existing variables, or introducing new variables that elucidate how the existing ones generate their effects (Bagozzi & Kimmel, 1995).

As a result, significant gaps remain between intentions and behavior, as well as between perceived usefulness and ease of use on one hand, and intention on the other. Although some attempts have incorporated moderators to qualify the effects of perceived usefulness and ease of use on intentions, these have predominantly centered on demographic variables, experience, or simplistic distinctions between voluntary and mandatory contexts of use. However, these tests of moderating effects often lack theoretical insight into the underlying mechanisms and suffer from an overwhelming number of potential moderators, rendering them unwieldy and "*...conceptually impoverished*". (Bagozzi, 2007, p. 244).

Another prominent model of technology acceptance - UTAUT - initially argued that technology acceptance was contingent on *" three direct determinants of intention to use (performance expectancy, effort expectancy, and social influence) and two direct determinants of usage behavior (intention and facilitating conditions)"* (Venkatesh et al., 2003, p. 467). This model ostensibly tried to unify fragments from several different technology acceptance models, aiming to remedy each one's limitations by cladding itself with each one's strengths (Venkatesh et al., 2003).

This unification worked. Due to its extensive use in research on technology acceptance in the decades since its initial publication, which helped enrich the initial model, a revised version of the model suggested a more complex, multi-level, perspective of this model (Venkatesh, Thong, & Xu, 2016). In the revised version of the model, the authors included, in addition to the aforementioned variables, both high-level attributes (including environment, location and organization attributes) and contextual factors (including user, task, technology and time attributes).

Both these models have evolved through time, being shaped both by advancements in research, and advancements in technology. In both cases, they have been applied to the study of the introduction of numerous forms of technology to many different contexts, including e-learning, e-commerce and e-government (M. D. Williams et al., 2015). However, its application to social technologies (i.e. technologies to which social interaction is a core element of functionality e.g., SRs) has been much scarcer, and they have been criticized for overlooking hedonic variables (such as enjoyment, (De Graaf & Allouch, 2013)).

They also share, however, important shortcomings, namely their progressive sacrifice of parsimony in favor of an increasingly complex conceptualization of technology acceptance. For instance, the UTAUT presents a model with 41 independent variables for predicting intentions and multiple variables for predicting behavior (Venkatesh et al., 2003). This raises concerns as important variables may have been overlooked, and future research is likely to uncover additional predictors beyond the existing ones, which will likely result in further expansions of the model (J. Wu & Du, 2012; Bagozzi, 2007).

Nonetheless, despite the unruly proliferation of these models into increasingly intricate and empirically challenging and interwoven branches, what is perhaps more disconcerting is the examination of the problems that lie at their roots. Namely, across all technology acceptance models discussed here, the presumed linkage between intention and behavior stands as one of the most common and least critically examined assumptions (J. Wu & Du, 2012; Bagozzi, 2007), even though it has been established that *"(...) behavioral intention is not a good surrogate for use"*. (J. Wu & Du, 2012, p. 680)

This issue encompasses three key aspects. Firstly, models that rely on this assumption (e.g., TAM, TRA, TPB) often treat behavior as an ultimate objective, neglecting the fact that many actions are undertaken not solely as ends in themselves, but rather as means to more fundamental objectives or goals (J. Wu & Du, 2012; Bagozzi, 2007). For instance, the adoption of new technologies often serves the purpose of enhancing the accuracy and efficiency of information storage, processing, and utilization compared to existing methods (Bagozzi, 2007). TAM, with its emphasis on usage, tends to overlook the actual benefits derived from utilization and their attainment. The gap between usage and goal achievement is largely disregarded in TAM, except as an anticipated belief within the model (Kemp et al., 2019; J. Wu & Du, 2012; Bagozzi, 2007).

Secondly, given the temporal gap between intention formation and action initiation, which can be substantial and fraught with unforeseen obstacles, it becomes crucial to explore the psychological and practical steps that unfold between these two phases. This further underscores the existence of an intention-behavior gap (Bagozzi, 2007).

Thirdly, decision makers, aware of potential hindrances and temptations following their commitment to act, perceive their circumstances as uncertain and requiring ongoing effort in a dynamic fashion. As a result, decision makers often focus on adopting a course of action or acquiring a technology, thereby altering their orientation in fundamental ways that extend beyond mere behavior *per se* (Bagozzi, 2007; Bagozzi & Edwards, 1998; Bagozzi & Kimmel, 1995). In the context of technology adoption/acceptance/rejection, this perspective underscores the importance of conceptualizing it as a process shaped by goal striving (Bagozzi, 2007; Bagozzi & Dholakia, 1999; Bagozzi & Kimmel, 1995).

Goal striving involves a sequence of steps following intention formation, such as planning (including considerations of when, where, and how to act instrumentally), overcoming obstacles, resisting temptations, monitoring progress toward goal achievement, readjusting actions, sustaining effort and willpower, and reevaluating and potentially revising goals and means (Bagozzi, 2007; Bagozzi & Dholakia, 1999). These processes might fill the gaps between intention and behavior and between behavior and goal attainment, and constitute elements that although disregarded by most models of technology acceptance, can play a crucial role in the successful adoption and use of technology (Bagozzi, 2007).

4.4. Humor, hedonism and technology acceptance

As highlighted above, traditional models of technology acceptance have emphasized the role of utilitarian variables, such as perceived ease of use and usefulness (F. D. Davis, 1989, TAM), and performance and effort expectancy (Venkatesh et al., 2003; Venkatesh & Davis, 2000, UTAUT); with the latter, and more recent model, also acknowledging more social and intrapersonal dimensions (such as intrinsic motivations and perceived enjoyment (Venkatesh et al., 2003; Venkatesh, 2000; Venkatesh & Davis, 2000)).

However, despite its inclusion in UTAUT2, still little is known about the role that the pleasure that users derive from their interactions with a specific technology plays as a determinant factor in predicting their decisions to adopt it into their lives when compared to other variables (Tamilmani, Rana, Prakasam, & Dwivedi, 2019). The ramifications stemming from this gap in the literature are many and intricate, yet its origins can be primarily attributed to one main factor.

Primarily, as previously highlighted in relation to humor research, the study of technology acceptance has been itself also influenced by the prevailing zeitgeist - thus leading to the emphasis put on utilitarian variables -, although with a notable distinction: the subject of investigation of the latter has undergone a much more *rapid* and *unpredictable* evolution.

Notably, the profound recognition prevails that the technological progress achieved throughout the 20^{th} century has become the cornerstone for many, if not most, of the successful operations and exchanges between different interdependent societies and economies. From an historical perspective, the short years between 1867 and 1914 saw the emergence of some of the most dramatic technological revolutions (e.g., telephone, car, lightbulb) which allowed increased power, efficiency, durability and flexibility (Arthur, 2009).

The later invention of computers in the 20th century was too a monumental milestone that revolutionized the course of human history. The first working general-purpose computer, known as the Electronic Numerical Integrator and Computer (ENIAC), was developed by John W. Mauchly and J. Presper Eckert at the University of Pennsylvania in the United States (Arthur, 2009). Completed in 1945, ENIAC was primarily designed to aid in military calculations during World War II, specifically for the U.S. Army's artillery trajectory calculations. However, quickly after these technologies begun garnering more acceptance and leaving the limited (yet, useful) circumpscrit environments to which they were devised, its true potential for applicabilty became more evident (Arthur, 2009).

In the 1950s and 1960s, businesses started adopting mainframe computers. By 1965, over 10,000 mainframe computers were in use worldwide, with companies like IBM leading the way in their production and deployment. The use of this new technology was argued to lead to great surges in productivity, and as the cost of production for these machines dropped in the 70s and the use of the internet prolliferated in the 90s, they became a staple of everyday life. Since then, the invention and widespread integration of computers have not only transformed the way we live and work but have also fueled unprecedented advancements, connectivity, and opportunities on a global scale.

This early focus on how computers (and other technologies) could increase efficiency and productivity in the sphere of the industrial and business worlds, the places where they could most commonly be encountered, meant that early technology acceptance researchers focused most often on variables related to utilitarian and instrumental variables (Tamilmani et al., 2019; Taherdoost, 2018; Marangunić & Granić, 2015). It also meant that, since these new technologies were primarily being introduced to the public in contexts in which they were intended to facilitate transactional exchanges of an instrumental nature, much emphasis was put on goal-orientation in early technology acceptance models and research (Tamilmani et al., 2019; Marangunić & Granić, 2015).

Indeed, a look at the research on technology acceptance published in the early 70s and 80s shows a predominant focus on the investigation of such type of exchanges, with researchers focusing on people's interactions with technologies like e-banking and eletronic e-mail platforms (Marangunić & Granić, 2015; Surendran et al., 2012; Y. Lee, Kozar, & Larsen, 2003; Legris et al., 2003)

The need for models that could include non-utilitarian variables, and that were useful in predicting the acceptance and adoption of technology outside of these formal environments was one that was recognized from very early on. In this context, early researchers alerted for the need to better understand how technology was received, and in turn influenced our interactions in more personal spaces, like our homes (Cowan, 1976, p. 1):

> When we think about the interaction between technology and society, we tend to think in fairly grandiose terms: massive computers invading the workplace, railroad tracks cutting through vast wildernesses, armies of woman and children toiling in the mills. These grand visions have blinded us to an important and rather peculiar technological revolution which has been going on right under our noses: the technological revolution in the home.

However, the issues that arose from this narrow orientation for goal-oriented, instrumental interactions with technology -which motivated this thesis - only became more evident with the passing of the years, as the evolving landscape of technology grew to accommodate an increasingly diverse range of uses and social roles (Tamilmani et al., 2019). In a practical sense, this meant that our interactions with technology evolved hand-in-hand with technology itself, and as the space technology occupied in our lives increased, we came to form emotional relations with it that far surpassed the utility to which they were created (Kool & Agrawal, 2016, p. 255):

> (...) for most objects we have some sort of emotional reaction. As a matter of fact, our attitude toward technology, too, is hardly ever neutral. Tools are not mere tools that we use and then forget about them till we need them again. Technology cannot be considered to be simply a means to help us achieve our desired ends. Some objects give you pleasure, others frustrate you. And, the pleasure/displeasure seems to vary from person to person. What do you think about a vacuum cleaner or the garbage dispenser in your home? Not much, I guess. These are mere tools that we use as and when we need them. On the other hand, if you have grown up with that vacuum cleaner, or if the vacuum cleaner was given to you by your mother on a special day, say when you bought your first home, you would find yourself feeling sentimental about this gadget. You are emotionally attached to that humble vacuum cleaner. If that vacuum cleaner is one that you never liked because you found it difficult to move around, your attitude toward it would be different.

The process through which we attribute these emotional qualities to technological objects is still not entirely understood, and, like other hedonic factors, were not included in early technology acceptance models, which only much later came to recognize its importance. Nonetheless, some authors have argued that these flexible interactions that we develop with technology might be the result of the evolving scope of said technology's *affordances* (Kool & Agrawal, 2016; Norman, 2014).

These affordances, which refer to the set limit to which a technology can be used, are defined not through the strict set of the prescribed uses of the technology, but through our perceptions of it (Kool & Agrawal, 2016; Norman, 2014). Take the following example (Kool & Agrawal, 2016, p. 256):

> Objects have salient features and we use them on the basis of our perception of these features. Let us think of a container such as the one we use in our homes to store groceries such as sugar. It has a shape, needs space to be kept, and must be placed in a vertical position to hold the stuff and avoid spilling it. Beyond this basic use, we may find various other uses for the container, such as using it as a support for another object, say a photo frame, or as an aquarium for newly bought fish (...).

As many of the most influential models of human behavior agree with the assumption that behavior is a result of the interplay between emotions and cognition (Pessoa, 2008; Minsky, 2007; Khalid & Helander, 2006; Kahneman, 2003; Simon, 1991); and given that

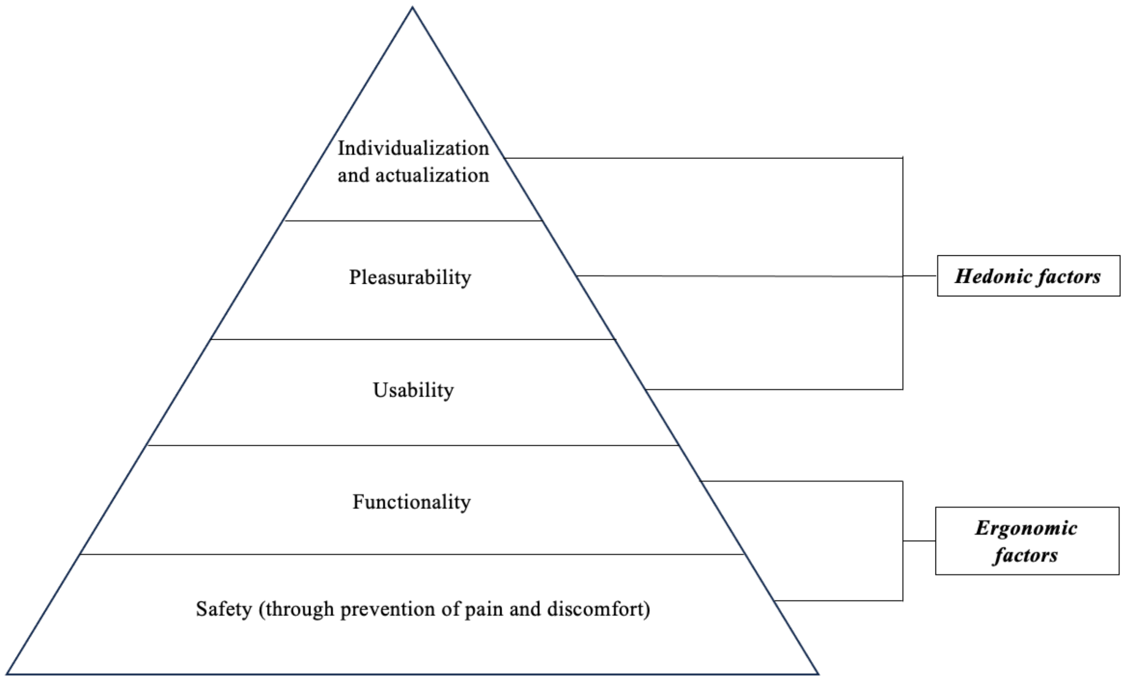


Figure 4.6. Conceptual model of the relation between ergonomic and hedonic factors in interactions with technology as a response to the user's needs (adapted from Hancock, Pepe & Murphy, 2005 and Kool & Agrawa, 2016).

the acceptance or rejection of any given technology is in itself a part of our behavior, why should we not then expect to observe the same dynamics in our interactions with technology as we observe in our interactions with other objects (Kool & Agrawal, 2016)?

The diverse set of affordances provided by most technological artifacts, makes it so technology can fulfill more than its user's goal-oriented needs and is the anchor for the multitude (and degree) of the sociability and emotional reactions that we attribute to it (Kool & Agrawal, 2016; Norman, 2014; Hancock, Pepe, & Murphy, 2005). As such, successful interactions with technology need, not only to consider aspects related to the ergonomic qualities of the object (which support utilitarian, goal-oriented interactions), but also the hedonic factors inherent to the interaction with said technology (see fig. 4.6).

In this context, the recent development and growing introduction of more social technologies, such as SRs has offered an interesting arena for the investigation of how these hedonic factors motivate and influence HMI. This is particularly noteworthy because SRs are, by definition a type of technology that revolve around social interaction and that encompass a distinctive range of affordances designed to facilitate or derive from *social* engagement. Indeed, much of the research on how we interact with SRs has been guided by a theoretical framework which argues that we apply many of the interaction schemas that we use when interacting with other people, to SRs, due, precisely to the social affordances they offer both through their embodiment, and through the mode of social interaction they allow (see chapter 5).

With this in mind, and although the set of different hedonic and intrinsically-motivation factors that could be investigated in relation to technology acceptance is vast, in this thesis we opted to focus on the role of humor. Not only because of its particular hedonistic nature and its association to entertainment-based interactions, but also because its particular role in interpersonal perceptions and interactions.

Namely, given the many benefits that it offers (as previously discussed in chapter 3), it is not surprising that humor is considered to be an important factor in the way we perceive others. In fact, we tend to seek out people who make us laugh (Greengross, 2013; Dunbar & Mehu, 2008); with others partaking in our sense of humor being seen as a favorable trait that enhances relational well-being (Kurtz & Algoe, 2017), increases attraction (Fuchs, Rathcke, Ginzburg, & Pelachaud, 2018) and relational satisfaction (Bazzini, Stack, Martincin, & Davis, 2007).

In this thesis, we will, thus explore how these effects of humor on human perception translate to object perception, and in particular, to those objects with capabilities that can support complex social interaction through the display of both verbal and nonverbal cues (namely, SRs).

Although research on this topic is still at its infancy, previous research delving into the effects of user's interactions with other technologies indicates that humorous features can have a positive effect on user experience (Y. Wang, 2020), engagement in online social networks (Imlawi & Gregg, 2014) and interaction with virtual agents (A. I. Niculescu & Banchs, 2019).

The TAM has also been applied to predict users' acceptance of SRs in contexts like schools (E. Park & Kwon, 2016) and elder care facilities (Ke, Lou, Tan, Wai, & Chan, 2020). These studies largely replicate the structure of the original TAM, with perceived usefulness and ease of use maintaining their predictive roles of user's intention to use, but they also add new factors such as perceived enjoyment, perception of the quality of the service provided by the robot (E. Park & Kwon, 2016; De Graaf & Allouch, 2013), adaptability and sociability (De Graaf & Allouch, 2013).

However, previous research has demonstrated that these beliefs about the ease of use and usefulness of robots are not static. In fact, engaging in constructive behavioral interactions with SRs improves not only perceived usefulness, but also attitudes towards technology in general over time (Ke et al., 2020).

Other important individual factors in predicting acceptance of SRs are the user's anxiety related to the use of said technology and the trust they place in it, which are both thought to directly influence the user's intention to use it (Heerink, Kröse, Evers, & Wielinga, 2009). Research has also suggested that environmental and social factors (in particular, facilitating conditions and social influence) are important determinants of usage intention (Forgas-Coll, Huertas-Garcia, Andriella, & Alenyà, 2022; Heerink et al., 2009).

Additionally, individual characteristics, such as gender, have been shown to have an effect on user's acceptance of SRs in entertainment settings, with women anchoring their acceptance mainly around social influence and perceived enjoyment; and men anchoring their acceptance mostly around perceived usefulness (Forgas-Coll et al., 2022). However, although there are already some studies that attempt to explore the effects of humor in HRI , to the best of our knowledge, there are still no empirical studies addressing the role of humor in HRI through the specific lens of the TAM.

Moreover, in the specific context of SRs, the introduction of more socially-oriented variables, such as trust, enjoyment and social presence, seems to improve UTAUT-based models in terms of their ability to predict use and intention to use (Heerink, Kröse, Evers, & Wielinga, 2010; D.-H. Shin & Choo, 2011; De Graaf & Allouch, 2013). In addition, and in accordance with the revised UTAUT, researchers in social robotics have also emphasized the need to take into account the characteristics of the robot (e.g., embodiment), of the user (e.g., sex) and the interaction between them (De Graaf & Allouch, 2013).

Our goal in the following chapters will be to examine on how adding humor in our interaction with SRs can contribute to its improvement by having a favorable effect on our perceptions of the SR's social affordances.

CHAPTER 5

Humor and perception of robots

Robots were pop-culture icons before they even existed. They were space creatures and monsters. When robots really started existing, they already had this whole image set up not based on reality. It'd be like if someone found a living mummy and he was actually a really nice guy but we'd only ever seen evil mummies in fiction. That's exactly what happened – a movie monster became real.

Daniel H. Wilson

Abstract

Humor is a pervasive feature of everyday social interactions that might be leveraged to improve HRI. Our goal is to evaluate how the use of humor can improve HRI and enhance the user's perception of the robot, as well as to derive implications for future research and development of humorous robots. We conducted a systematic search of 7 digital libraries relevant in the areas of HRI and Psychology for papers that were relevant to our goal. We identified 431 records, published between 2000 and August of 2020, of which 12 matched our eligibility criteria. The included studies reported the results of original empirical research that involved direct or video-mediated interaction of humans and robots. Humor seems to have a positive effect in improving the user's perception of the robot, as well as the user's evaluation of the interaction. However, the included studies present a number of limitations in their approaches to robotic humor that need to be surpassed before reaching a final verdict on the value of humor in HRI.

5.1. Introduction and overview

The Computers are Social Actors (CASA) paradigm argues *"... that the social rules and dynamics guiding human-human interaction apply to human-computer interaction"* (Nass et al., 1996, 1994) (p. 670). This idea has been extended to many types of technological artifacts including smartphones (W. Wang, 2017) and SRs (K. M. Lee, Peng, Jin, & Yan, 2006), and its effects have been demonstrated to be culturally robust (Katagiri, Nass, & Takeuchi, 2001). As humor has demonstrated a broad array of psychological, physical and interpersonal positive effects in interpersonal interactions, it follows that the same effects should be observed when employing humor in interactions with technological artifacts.

The recognition and modeling of humor is a multidisciplinary challenge that has caught the attention of many researchers in the past few decades (Nijholt, 2016; Nijholt, Niculescu, Valitutti, & Banchs, 2017). A recent short survey on the use of humor in Human-Computer Interaction (HCI) has demonstrated the many possible applications and benefits of using humor in virtual environments and in HRI (Nijholt et al., 2017; Giger et al., 2019).

The authors of this survey argue that humor can enhance HRI by reducing the tension in the interaction and by lowering the users' expectations regarding the interaction. This is important as robots are continuously being built to display increasing levels of human resemblance, which on one hand brings familiarity, but on the other, brings heightened (and sometimes unrealistic) expectations of robots and possible feelings of eeriness or uncanniness (Nijholt, 2016).

In addition, some authors have also argued that humor can help make transparent communication between robots and their users' more naturalistic and less cumbersome, especially within error communications and clarification queries (Raskin, 2008). Humor can also contribute towards making SRs appear friendlier and more human when they fail, thus easing the interaction and having a positive effect on users' perceptions about their computerized counterparts (Binsted et al., 1995; Nijholt, 2016).

As a result of the extensive list of possible functions and advantages that humor might implicate for HRI and HCI, a large amount of research has been conducted to tackle this issue. Some surveys have been written in the past few years to cover these advances (Mulder & Nijholt, 2002; Nijholt, 2018a; Nijholt et al., 2017), however, to the best of our knowledge, no systematical search and review has been conducted. By systematizing the results of previous studies in this area, we seek to identify the gaps in our knowledge of the effects that humor can have in HRI. We aim to map out possible future avenues of research in this domain that can fill those gaps in order to achieve a holistic representation of the role of humor in HRI.

5.1.1. Goals and Research Questions

The goal of this review is to summarize the results of quantitative studies involving humor manipulations (both verbal and non-verbal) in the context of HRI, and to assess the effectiveness of such interventions. In addition, we seek to map the current methods that are employed by researchers studying humor in HRI, to outline the strengths and limitations of such studies, and to offer suggestions for future avenues of research in this domain. To achieve this goal, we will systematically search for all papers detailing original empirical studies involving HRI in humorous settings. We seek to respond to the following research questions (RQ):

- ◇ RQ1: What are the extrinsic characteristics of the studies tackling humor in HRI? In particular, we are interested in understanding the overall quality of the research conducted thus far in this domain and the contexts in which humor has been employed to enhance HRI.
- ◇ RQ2: What is the role of humor in HRI? The second goal of this review is to identify the interaction outcomes that have been observed as a result of the introduction of humor in HRI. We are also interested in understanding how individual differences across users have an effect on the user's appreciation of humor in their robotic partners.
- ◇ RQ3: How is humor being studied and measured in HRI? Finally, we seek to identify the technical and methodological characteristics of the systems that have been developed to create and study humorous interactions in HRI.

5.1.2. Pre-registration and Protocols for Review

This review was pre-registred in PROSPERO with the following reference: CRD42020135724. The protocol for data collection, synthesis and reporting followed the PRISMA guidelines, as recommended for systematic reviews and was established before the data collection process (Moher et al., 2015).

5.1.3. Sources of Information

For this review, and due to the multidisciplinary nature of the topic, we conducted searches on online digital libraries relevant to both psychology and HRI. In particular, we conducted searches on ACM (Association of Computing Machinery) digital library, Science Direct, EBSCO, IEEE (Institute of Electrical and Electronics Engineers) and Scopus. After selecting all relevant papers that matched our eligibility criteria, we read each one and sought for other papers that could also fit our inclusion criteria in the reference section of each paper. In addition, we searched OSF, Google Scholar and Researchgate for pre-prints and unpublished works (grey literature) that could be relevant to our goals.

5.1.4. Data Collection and Eligibility Criteria

The search was last conducted during the month of September 2020. The keywords used for the independent variable were connected by boolean operators and wildcards, and were as follows:

("humor*" OR "humour*" OR "fun*" OR "jok*" OR "comed*" AND "robot*") [Title/Abstract or Keywords]

At this stage, we decided not to restrict our search using more exclusive keywords in order not to exclude papers that could be relevant to our goal that used different terminology.

Furthermore, we limited the inclusion of papers in this review according to 3 criteria. First, we only included papers published between January 2000 and August 2020.

Second, within all papers published during this time interval, we only included quantitative empirical studies reporting original research, resulting from experiments that involved direct or indirect (video) interaction with one or more SRs and in which the independent variable under analysis was directly related to humor (verbal or non-verbal).

We did not include studies that sought to analyze the role of humor as a performative form of expression and entertainment, such as the extensive list of studies analyzing manzai robotic performances (e.g. [20, 68, 69]) or reports concerning robotic stand-up comedy [26, 27]. A recent survey detailing the state of art of research in that specific domain has already recently been conducted by [53].

Thirdly, we only included papers that presented an abstract and were published in English.

5.1.5. Coding, Extraction and Quality Appraisal

The papers that matched our inclusion criteria were coded based on the following information: (1) extrinsic characteristics, (2) methodological characteristics and (3) results observed.

In regards to the first category, we collected relevant information about each study considered that was not related to methodological aspects, including (a) year of publication; (b) journal or conference proceedings in which the study was originally published and its' classification according to Scimago; (c) country of the first author and (d) information regarding funding entities and Ethical Committee approval.

Secondly, we collected information directly related to the methodological characteristics of the studies in consideration, which included (a) type of study (experimental, quasi-experimental or correlational), type of study-design (within or between-participants) and type of interaction (one-to-one or group; if in group, we also collected information regarding the composition of the group); (b) information regarding the sample used in the study (sample size, female percentage, mean age and occupation); (c) information regarding the materials used, in particular, the robot used and its embodiment and (d) information regarding the operationalization and the dependent and independent variables, measured and manipulated in each study.

Thirdly, we collected a summary of the results reported for each study.

The titles and abstracts of all studies were extracted jointly by two coders who are experts in the area of psychology. These two coders were informed of the goals and eligibility criteria of the present study and they jointly selected all the studies that fit those criteria.

A third coder, who is one of the authors of this paper, worked with the coders in order to solve possible disagreements and held bi-weekly meetings to assess the development and answer any questions the coders had. The three coders also jointly analysed the references of each paper in order to extract papers that could be relevant to this review and then searched OSF (Open Science Framework), Google Scholar and Researchgate and repeated the aforementioned process of conflict resolution.

After all relevant studies were identified and extracted, the two original coders coded them separately according to the pre-defined coding scheme. Disagreements were then again solved by a third coder jointly with the two primary coders until full agreement was achieved.

Regarding the quality appraisal, the same coders involved in the aforementioned process, scored each paper included using the coding scheme proposed by (Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012). This coding scheme involves three main dimensions that cover (1) the suitability of the research design, methods, and data analysis to the goals and research questions in consideration, (2) the ecological validity of the study, and (3) the relevance of the methods used in relation to the research questions posed. Each of these dimensions could receive individual scores ranging from 1 to 5, resulting in overall quality scores (corresponding to the sum of the scores for each dimension) ranging between 3 and 15 (fig. 5.1).

5.1.6. Results

5.1.7. Quality and Extrinsic Characteristics of Humor Research in HRI

All but two of the 12 papers included in this review were published in conference proceedings in the area of computer science and human–computer/robot interaction. The two papers which were published in journals, were published in high-ranked journals

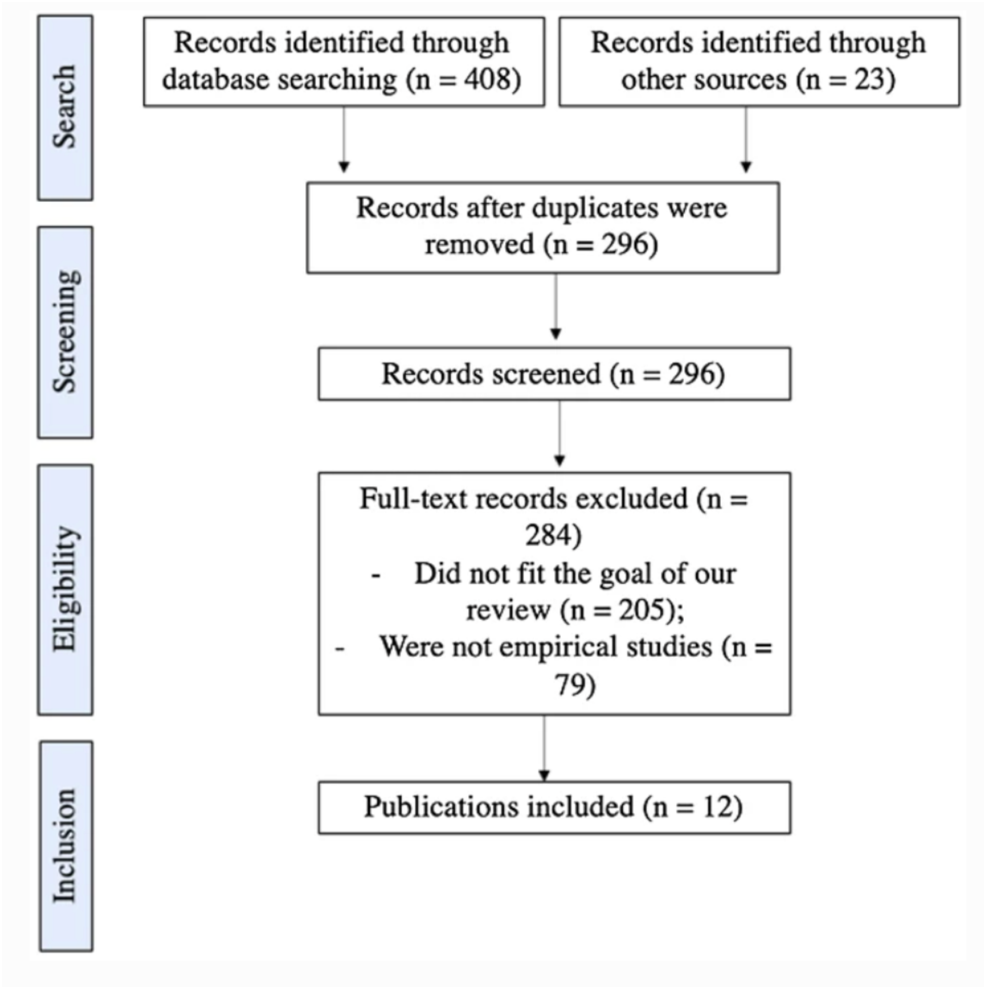


FIGURE 5.1. PRISMA diagram detailing the search and screening processes

(Q1; (A. Niculescu, van Dijk, Nijholt, Li, & See, 2013; Tay, Low, Ko, & Park, 2016)) in the same thematic areas. Seven of the publications reported funding information (Devillers et al., 2015; Mirnig, Stadler, Stollnberger, Giuliani, & Tscheligi, 2016; Mirnig, Stollnberger, Giuliani, & Tscheligi, 2017; A. Niculescu et al., 2013; Sjöbergh & Araki, 2008; Stoll, Jung, & Fussell, 2018), whereas the other five did not. None of the authors of the publications included in this review reported submitting or receiving approval from an Ethical Committee nor pre-registering their work before the commencement of the experiments.

Seven studies reported using the NAO robot developed by Softbank Robotics in their experiments (Bechade, Duplessis, & Devillers, 2016; Devillers et al., 2015; Menne, Lange, & Unz, 2018; Mirnig et al., 2016, 2017; Tae & Lee, 2020; Tay et al., 2016), one of which used it together with the iCat robot (Mirnig et al., 2016). One study used the Olivia robot, another study used the Reeti robot (K. Weber, Ritschel, Aslan, Lingenfelser, & André, 2018) and another used Romeo robot (Stoll et al., 2018). The two remaining publications reported using Robovie-i (Sjöbergh & Araki, 2008) and a Pioneer P3-DX robot (Wendt & Berg, 2009).

Only two studies reported the results of group interaction scenarios and both of them reported on experiments in which one human participant interacted with two robotic devices (Mirnig et al., 2016; Sjöbergh & Araki, 2008).

Most of the studies did not present a clear definition of humor, with the exception of the paper written by Wendt and Berg (2009), which defined humor as a *"... quality of action, speech, or writing which excites amusement"* (Wendt & Berg, 2009, p. 185) and the paper written by Tay and colleagues (2016), which adopted the theoretical framework of the Incongruity–Resolution theory (Tay et al., 2016). One of the studies (Stoll et al., 2018) used constructs related to the styles of humor advanced by Rod Martin, but made no direct mention to the work of this author (R. A. Martin et al., 2003).

All studies, with the exception of the studies by Wendt & Berg (2009) and Mirnig and colleagues (2017), operationalized humor in the shape of verbal jokes or humorous remarks. Wendt and Berg (2009) operationalized non-verbal humor as situational humor: in their experiment the humorous robot pranked the participant (by giving it a box with a paper snake, when the participant requested a box of chips), by pulling away an object that the participant wanted to grab from the floor and by dancing to the sound of music. The studies by Mirnig and colleagues (2016, 2017) also included situational humor, however, it was accompanied by verbal utterances spoken by the robots.

The majority of the remaining 8 studies used prompt or canned humor (Devillers et al., 2015; Menne et al., 2018; Sjöbergh & Araki, 2008; Tae & Lee, 2020; K. Weber et al., 2018, i.e. the robot told pre-determined jokes). Two studies used conversational humor (A. Niculescu et al., 2013; Stoll et al., 2018, i.e. humor that was embedded in a conversational context between a human and a robot). One study employed both types of humor in order to see its effects on the participants' responses to the humorous comments of the robot (Bechade et al., 2016).

The overall quality of the studies included in this review was good ($M = 3.67$, $SD = 0.13$). In particular, the coders agreed that the majority of the studies included in this review focused on relevant variables to answer their research questions and goals and that these studies addressed relevant questions for the study of humor in HRI ($M = 4.50$, $SD = 0.47$). In addition, the research design, methods and data analysis strategies described in the publications included in this review also presented satisfactory levels of quality ($M = 3.50$, $SD = 0.50$). The factor of quality with the lowest scoring was the generalization of the results described to the wider population ($M = 3.00$, $SD = 0.70$). This low score is due mainly to the lack of statistical power resulting from insufficient or non-representative samples.

Overall, all studies included in this review involved a total of 1100 participants, resulting in an average of 85 participants per study. However, this total is inflated by one study that used a sample particularly large sample ($n = 548$; (Stoll et al., 2018)). If we do not consider this study, the average number of participants per study drops to nearly half 42.28. Two studies did not present information regarding its participants' ages (Sjöbergh

& Araki, 2008; Devillers et al., 2015). The remaining studies were comprised of participants between 18 and 86 years old. Most of the studies included ($n = 7$) used samples in which the mean age of participants was below 35.

5.1.8. Humor in HRI

Seven of the publications included in this review reported the results of experiments that involved direct interaction with SRs. The remaining five reported the results of experiments in which participants saw a video of a SR displaying some type of humoristic capability. Given that several studies suggest that the embodied presence of a robot (versus the virtual presence) can have an effect in variables that are important in the context of our review, such as engagement (Bainbridge, Hart, Kim, & Scassellati, 2008), the results of studies involving direct interaction with robots and of studies involving video interaction will be presented separately.

5.1.8.1. *Humor in direct HRI* A summary of the main variables and results from the studies included in this review involving direct interaction with SRs is presented in table 5.1.

TABLE 5.1. Studies including direct interaction with social robots in humorous scenarios.

Study	***Sample size***	***Age***	***Dependent variables***	***Independent variables***	***Summary***

Wendt & Berg, 2009	32 (31%F)	$M = 29$	Perceived characteristics of the robot and the subjective quality of the HRI	Non-verbal humor versus no humor	The funny robot was perceived as being more human-like, more likable, funnier to interact with, more entertaining and was judged as more likely to be able to cheer people up. The funny robot was also perceived as being more patronizing, more annoying and less reliable than the robot that did not display humor (although the values for these variables were very low in both conditions). Humor did not have an effect on the perceived intelligence of the robot nor on its overall appealing value. Humor improved the perceived interaction quality.
Sjöbergh & Araki, 2018 (a)	60 (28%F)	N/A	Perceived funniness of the jokes	Form of delivery (Jokes told by a robot versus jokes in a written format)	Some jokes (2/10) were perceived as being significantly funnier when told by a robot than when read by participants. Both the written jokes and the jokes told by the robot are highly correlated in terms of funniness

Sjöbergh & Araki, 2018	60 (28%F)	N/A	Perceived funniness of the jokes	Reaction of a robot to the jokes (Laughter versus booing versus no reaction)	A robot reacting to a joke told by another robot increases the perceived funniness of the jokes when compared to a situation in which no reaction is observed from the second robot
Niculescu et al., 2013	28 (37%F)	77.8%-under 30 years old	Participants' perception of the robot, the task and the similarity between the robot and themselves.	Humor, pitch (high versus low) and display of empathy	The robot displaying humor was considered to have a more appealing speaking style, a stronger, more emotional and more extroverted personality and better social skills. The task was perceived as being more enjoyable when interacting with the robot displaying humor than with the one not displaying humor. Humor did not affect trustworthiness or likability

Devillers et al., 2015	45 (31%F)	N/A	Participants' perception of the robot and the interaction	Type of data collection system in humorous interactions (paralinguistic system; linguistic system; Wizard of Oz (WoZ))	Participants' desire to interact again with the robot increased over time. Participants felt that the robot was friendly, adapted to them and was amusing in all three conditions
Bechade et al., 2016	49 (45%F)	21–86 years old	Participants' responses to humor	Type of humor (canned jokes versus conversational humor)	The authors found three main categories of responses to robotic humor: (a) recognition of the attempt at humor; (b) replying with more humor and (c) no humor support (defined as the lack of acknowledgement of the attempted joke). No humor support is more frequent after conversational humor, whereas the recognition of the robots' attempted humor is more frequent after canned jokes. The authors observed differences related to age in terms of the type of responses to robotic humor, but no sex differences

Weber et al., 2018	24 (50%F)	18–29 years old	Amusement level	Display of humor adapted to the user's preferences versus pre-programmed humor	The display of user-tailored humor did not have an effect on the amusement level reported by participants
Tae et al., 2020	60 (58%F)	$M = 24.78$; $SD = 4.52$	Likeability and future intention to interact with the robot	Timing of the robot's display of humor (before and in between two tasks; during the task) versus no humor	Humor displayed by a robot at the beginning of the interaction improves robot's likeability. No significant effect was observed on future intention to interact

In regards to the studies involving direct interaction with robots ($n = 8$), the measurement of the effects of humorous interactions seems to focus largely around two main areas. First, four of the studies included in this review measure the effect of humor on variables that are related to the users' perception of the robot (Devillers et al., 2015; A. Niculescu et al., 2013; Wendt & Berg, 2009).

These studies have looked at the effect of different independent variables and used different control groups, but overall the effects seem to be positive in nature.

In particular, the study by Wendt & Berg (2009) in which the authors compared the users' perception of a robot displaying non-verbal humor versus a robot displaying no humorous behaviour has shown that the funny robot was perceived as being funnier and more likable. In addition, despite considering the robot that displayed humor slightly more annoying, patronizing (both values below the central point of the scale used) and equal in perceived intelligence to the neutral robot, participants still preferred the funny robot.

In a study by Niculescu and colleagues (2013), the authors observed that despite not having an effect on trustworthiness or likability, the display of humor resulted on the robot being perceived as having a more appealing speaking style, a stronger personality and better social skills in comparison to a robot not displaying humor.

The third study, authored by Devillers and colleagues (2015), looked at the effect of different systems of data collection (paralinguistic, linguistic and WoZ) for the production of user-personalized humorous interactions. These authors however found no difference among the three conditions, with participants indicating that the robot was friendly, amusing and adapted to their preferences during the interaction. However, because they did not employ a control group involving the absence of humorous interactions, it is unclear what the exact role of humor in eliciting these responses was.

A fourth study conducted by Tae & Lee (2020), demonstrated that the use of humor as an ice-breaker at the beginning of an interaction with a robot and in-between tasks has positive effects in terms of increasing likeability and reducing awkwardness.

Another set of dependent variables explored in the studies included in this review was related to the user's perception of the task. This was the most common category and nearly every study included in this review addressed, to some extent, task-related factors (except (Bechade et al., 2016)). In this category we include factors that are related to participants' feelings towards the interaction itself (e.g; amusement level, future intention to interact), but also factors related to the participants' perception of the humorous content (e.g. jokes) of the task (Sjöbergh & Araki, 2008).

In this context, three of the studies included in this review presented manipulations oh humor that involved spontaneous or conversational humor (A. Niculescu et al., 2013; Tae & Lee, 2020; Wendt & Berg, 2009), whereas the other two used prompt humor (Sjöbergh & Araki, 2008; K. Weber et al., 2018). The studies conducted by Bechade and colleagues (2016) and by Devillers and colleagues (2015) involved both types of humor.

Of all of the studies included in this category, four reported positive effects associated with the employment of robotic humor in the interaction (A. Niculescu et al., 2013; Sjöbergh & Araki, 2008; Wendt & Berg, 2009) (study 2). The other four did not reach the significance threshold necessary for statistical significance (Sjöbergh & Araki, 2008; Tae & Lee, 2020; K. Weber et al., 2018)(study 1) and one did not conduct any inferential statistics (Devillers et al., 2015).

In the study conducted by Wendt & Berg (2009), the authors compared a robot displaying non-verbal humor versus a robot displaying no humor and found that participants rated the interaction with the funny robot funnier. The same effect was found when comparing robots displaying verbal humor to robots not displaying humor (A. Niculescu et al., 2013).

On the other hand, when Sjobergh & Arak (2008; study 1) compared the users' evaluation of the funniness of a set of jokes written or told by a robot, they found that the mean score of funniness for the jokes told by the robot was higher than the perceived funniness of the written jokes. However, this effect was only significant for two out of ten jokes and might be explained by the content of said jokes. These authors also observed a strong correlation between the funinness ratings of the written jokes and the jokes told by the robot, which they interpreted as meaning that *"...the robot improves the impression of the jokes, and not that the robot is simply funny in itself"* (p. 309).

These authors also report the results of a second study in which they introduced a second robot to react (laughing or booing) to the jokes of the first robot and found that this improves the perception of funniness of the jokes compared to a control condition (in which the second robot does not react).

One study conducted by Weber and colleagues (2008) found no differences between the reported level of amusement of participants when interacting to a user personalized system that adapted to the participants' responses to humor and one that was pre-programmed. In the study by Devillers and colleagues (2015), the authors report similar median values for participants' enjoyment and amusement of the interaction with a robot that used three distinct modes of data collection for adaptation to the user (para-linguistic, linguistic and WoZ), which were all above the middle point of the scale.

Finally, in the study conducted by Tae and Lee (2020) the authors manipulated the timing of the robot's humorous interventions (before and in between tasks; during a task) and compared it to interaction with a robot that did not display humor and found no differences in participant's reported willingness to interact with robots in the future.

5.1.8.2. *Humor in Video-Mediated HRI* A summary of the main variables and results from the studies included in this review involving video-mediated interaction with SRs is presented in table 5.2.

TABLE 5.2. Studies including video-mediated interaction with social robots in humorous scenarios.

Study	***Sample size***	***Age***	***Dependent variables***	***Independent variables***	***Summary***
Tay & Lee, 2020	58 (48%F)	$M = 23$	Appropriateness of the type of humor and social presence	Author of the humor (human versus robot) and type of humor (disparaging versus non-disparaging)	When the robots displayed a type of humor that pleased the participant, its social presence increased. Non-disparaging jokes were perceived as being funnier when they were told by a human, and were perceived as being more funny than disparaging jokes regardless of the author of the joke

Mirnig et al., 2016	22(55%F)	M = 28	Perception of the robots	Type of humor displayed (self-irony or schadenfreude)	Females preferred the robot that displayed schadenfreude, whereas males preferred the robot displaying self-irony. Participants with higher levels of neuroticism preferred the self-ironic robot when no robot laughed whereas people with a higher level of openess preferred the robot displaying self-irony when both robots laughed
Mirnig et al., 2017	113 (58%F)	M = 30	Perceived intelligence, likability and anthropomorphism	Type of humorous response after knocking down a glass of water (neutral, verbal humor, non-verbal humor or laughter)	The type of humorous response did not have an effect on likability, anthropomorphism. Female participants rated the robot higher in perceived intelligence than male participants
Menne et al., 2018	61 (79%F)	M = 22	Perceived intelligence of the robot and likability	Author of the joke (human versus robot) and type of joke (neutral introduction, clever joke, anti-joke)	No differences in likability towards the robot were observed according to the type of joke told. Robots telling clever jokes are perceived as being more intelligent than robots saying a neutral introduction

Stoll et al., 2018	548 (47%F)	M = 38	Funinness of the interventions and perception of appropriateness of the use of a robot as conflict mediation tool	Author of the humor (human versus robot) and style of humor (affiliative, aggressive and self-defeating)	The authors observed no effect in the funniness of the interventions. Participants rated the affiliative and aggressive styles of humor as being more appropriate when enacted by a human actor than by a robot

Most of the studies in this category, focused on the use of situational or spontaneous humor (n = 3). The remaining two, used canned or prompt humor. In terms of the effects of the humor manipulations used in these studies on the perception of the robot, of the three studies that analyzed its effects on likability, two could not find an effect. In particular, in the study conducted by Mirnig and colleagues (2017), the authors did not find a difference in likability towards the robot according to the type of response (neutral, verbal humor, non-verbal or laughter) that it gave to a funny incident (knocking down a glass of water).

In addition, when Menne and colleagues (2018) manipulated the the type of joke told by the robot, they did not observe an effect on likability. They did, however, observe an effect of the type of joke told in the perceived intelligence of the robot, with robots that said clever jokes being evaluated as more intelligent than robots that only said a neutral introduction. The only factors in the studies included in this review that seemed to have had an effect on the robot's likability was the type of situational humor in the study conducted by Mirning and colleagues (2016), and the timing of the display of humor in the study conducted by Tay and colleagues (2020).

In this case, participants reported liking the robot that displayed schadenfreude better than the robot that displayed a more deprecating type of humor (self-irony). In addition, the participants' own preferences in terms of humor also seem to have an effect on the evaluation of humorous robots. Namely, one study reports that SRs that displayed a type of humor that was enjoyed by the participant, were seen with a heightened sense of social presence (Tay et al., 2016).

In terms of user's perception of task-related variables, two studies reported differences in the appropriateness of the display of robotic humor in distinct situations. For example, non-disparaging jokes seem to be considered more appropriate when told by a human actor than when told by a robot (Tay et al., 2016). In addition, affiliative and aggressive styles of humor present the same pattern of preference in the context of conflict mediation, with participants judging the use of these styles of humor more appropriate (but with no difference in terms of the level of funniness) when told by a human than when told by a robot (Stoll et al., 2018).

5.1.9. Interpersonal Differences in Humorous HRI

Some of the studies included in this review analyzed the role of interpersonal differences (in particular, sex, age and some dimensions of the personality of users) in their perception of humorous robots and enjoyment of the interaction.

Bechade and colleagues (2016) found differences in participants' responses to humorous interaction with a robot according to the age of the participants. The participants in this study were between 21 and 86 years old and the authors observed that older participants (ages 60 to 86) showed a marked preference towards responses that acknowledged the attempt of humor by the robot, whereas younger participants opted for this type of response less frequently.

Two studies, both involving video interaction with robots, found significant differences related to the sex of the participant. In particular, in one study the authors observed that female participants preferred a robot that displayed schadenfreude, whereas male participants preferred a robot that displayed self-irony, and female participants perceived a funny robot higher in perceived intelligence, when compared to male users (Mirnig et al., 2016; Tay et al., 2016).

5.1.9.1. *RQ3: Technical and Methodological Characteristics of Humor used in HRI* All studies included in the category of video-mediated interaction used WoZ protocols to enact the types of humor presented in their experimental or quasi-experimental scenarios.

In terms of the technical characteristics of the systems used to generate humour in direct interaction with robots, we observed that most of the studies that focused on verbal humor used jokes collected from different websites or sources. At least one of the studies (Sjöbergh & Araki, 2008), used an automatic method for joke identification and extraction similar to one previously described in the literature (Y.-C. Wang et al., 2020).

Three studies described two different methods for personalized delivery of humorous content based on the user's feedback and response to that content. In particular, the study by Devillers and colleagues (2015) described the development of a generic intelligent user interface with the capability to collect linguistic and para-linguistic (i.e. facial response) cues that can be used to personalize the delivery of robotic humor. The study conducted by Bechade and colleagues (2016) used the same system.

The study by Weber and colleagues (2018) described the creation of a reinforcement learning algorithm that considered para-linguistic cues to deliver more jokes that fit the types of humor that users previously enjoyed (K. Weber et al., 2018).

Regarding the methodological characteristics of the instruments that have been commonly used to study humor in HRI, we have observed in the studies included in this review a pronounced dominance of quantitative tools, namely questionnaires. In this regard, most authors used questionnaires developed ad-hoc to fit the specific context of their studies, without presenting significant theoretical framework (Devillers et al., 2015; A. Niculescu et al., 2013; Sjöbergh & Araki, 2008; K. Weber et al., 2018; Wendt & Berg, 2009).

Some authors used questionnaires previously developed to evaluate HRI, such as the Godspeed Series (Bartneck, Kulić, Croft, & Zoghbi, 2009), AttrakDiff (Walsh et al., 2014) and SASSI (W. Wang, 2017), or adopted questionnaires developed in other studies (Mirnig et al., 2016, 2017; Tae & Lee, 2020). The remaining studies either used a combination of the two (e.g., (Tay et al., 2016)) or presented unclear details regarding this issue (e.g., (Sjöbergh & Araki, 2008)).

A few studies employed triangulation of methods by employing simultaneously subjective (i.e. self-report questionnaires)and objective measures (i.e. behavioural observation) of human's responses to robotic humor (Bechade et al., 2016; Tay et al., 2016; K. Weber et al., 2018). These studies mostly correlated mirth or laughter responses to the evaluation of humorous stimuli or interactions.

In terms of the research scenarios used to study HRI, most involved positive or neutral tasks. For example, in one study, participants engaged in two tasks: adding to a schedule and ordering food. In another study, participants were approached when entering a cafeteria and presented with the jokes (Sjöbergh & Araki, 2008).

A few studies included scenarios that involved interactions or incidents that could have been perceived negatively. One study in particular, due to its research questions, presented participants with a conflict situation in which the robot intervened (Stoll et al., 2018) and another study involved a robot committing an error (knocking down a glass of water) and then making a joke about it (Mirnig et al., 2017).

Another study involved a robot falling down, and then manipulated the response of either a second robot watching the fall (schadenfreude) or of the fallen robot itself (self-irony), (Mirnig et al., 2016).

5.1.10. Discussion

Taken together the studies included in this review tell us little of definitive consequence about the role that humor plays in enhancing interaction with SRs.

The majority of research conducted to date has focused explicitly or implicitly on the effects of using humor to enhance either the perception of the robot or the perception of the task, paying little systematic attention to the mechanisms through which the use of humor might achieve this goal or to the specificities of the humor used. This seems to be a general problem of humor research and not one solely observed in literature covering the role of humor in HRI (L. R. Martin et al., 2002).

Nonetheless, there seems to be moderate reason to assume that humor has (or at least, it has to potential to bring about) some positive effects in HRI. To this date, these effects have been studied mostly in regards to the role they have in enhancing the perception of the robot or of the task.

In particular, humor seems to have a positive effect in robots' likeability and in the level of amusement and enjoyment that users report while interacting with robots. Regarding the effects of humor in users' future intention to interact with robots, the results have been mixed, with a few studies suggesting that humorous robots are generally preferred to non-humorous robots, but with other studies finding no effects of humor in this variable. In addition, although not examined directly by the studies included in this review, social and physical presence seems to be important in how humor is perceived, as the studies included that report on direct HRI present overall more positive results than the studies involving video-mediated interaction.

In terms of the humorous content, it seems that jokes are generally perceived as being funnier when told by a human than when told by a robot, and funnier when told by a robot than when presented in plain text. Moreover, the perception of humorous displays by a robot seems to also depend on the users' characteristics (e.g., age, sex and personality traits), which might be variables worthy of being taken into account in future studies focusing on humor and HRI.

One of the limitations found in the literature about humor in HRI is the diversity and inconsistency of the terminology used. For example, type of humor seems to be used to describe very different facets of humor, such as its contents, its form of delivery (verbal, non-verbal, written) or its level of context embeddedness (situational or prompt humor). In addition, if on one hand the thematic content of humorous remarks by robots has been the target of experimental or quasi-experimental manipulations in which it was shown to have an effect on some dependent variables, on the other hand, studies in which this variable is not the main focus, keep it under-reported and not controlled for as a possible confounding. Similarly, very few studies attempt to measure or include in their analysis situational, dispositional or personality-related variables, which have been shown to have a central role in determining what is considered funny.

Another front on which the current studies on the effects of humor in HRI seems to be limited is the non-consideration of humor (and laughther) as naturally emergent group phenomena. Indeed, very few studies identified during the course of this review considered humor in group scenarios and of the two which did, none included a multi-user scenario. Although it is known that people laugh and joke much more often when in the presence of others than when they are alone and that laughter and humor have a contagious nature, the dynamics caused by these characteristics of humor in group scenarios involving robots remains a gap in the literature.

Similarly, we also found that the coverage given to different age groups in the studies included is predominantly focused on young adults, leaving out the effects that humor can have in children, adolescents and older adults. The reasons why this could be an interesting path of research are twofold. On one hand, when using humor in robots dedicated to act in care contexts with elder people, the clinical and therapeutic benefits of humor could be leveraged in an easy-to-achieve, technological-aided fashion. On the other hand, given that humor has been shown to be an effective promoter of learning with children in classrooms in the context of human-human interaction and (Savage et al., 2017), it could present a valuable feature to robotic systems being designed to act in this context.

The methodological characteristics of the studies included also significantly narrow the scope and robustness of conclusions that can be taken out of the existing studies. Although some studies collect information about the facial responses of participants to the jokes told by a robot, none of the studies included in this review use it as a triangulation method to confirm the reliability of information retrieved through other sources (e.g. mirth responses). Furthermore, not all studies that analyze the effect of humorous robotic interactions on the perception of the robot or the task, control the funniness of the jokes when delivered through other means (e.g. written) or of the content of the jokes. In this context, when crossing information from studies that manipulated the content of the humor and that observed effects in participants' responses to the robot and the task, with information that manipulated the content in concurrence with another variable of interest, it becomes impossible to isolate the origin of the effects observed.

In terms of ecological validity, very few studies use contexts of interaction in which humor emerges as a feature of the interaction, as opposed to being the central theme of the interaction. In particular, most of the studies use the robot telling jokes or engaging in non-verbal funny behaviour as the thematic core of the interaction, instead of introducing humor in regular contextualized social interactions with robots, which is a more realistic way of looking at humor as it emerges in everyday life. Two studies that stand out in this regard, are the studies conducted by Niculescu and colleagues and by Tae and colleagues in which participants had to engage in a task-oriented interaction (e.g., scheduling an appointment) in the presence of a robot. In this way, humor is inserted seamlessly in to the the interaction, granting a more naturalistic and realistic interaction scenario (Tae & Lee, 2020; A. Niculescu et al., 2013).

It is also important to acknowledge here that some of the limitations in these studies are partially due to the challenges that emerge when researchers try to study humor. For example, going back to Martin's quote on the first paragraph of the introduction, studying something that few agree on how to define or explain can be an added difficulty when one is in the practical process of operationalizing variables or creating controlled experimental manipulations that rely on those same operationalizations of humor.

This difficulty is reflected by the scarcity of validated measures and by the lack of information regarding the psychometric properties of the measures used in some of the studies included; and by the difficulty to control participants' dispositional variables (e.g. mood) before and during the time they take part in the experiments.

In this context, emotional arousal, valence and mood can be controlled through priming and are variables that should be controlled in other experiments involving humor due to their possible confounding effects.

To overcome this challenge, some taxonomies of humor have been proposed, focusing mainly on verbal or written interactions. For example, some authors proposed a humor taxonomy that was based on humorous content collected from blogs and it posits the existence of verbal humor containing low-level features (i.e. containing items that are prototypically used to create humorous situations, e.g. sex) and high-level features (i.e. information that is not directly related to humorous topics, but that is turned into humor through the use of certain linguistic strategies), (Reyes, Rosso, & Buscaldi, 2009).

In addition, the authors also suggest a further distinction related to the type of knowledge that is necessary to properly understand the content of the joke. A joke that requires knowledge of the context, is different from a joke which contents' are relayed only through the literal words (intra-textual) and also different from one that requires extra-textual knowledge. This difference in terms of the amount and type of knowledge that one needs to get a joke, can imply different levels of understanding of the world and, if applied in the context of HRI, it can lead to improved perception of the robot. The development and application of a taxonomy in future user-studies in HRI can lead to a better systematization of humor manipulations and hence, to more reliable results.

The creation of automatic computerized humor and the mapping of its effects in HRI is a challenge that has not yet been surmounted. What comes as a spontaneous feature of daily interactions among humans, has proven to be hard to fully replicate and evaluate in robotic agents. This is probably due to the complex and multi-layered nature of the set of factors that, at any given time, contribute to making something funny.

Several experiments have attempted to isolate individual variables that might contribute to the creation of robots that are able to apply humor in their interactions with humans. However, the results and variables manipulated in the discussed studies vary so extensively that it is hard to draw general conclusions from their content. If the CASA theory is valid and extensible to humor, it is to be expected that humor does, indeed, have a positive effect in HRI and in the human perception of SRs. However, at this point more research is needed to support this claim.

CHAPTER 6

Assessement of instrument's psychometric properties

Thought and science are therefore raising problems which their terms of study can never answer, many of which are doubtless problems only for thought. The trisection of an angle is similarly an insoluble problem only for compass and straight-edge construction, and Achilles cannot overtake the tortoise so long as their progress is considered piecemeal, endlessly having the distance between them. However, as it is not Achilles but the method of measurement which fails to catch up with the tortoise (...).

Alan Wilson Watts (1958, p. 65)

Abstract

This chapter focuses on the assessment of the instrument's measurement properties of two scales that were central to the thesis. It reports the translation of and the measurement evaluation of the RoSAS and the HSQ to the European Portuguese population. In this context, we conducted a validation study with 185 participants for the RoSAS scale and 329 participants for the HSQ. For the RoSAS scale, we found a positive correlation between the warmth and competence dimensions, and through a factorial analysis we achieved a shortened version of the scale with 11 items while maintaining the original three-factor structure. However, the scale exhibited poor to acceptable levels of temporal reliability. Regarding the HSQ, the internal consistency estimates for the translated version were moderately acceptable. The affiliative humor style scale had the highest consistency, while the aggressive humor style scale had the lowest. A confirmatory factor analysis did not support the proposed four-factor model for the translated scale. Test-retest correlations ranged from moderately strong to weak. Overall, the translated HSQ may be useful to researchers, although additional work is required, especially for the aggressive humor style scale. The results provide researchers with tools to study social robot perception and humor styles in the European Portuguese population, but further refinement of the latter scale is recommended.

6.1. Robot perception

In the past few decades, many advancements in technology have led to drastic changes in the way people communicate and interact with one another. In particular, the creation and introduction of SRs in many social human environments has opened the door to a new type of techno-socialization that encompasses the relations and communication dynamics between humans and technological social artifacts (Gutierrez, Ochoa, Cornejo, & Vassileva, 2019; Katz, 2002; Nikitina, 2007).

In this context, these technological artifacts take on the role of interactive social agents that can help and collaborate with their human counterparts in a wide range of tasks (J.-E. R. Lee & Nass, 2010; Nass et al., 1994). The emergence of these computerized agents as social actors has, thus, resulted in increased concern about the role of different robot-related characteristics in the users' perceptions, attitudes, and level of trust toward robots (Anzalone, Boucenna, Ivaldi, & Chetouani, 2015; A. Edwards, Edwards, Westerman, & Spence, 2019; Höflich & El Bayed, 2015). These factors are believed to predict several important variables, such as user engagement, which are central to those developing and studying SRs.

The RoSAS was designed to assess the central attributes implicated in human perception of SRs (Carpinella, Wyman, Perez, & Stroessner, 2017). Since its creation, it has been used in multiple studies in the area of HRI (Bonani et al., 2018; Pan, Croft, & Niemeyer, 2018; Strohkorb Sebo, Traeger, Jung, & Scassellati, 2018), presenting good psychometric properties (Carpinella et al., 2017; Pan et al., 2018). This scale includes three main dimensions around which perception of SRs is organized: warmth, competence, and discomfort, and it is based on psychological research on human social perception that also encompasses warmth and competence attributes (Cuddy, Fiske, & Glick, 2008). In addition, it draws from and attempts to overcome the shortcomings of another widespread scale used in HRI research, the Godspeed series (Ho & MacDorman, 2010; Weiss & Bartneck, 2015).

The Godspeed series is a set of questionnaires meant to provide a reliable, validated measure of the dimensions relevant to the evaluation of SRs (Bartneck et al., 2009). The identification of these main dimensions was conducted in a set of prior studies (Bartneck & Forlizzi, 2004; Dautenhahn, 2007; Fong et al., 2003) by extracting the main dimensions usually considered in previous research on social robotics and then evaluated by the authors in terms of its theoretical and practical relevance to the field of HRI (Bartneck et al., 2009). Despite its creation not having followed the traditional standards for scale development and validation, since its inception, the Godspeed series quickly became one of the most widely cited (and hence, used) (Weiss & Bartneck, 2015) instruments to measure HRI in a wide range of contexts (Ho & MacDorman, 2010), with small regard to its quality in terms of validity and reliability. Later analysis of the psychometric properties of this scale revealed a suboptimal level of quality with concerns about a lack of systematic approach to the original scale development and validation process, the high correlation between different scale dimensions, and nonreplication of the supposed factor structure (Ho & MacDorman, 2010; Weiss & Bartneck, 2015).

The RoSAS proposed to build on the perceptual dimensions advanced by the Godspeed series by incorporating insights from human social perception. In particular, the RoSAS builds on the premise that people make automatic social inferences about other social actors and that the process of social categorization can be extended to robots and other technological artifacts (Carpinella et al., 2017; Lang, Klepsch, Nothdurft, Seufert, & Minker, 2013; Nass et al., 1994). This latter premise has been widely adopted and served as a background to much recent research in social robotics and computing (Lang et al., 2013). In this context, much of the research has been oriented toward the measurement of the social outcomes of the implementation of SRs in human social environments, such as effects on human engagement in prosocial behaviors (Correia et al., 2019), human disclosure of information to SRs (Noguchi, Kamide, & Tanaka, 2018), and the ability of robots to nudge human decision-making toward a predefined intended goal (Hashemian, Paiva, Mascarenhas, Santos, & Prada, 2019).

In developing the RoSAS, the authors considered research involving the stereotype content model (Cuddy et al., 2008). This model, prominent in social psychology, suggests that human perception is mainly anchored around two main dimensions: warmth and competence. In addition, initial factor analyses prompted the recognition of a third dimension that measures feelings of discomfort toward robots. These three dimensions (warmth, competence, and discomfort) parallel the dimensions of likeability, perceived intelligence, and security concerns (respectively) included in the Godspeed questionnaire.

However, the RoSAS possessed stronger psychometric qualities (i.e., higher eigenvalues and higher levels of reliability) compared with the Godspeed questionnaire, thus offering a more parsimonious manner to evaluate individuals' perceptions of SRs.

In the original validation study, participants were asked to evaluate how closely various terms (e.g., social, strange, reliable) were associated with their perception of robots, using a Likert-type format scale ranging from 1 (definitely not associated) to 9 (definitely associated (Carpinella et al., 2017, study 2). Factor analyses revealed the existence of three factors, each of which was composed of six items. The dimension of warmth is measured by collecting judgments of a robot on the terms (in the original version) happy, feeling, social, organic, compassionate, and emotional. The competence dimension includes capable, responsive, interactive, reliable, competent, and knowledgeable. Finally, perceptions of discomfort are captured by the items scary, strange, awkward, dangerous, awful, and aggressive.

The original authors underline the practical potential of this scale in three main areas: (1) as a tool to evaluate preexisting robots; (2) as a way to inform the development of new robots, especially human-like robots designed to mimic human appearance and behavior, and (3) to serve as a standardized metric for those conducting HRI research (Carpinella et al., 2017). The scale was not intended to replace other metrics employed in social HRI such as the Godspeed questionnaire or measures of specific attributes. However, it presents a parsimonious and validated general scale that might be of value to researchers and developers of SRs (Carpinella et al., 2017). It has been used in over 200 studies in various countries in its brief existence.

Despite widespread international use of the RoSAS, no validated version of this scale exists in any language other than the original English. This instrument has been adapted for use in several other languages, including Portuguese (Correia et al., 2019; Bonani et al., 2018) and French (Spatola et al., 2018) to study how participants create and change their perception of SRs after interacting with them. However, translating and validating questionnaires in different languages is critical for ensuring that results are reliable, valid, and methodologically sound (Colina, Marrone, Ingram, & Sánchez, 2017; Tsang, Royse, & Terkawi, 2017).

6.1.1. Goals and hypotheses

Our goal was to validate and evaluate the psychometric properties of the Portuguese translated version of the RoSAS scale. The scale validation was preregistered using Open Science Framework preregistration services[1]. In particular, we evaluated the convergent validity using the Godspeed scale and the divergent validity using the Negative Attitudes Towards Robots (NARS); (Nomura, Suzuki, Kanda, & Kato, 2006; Piçarra, Giger, Pochwatko, & Gonçalves, 2015).

[1]For more information, consult: https://archive.org/details/osf-registrations-vrnx5-v1

We also evaluated test–retest validity, construct validity, and conducted a Confirmatory Factor Analysis (CFA) to validate the arrangement and item allocation of the original scale and the model fit of the translated scale.

In this context, the following hypothesis were formulated and tested:

◇ ***Structure of the RoSAS***

H1: The CFA of the Portuguese version of RoSAS would replicate the three-dimensional structure (i.e., warmth, competence, and discomfort) observed in the original English version of the scale.

◇ ***Temporal reliability***

H2: The Portuguese version of RoSAS would exhibit a good level of test–retest reliability over a 2-week interval between applications.

H3: Warmth and competence would be positively correlated with the dimensions of likeability, perceived intelligence, and perceived safety of the Godspeed questionnaire. Discomfort was expected to negatively correlate with all of the dimensions of the Godspeed questionnaire.

◇ ***Convergent and divergent validity***

H4: The warmth and competence dimensions of RoSAS was expected to negatively correlate to the items of NARS. In contrast, the discomfort dimension was predicted to positively correlate to the items of the NARS.

6.2. Method

An Ethical Research Committee approved the study before data collection and all relevant ethical guidelines were followed.

This study was conducted in three phases. First, we translated the original English scale to Portuguese and examined its translation equivalence using the back-translation method proposed by Guillemin et al. (1993). Then, we collected data from a sample of Portuguese native speakers to evaluate the scales' psychometric properties. Finally, we collected data from the initial set of respondents to evaluate test–retest reliability.

6.2.1. Translation process

The original version of the RoSAS scale was translated into Portuguese (European) by two bilingual Portuguese native speakers. A third individual (one of the authors, also bilingual and native Portuguese) checked the translation and coordinated with the other two translators to solve disagreements. The back-translation was conducted by a native

Portuguese individual with academic training in English translation and later checked by a bilingual native English speaker and by one of the authors (native Portuguese speaker).

A committee composed of the individual with training in English translation, one of the authors (Portuguese native speaker), and a bilingual English native speaker reviewed the back-translated version and agreed upon a final version. Disagreements were resolved using a decentering technique and adding multiple synonym alternatives to accommodate all different possible translations, thus increasing redundancy and improving the likelihood of better comprehension (Brislin, 1973). The original study instructions for participants were also analyzed, and changes were implemented to improve clarity before the start of the data collection.

To ensure that the questionnaire was easy to understand, we asked a convenience sample of 10 native Portuguese speakers to answer the survey. Participants were provided a printed version of the questionnaire and told to pay attention to the phrasing of the questions. They were asked to indicate if there was any instruction or sentence that was difficult to understand. Small changes were made to the questionnaire at this stage based on participants' comments.

6.2.2. Main data collection

A convenience sample of participants was recruited using a snowball strategy for disseminating the survey in social media and through a voluntary pool of participants. The latter group of participants was compensated for their participation with course credits. The data collection was completed using the Qualtrics platform for online surveys.

Participants were told that the study's main aim was to investigate people's perceptions of certain social groups, so as not to influence their responses or willingness to participate in the study. After providing informed consent, participants responded to the following instruments:

- ◇ The Portuguese version of the RoSAS scale asking participants to indicate the extent to which they associated various words with SRs. The words presented correspond to the 18 translated items of the original RoSAS. Participants responded using a 9-point scale, with lower values indicating weaker associations and higher values reflecting stronger associations. In addition, one attention-check item requesting that participants select a particular response value was also included.
- ◇ The PNARS, initially developed by (Nomura et al., 2006) and validated for the Portuguese population by (Piçarra et al., 2015)) composed of 12 items. NARS is divided into three subscales: one relative to negative attitudes toward robots with human traits (Negative Attitudes Towards Robots with Human Traits (NARHT)), one relative to negative attitudes toward interactions with robots (Negative Attitudes Towards Interaction with Robots (NATIR)), and a third one concerning negative attitudes toward the social influence of robots. This scale includes items like *"I would feel very nervous just standing in front*

of a robot" and *"I feel that if I depend on robots too much, something bad might happen"*. Higher scores indicate more negative attitudes toward robots. The Portuguese NARS (henceforth, PNARS) has only two factors: NATIR and NARHT, with six items each. Participants were asked to indicate the extent they agreed or disagreed with each statement, using a 7-point scale. Lower values represent lesser agreement, and higher values represent stronger agreement.

- ◇ A translated version of the Godspeed questionnaire composed of 13 items. These 13 items correspond to the subscales of likeability (5 items), perceived intelligence (5 items), and perceived safety (3 items). Participants were asked to indicate to which extent each item corresponded well to their impressions about robots, using a 5-point semantic differential scale. Lower values indicated more negative evaluations, and higher values reflected more positive evaluations.
- ◇ A set of sociodemographic questions for sample characterization. This set of questions inquired about participants' sex, age, level of education, native tongue, frequency and familiarity with psychology studies, and previous interaction with robots.

The order of presentation of all scale items was randomized. After responding to these questionnaires, participants were presented with a debriefing statement, which included an explanation of the study goals. They were also invited to participate in the second part of the study, to take place 15 weekdays after their initial participation.

Participants who agreed to participate in the second stage were contacted via email 15 days later. This message provided a link for the second part of the study, and participants were given 3 days to respond. Email information was stored separately from their responses to the first part of the study and deleted immediately after the conclusion of data collection to avoid any risks to participants' right to anonymity and confidentiality.

The second part of the study was composed of the same Portuguese version of the RoSAS. Participants' responses to both parts of the questionnaire were linked using a personal unique identification code.

After completing the second part of the study, participants were again presented with a debriefing statement explaining the goal of this study. In addition, they were provided the first author's email contact to use in case of questions, suggestions, or requests. Participation in the first part of the study took approximately 15 min, and the second part took approximately 5 min to complete.

6.2.3. Sample

Using the G*Power software (version 3.1.9.6 for macOS; Faul et al., 2007, 2009), we estimated a necessary sample size of 195 participants. We included only young adults (18–35 years old) living in Portugal and excluded participants who were native speakers of other variations of Portuguese (in particular, Brazilian Portuguese).

We collected data from 205 participants. Of those 205, 20 were excluded for failing to answer correctly to the attention check item. A total valid sample of 185 participants was used for the preliminary validation analysis. Most of the participants in this study were female (55%), with ages ranging between 18 and 35 years ($M = 3.40$; $SD = 5.21$).

Approximately 43% of the participants reported having a university degree (bachelor's degree: 28.10%; master's degree: 14.60%; doctoral degree: 0.50%). The participants reported being somewhat familiar with research in psychology ($M = 3.56$; $SD = 1.76$) and participated in psychology studies frequently ($M = 4.15$; $SD = 1.97$). Most participants reported either never interacting with a robot ($n = 84$) or interacting with a robot at least once ($n = 82$).

The remaining 13 participants reported that interacting with robots was something they consider a normal activity. All participants were native speakers of Portuguese, and almost all participants identified themselves as being Caucasian Europeans.

Of the original 185 participants, 85 participated in the second part of the study after the 15 weekday interval.

6.3. Results

6.3.0.1. *Data analysis* The data were analyzed using International Business Machines Corporation (IBM) SPSS and AMOS software (both version 26). The scales presented some missing values, the distribution of which was analyzed using Little's Missing Completely at Random (MCR) test. This test revealed that a few existing missing values were missing at random ($p > .005$) and were replaced using the Expectation Maximization (EM) method.

To analyze the structural properties of the scales, we conducted CFA. The best factor organization was achieved iteratively by examining item loadings onto each dimension (removing items with loadings < 0.40), analyzing the consistency of the items of each subscale, and assessing the impact of (removing or maintaining) each item on the subscale consistency. Moreover, the suitability of the data for structure detection was evaluated using the Kaiser–Meyer–Olkin (KMO) and Bartlett's test of sphericity.

Next we conducted structural equation modeling (Structural Equation Modelling (SEM)), and according to recommendations (Boateng et al., 2018; Ximénez, 2006), we report the following indicators for goodness-of-fit: the χ^2/df, the square root mean residual (Square Root Mean Residual (SRMR)), the comparative fit index (Comparative Fit Index (CFI)), and the root mean square error of approximation (Root Mean Square Error of Approximation (RMSEA)). The following thresholds for each indicator were considered acceptable: $\chi^2/\text{df} < 3$, SRMR < 0.08, CFI > 0.09 and RMSEA < 0.08. In terms of validity and reliability, we sought average variance extracted (Average Variance Extracted (AVE)) values higher than 0.5 and squared AVE values superior to maximum shared variance values (for convergent and discriminant validity, respectively); and composite reliability values superior to 0.7.

Following recommendations to improve goodness-of-fit (Piçarra et al., 2015; Schumacker & Lomax, 2010), we considered the factor loadings of each item of the scale, the modification indices, the presence of cross-loadings, and interitem correlations.

Temporal reliability was assessed by analyzing Cronbach's α. In this context, if .06 $> \alpha \geq$ .05, we considered the reliability to be poor; if .07 $> \alpha \geq$ .06, we considered the reliability to be questionable; if 08 $> \alpha \geq$ .07, we considered the reliability to be acceptable; if .09 $> \alpha \geq$ .08, we considered the reliability to be good. Cronbach's α below .05 and superior to .09 were considered unacceptable and excellent reliability indicators, respectively.

Bivariate correlations were calculated between all items of the RoSAS scale and between its subdimensions and the subdimensions of the other scales included in this study, using both the entire sample and separately for each sex.

Independent t-tests were conducted to examine potential mean differences in the participant's scores for each dimension of the RoSAS according to previous interaction with robots (coded in binary terms: with and without) and according to sex.

Across all analyses, we used the standard α =.05 cut-off criterion. Thus, the null hypothesis was rejected when p $<$ .05 and not rejected when p $>$ .05.

6.3.0.2. *Hypotheses tests*

◇ ***Structure of the RoSAS:***

We initially conducted a CFA using maximum likelihood estimation to evaluate the goodness-of-fit, allowing each item to load only on one factor and the factors to correlate. In the initial CFA, we observed that the original scale structure did not present a good fit to our data, with several items not loading onto the expected dimensions (see table A.2).

After iteratively making several adjustments to the model (see details of the 7 models that were tested in table 6.1), we achieved a solution that retained 11 items organized in the three original proposed dimensions: warmth (emotional, feeling, happy, and compassionate), discomfort (dangerous, scary, strange, and aggressive), and competence (competent, interactive, and responsive). The final solution obtained also indicated both good levels of convergent and discriminant validity and good levels of reliability (see table 6.1).

TABLE 6.1. Model fit indicators for the models estimated through the iterative process.

Model	χ^2	***df***	χ^2/***df***	***p***	***CF***	***RMSEA***	***SRMS***	***AIC***	***AVE***			***CR***			***MSV***		
									1	2	3	1	2	3	1	2	3
1	317.90	132	2.41	.000	0.91	0.08	0.12	395.90	0.47	0.48	0.46	0.83	0.82	0.80	0.008	0.008	0.000
2	252.20	116	2.17	.000	0.91	0.08	0.10	326.18	0.48	0.44	0.52	0.84	0.82	0.81	0.03	0.009	0.03
3	205.90	101	2.04	.000	0.92	0.07	0.09	275.92	0.47	0.45	0.57	0.83	0.83	0.81	0.07	0.009	0.07
4	164.00	87	1.89	.000	0.94	0.07	0.09	230.04	0.48	0.47	0.56	0.84	0.82	0.81	0.07	0.005	0.07
5	146.10	74	1.97	.000	0.92	0.07	0.08	208.13	0.47	0.47	0.31	0.83	0.82	0.57	0.02	0.005	0.02
6	127.30	62	2.05	.000	0.93	0.07	0.08	185.28	0.55	0.47	0.31	0.86	0.82	0.57	0.02	0.004	0.02
7	58.2	41		.04	0.98	0.05	0.06	108.24	0.59	.51	.61	.85	.81	.81	.04	.004	.04

Table 6.2. Scale configurations of the RoSAS and Godspeed scales and translated items.

RoSAS			***Godspeed (Model 2)***		
Warmth	Discomfort	Competence	Perceived likeability	Perceived safety	Perceived intelligence
Emotional (Emocional)	Dangerous (Perigoso)	Competent (Competente)	(Dis)Like/ (Gosto/ Não gosto)	Anxious/Relaxed (Ansioso/Relaxado)	(In)Competent (Competent/Incompetente)
Feeling (Sentimental)	Strange (Estranho)	Interactive (Interativo)	(Un)Friendly (Amigável/Pouco Amigável)	Agitated/Calm (Agitado/Calmo)	Ignorant/Knowledgeable (Ignorante/Culto)
Happy (Feliz)	Aggressive (Agressivo)	Responsive (Responsivo)	(Un)kind (Simpático/Pouco simpático)		(I)Responsible (Responsável/Irresponsável)
Compassionate (Empático)	Scary (Assustador)		(Un)Pleasant (Agravável/Pouco agradável)		(Un)Intelligent (Inteligente/Pouco Inteligente)
			Awful/Nice (Péssimo/Fantástico)		Foolish/Sensible (Pateta/Sensível)

In a second CFA of the final solution, all these items presented loadings higher than 0.40 to their respective categories (loadings ranging between 0.98 and 0.58; see table A.2). The interitem correlations are presented in Table S3.

All subdimensions presented good levels of internal consistency (ranging between 0.74 and 0.84; see table A.5); together, these three dimensions explain 58.17% of the variance observed (see table A.2).

In terms of the data collected, we found that men and women differ in their perceptions of competence associated with SRs, but not in their perceptions of warmth or discomfort (see table 6.3).

Table 6.3. Average scores for the warmth, discomfort, and competence dimensions of the Portuguese RoSAS.

Dimension	M ± SD			t	p	d
	Overall	Women	Men			
Warmth	2.32 ± 1.56	2.14 ± 1.46	2.53 ± 1.65	1.69	.09	
Discomfort	4.15 ± 1.70	4.26 ± 1.56	4.02 ± 1.85	-0.97	.34	
Competence	5.78 ± 1.67	5.47 ± 1.63	6.16 ± 1.65	0.79	.005	

Interestingly, in our sample, previous interaction did not appear to offer an advantage in terms of the perception of SRs, with participants expressing similar views on SRs in all dimensions regardless of experience (all $p > .05$).

Analyzing the overall averages for each dimension (see table 6.3), we see that, regardless of sex, participants reported low perceptions of warmth, suggesting that they typically do not associate warmth attributes with SRs.

6.3.0.3. *Temporal reliability* The pre–posttest correlations for each item are presented in tables A.4 and A.5 provide the interitem correlations according to sex.

The warmth dimension presented a good level of correlation between the two applications $(0.83, p < .001)$. However, both the discomfort $(0.61, p < .001)$ and the competence dimension $(0.41, p < .001)$ presented poor and unacceptable levels of correlation, respectively, between measurements. Despite this low level of correlation for the competence and discomfort dimensions, none of the subdimensions presented significant mean differences when comparing the initial full-sample average and the subsample that responded to the questionnaire a second time 15 days later (all $p > .05$).

When analyzing the separate correlations between the two applications of RoSAS according to sex, we observed that the majority of items presented good levels of correlation (i.e., > 0.8) for men, but that the correlation levels for the same variables in women broadly fell below the minimum threshold for acceptability (i.e., 0.50).

6.3.0.4. *Convergent and divergent validity* Before analyzing the correlations between the RoSAS and the PNARS and Godspeed scales, we examined the psychometric properties of the latter two questionnaires.

The PNARS presented good levels of internal consistency both for the NATIR dimension (0.83) and for the NARHT dimension (0.80), superior to those reported in the validation study (0.75 and 0.73, respectively, (Piçarra et al., 2015); see table A.6 for consistency values according to sex).

The Godspeed items also presented good levels of consistency for perceived likeability and perceived intelligence; however, the perceived safety dimension presented unacceptable consistency (see table A.6). Furthermore, upon inspecting the factorial structure of the Godspeed scales, we observed that the items did not present the expected structure (see table A.3). In particular, the item "quiescent" did not present acceptable loadings (i.e., > 0.40) in any of the dimensions. As such, we removed this item and estimated a second model.

The removal of this item generated a different model that presented a conceptual structure distinct from the original scale and of the organization of the first model estimated. Because the resulting factors could not be aggregated coherently in terms of their meaning (see table A.3), we opted to examine each of these three models separately (see table A.8). The interdimension correlations, however, were calculated only for the first and second model, given that the lack of coherent organization of the items of Model 3 made it difficult to interpret constructively (see table A.3).

As expected, we found the RoSAS' competence dimension to be negatively correlated with both the NARHT and NATIR dimensions of PNARS; and the discomfort dimension to be positively correlated with both. The warmth dimension was negatively correlated with NARHT but was not significantly correlated with NATIR (see tables A.7).

Regarding the Godspeed scales, we found that warmth was not significantly correlated with perceived likeability in neither of the models we estimated. However, warmth was negatively correlated with perceived intelligence in Model 1 (corresponding to the scale's original configuration) and with perceived intelligence and safety in Model 2 (estimated based on the organization of the scale's items in the CFA).

In addition, as expected, we also found that the discomfort dimension of RoSAS was negatively correlated with all of the Godspeed dimensions.

When considering the original configuration of the Godspeed scales, we found competence to be positively correlated to perceived intelligence and likeability. When considering the alternative configuration, we found that competence was positively correlated with perceived likeability but not with other dimensions.

As expected, all of the dimensions of the Godspeed scales were negatively associated with both dimensions of the PNARS.

6.4. Discussion, limitations and conclusion

The use of subjective measures is common in many areas of research, including HRI. In this area, subjective measures can determine how users perceive certain aspects of SRs or their interaction with them, influencing how future SRs are designed and developed. Thus, it follows from the important practical implications of the results that access to validated subjective measures that present both good levels of reliability and validity is a fundamental necessity for researchers in this area.

RoSAS is a scale developed by Carpinella et al (1027) that has been used to evaluate users' perceptions of SRs in multiple studies. In this paper, we sought to validate the RoSAS for the European Portuguese-speaking population. To investigate the psychometric properties of this scale, we collected responses from a sample of 185 native Portuguese individuals. We examined the scale's reliability (both across time and items) and criterion validity (in relation to the PNARS and Godspeed scales).

Based on SEM, we propose a shortened version of the original scale in Portuguese, with 11 items instead of the original 18, while maintaining the original three-factor structure. The Portuguese version of RoSAS also presents good psychometric properties, satisfying all the relevant recommended criteria to evaluate model fit, composite reliability, and convergent and divergent validity (see table 6.1).

In terms of criterion validity and following our hypotheses, we found that competence is negatively associated with both dimensions of PNARS; and that comfort is positively associated with them. These results were expected as PNARS items measure general negative attitudes. In other words, participants who associated robots with warmth and perceived them to be competent tended to have fewer negative attitudes toward them. In contrast, participants who report higher levels of discomfort with SRs tended to have more negative attitudes toward them.

We found only partial support regarding our hypothesis about the warmth dimension, which we expected to be negatively associated with both dimensions of PNARS. In our data, this variable was negatively associated with NARHT, but not NATIR. This finding suggests that the items of the warmth dimension seem to capture (or evoke) essentially aspects related to the perception of robots with human traits and less to aspects related to interaction with robots.

Besides PNARS, we also examined the relationships between responses to RoSAS items and Godspeed items. We did this even though the Godspeed scales have not yet been validated for the European-speaking Portuguese population. Nonetheless, we pursued this issue because of the conceptual proximity between these measures and because the Godspeed has also been used many times in studies with Portuguese participants. In this context, we argue that its use and the information collected during this study is potentially informative and valuable for the community.

The Godspeed scales used in this study did not present good psychometric qualities. As proposed by (Bartneck et al., 2009), the original model did not fit well with our data, with the items displaying a different organization than the one expected. In our study, the items allowed structure detection explaining approximately 49% of variance. However, the resulting factorial structure (see table A.3) did not correspond conceptually to the dimensions it proposed to measure (i.e., perceived likeability, perceived intelligence, and perceived safety).

The final factorial structure revealed a considerable overlap between items that were supposed to belong to the perceived intelligence dimension and items that were supposed to fit in the perceived safety dimension (Factor 1 of the final model in table A.3). The items belonging to the perceived likeability dimension in the original model were divided into two factors in our analysis (Factor 2 including (Dis)Like; Awful/Nice and (Un)Pleasant and Factor 3 including (Un)Friendly and (Un)Kind; see tables 3 and A.3).

In addition, we cannot compare our findings regarding the factorial structure of the Godspeed scales to other validation and evaluation attempts, given that, to the best of our knowledge, none exist. The original proposal collected and summarized a small number of items that had been used in previous empirical studies to measure the concepts of interest and reported only internal consistency measures (Bartneck et al., 2009).

A later qualitative analysis of the use of the Godspeed scales revealed more in terms of its psychometric properties. However, this analysis added two main limitations in its use: one regarding the inconsistency in the use of the initially proposed answer format, and another observation concerning the participants' concerns regarding the repetitiveness of the items and the difficulty in assigning some high-level attributes to the robots.

It is notable in our analysis that, contrary to our expectations, we found no correlation between warmth and perceived likeability. The consistent findings of both models estimated for these scales seem to indicate that (a) warmth is negatively correlated to perceived intelligence, (b) competence is positively correlated with likeability, and (c) discomfort is negatively correlated with all Godspeed dimensions. When considering the original configuration of the Godspeed dimensions, competence presents a positive correlation with perceived intelligence, as expected.

In terms of the temporal reliability of the scale, we found overall poor values of correlation between pre–postmeasurements. However, these poor levels of temporal reliability seem to be partially tied to the sex of the respondent, with women consistently presenting worse values of reliability across all dimensions compared with their male counterparts.

In general, all subscales presented acceptable or good levels of internal consistency. One exception was the set of items that originally composed the subdimension of perceived safety (which can likely be explained, in part, by the weak loadings of the "quiescent" item on this dimension).

Regarding the relation between dimensions of the RoSAS, we found a positive correlation between the warmth and competence dimensions, but no other significant correlations, suggesting that participants who perceive robots as being more competent also perceived them higher in terms of warmth.

This study focused on developing and utilizing a psychometrically validated general scale of robotic social perception in a new language, broadening the tools available to HRI researchers and robot designers. We look forward to the development of RoSAS scales adapted for other cultural settings with a continued focus on the psychometric properties of the scales as it is translated into other languages.

6.5. Humor perception and humor styles

The HSQ is one of the most widely used instruments in humor research (R. A. Martin et al., 2003). The questionnaire is based on a conceptualization of humor that proposes the existence of humor styles (each style captures individual differences in people's everyday use of humor) anchored around two main components: (a) the target of the humor (oneself vs. others) and the valence of the humor use (positive or adaptive vs negative or maladaptive).

As a result of this conceptualization, the authors identify four main humor styles: affiliative, self-enhancing, aggressive, and self-defeating (R. A. Martin et al., 2003). Affiliative and self-enhancing humor styles are characterized by being positive humor styles that can be used to enhance one's relationships with others (affiliative) or the self (self-enhancing) in ways that are tolerant and non-detrimental. Conversely, the aggressive and self-defeating humor styles reflect mostly maladaptive (or negative) uses of humor intended to enhance one's own status at the expense of others (aggressive) or of oneself (self-defeating).

Although these humor styles reflect different types of humor usage in everyday life, they do not appear to present independent conceptual dimensions, with the distinction between each one being, *"...one of degree, rather than a dichotomy"* (R. A. Martin et al., 2003, p. 52). For instance, the use of adaptive styles of humor might involve some degree of disparagement or teasing as a strategy to enhance one's relationship with others. This overlap between positive and negative styles of humor results in a four-dimensional conceptualization of intercorrelated humor styles (R. A. Martin et al., 2003).

As humor is an important aspect of people's daily lives, the humor styles proposed by Martin and colleagues (2003) have shown to be associated with both other humor-related constructs as well as with different aspects of psychological functioning. Positive humor styles typically present positive correlations with a sense of humor, coping humor, and cheerfulness and negative correlations with seriousness and bad moods (R. A. Martin et al., 2003). Negative humor styles, on the other hand, present positive correlations with multi-dimensional measures of a sense of humor and coping humor, with aggressive humor being negatively correlating with seriousness, and self-defeating humor positively associated with bad moods (R. A. Martin et al., 2003).

Humor styles, particularly, positive humor styles, are associated with psychological well-being and optimism (Heintz, 2017; Kuiper & McHale, 2009; R. A. Martin et al., 2003).

This association between humor styles and well-being has been noted consistently in the existing literature and does not appear to be culture or age-dependent (Jiang et al., 2020). Moreover, positive humor styles have also been found to be positively associated with self-esteem (Ford, Lappi, & Holden, 2016; Schermer et al., 2021; Stieger, Formann, & Burger, 2011), happiness (X. D. Yue, Liu, Jiang, & Hiranandani, 2014), life satisfaction

Table 6.4. Psychometric properties of the humor styles questionnaire in different samples.

Authors	***Sample (n)***	***Internal consistency***				
		AFF	***SEN***	***AGG***	***SDE***	***Model fit***
Branković, Rogoza & Schermer (2022)	Serbian (404)	.75	.76	.64	.79	χ^2 (374) = 725.356, p <0.01, CFI = 0.87, RMSEA = 0.05, SRMR = 0.04.
Anlı, 2019	Turkish (300 children)	.83	.80	.82	.73	χ^2(113)= 202.117, p <.05), χ^2/df = 1.78, CFI = 0.95, RMSEA = 0.051, SRMR = 0.05
Boda-Ujlaky, Séra, Köteles, Szabo, 2017	Hungarian (425)	.83	.85	.72	.76	–
Ruch & Heintz, 2016	German (1101)	.87	.83	.70	.81	$\chi^2(\chi^2)$ = 1271.97, p <.001, χ^2/df = 2.78, CFI = .84, RMSEA = .057, SRMR = .076
Sirigatti, Penzo, Giannetti & Stefanile, 2014	Italian (293)	.80	.70	.58	.74	χ^2(458) = 697.67, p <.001, χ^2/df = 1.52, CFI = .96, RMSEA = .042, SRMR = .09
Taher, Kazarian & Martin, 2008	Lebanese (435)	.67	.79	.55	.76	–
Chen & Martin, 2007	Chinese (354)	.81	.78	.61	.72	GFI = .86, AGFI = .83, RMSEA = .06
Kalliny, 2006	Egyptian (94)	.80	.81	.77	.80	χ^2/df = 1.40-1.94, CFI = .84-.94, RMSEA = .05-.08
Martin, Puhlik-Doris, Larsen, Gray & Weir, 2003	Canadian (1,195)	.80	.81	.77	.80	CMIN/DF=3.37, GFI=.91, AGFI=.90, RMSEA=.048
Saroglou & Scariot, 2002	Belgian (94)	.75	.73	.70	.72	–

Notes: AFF = Affiliative; SEN = Self-enhancing; AGG = Aggressive; SDE = Self-defeating.

(Zhao, Wang, & Kong, 2014; Jovanovic, 2011), and social attitudes (Schermer et al., 2022).

To measure the four humor styles, Martin and colleagues (2003) produced a 32-item scale (8 items per humor style). Previous evaluations of the psychometric properties of the HSQ have yielded mixed results (see table 6.4 for some of the results previously reported). Namely, internal consistency estimates, as assessed by Cronbach's α, for the four humor styles range from poor to acceptable (affiliative: .67 - .87; self-enhancing: .70 - .85; aggressive: .55 - .82; self-defeating: .72 - .81), with the aggressive dimension being consistently the worst-performing dimension in this regard.

Moreover, although most of the previous assessments of the HSQ (for an exception, see Sullivan & Dithurbide, 2007) support a four-dimensional structure, some report poor model fit values (see table 6.4). This poor model fit is reflected by item arrangements presenting significant deviations from the intended factorial structure, especially for items in the negative humor styles dimensions (Ruch & Heintz, 2016), sometimes resulting in item deletion from the scale (Anlı, 2021). In addition, the few studies that investigated test-retest reliability suggest poor to acceptable levels of reliability, with the aggressive humor style consistently presenting the worst results (Sullivan & Dithurbide, 2007).

6.5.0.1. *Goals and hypotheses* In this study, we sought to translate and evaluate the psychometric properties of the European Portuguese version of the HSQ. In this context, we expected that the newly translated scale would demonstrate specific results, as outlined below in our hypotheses.

◇ ***Factorial structure and internal Consistency:***

H1: A CFA of the translated version of the HSQ should replicate the original factor structure, with each item loading onto one factor (loadings $\leq$ .40 for the designated factor) and demonstrating good-excellent model fit estimates.

H2: Each of the four subscales of the HSQ will show acceptable internal consistency as estimated using Chronbach's α.

◇ ***Criterion validity:***

Following the meta-analytic results reported by Plessen et al. (2020) examining the correlations between the humor style scale scores and the Big Five personality dimensions and the results reported by Martin et al. (2003) examining humor styles and mental health:

H3: We expect to observe positive correlations between the affiliative humor style scores and the (a) extraversion and (b) openness dimensions of personality.

In addition, the affiliative humor style scores should also correlate positively with (c) positive affect (and negatively with negative affect), (d) with life satisfaction, and (e) subjective well-being.

H4: A positive correlation is expected between the self-enhancing humor style scores and the personality dimensions of (a) extraversion, (b) openness, (c) emotional stability, and (d) agreeableness. Moreover, the self-enhancing humor style scores should also correlate positively with (e) positive affect (and negatively, with negative affect), (f) life satisfaction, and (g) subjective well-being.

H5: The aggressive humor style should negatively correlate with the personality dimensions of (a) consciousness and (b) agreeableness. The aggressive humor style scores should also negatively correlate with (c) life satisfaction and (d) well-being.

H6: The self-defeating humor style should negatively correlate with the dimensions of (a) emotional stability and (b) consciousness. In addition, the self-defeating humor style scores should negatively correlate with both (c) life satisfaction and (d) well-being.

◇ ***Test-retest reliability:***

H7: We expect to observe significant correlations for the four humor style dimensions over a two-week interval between participants' responses.

6.6. Method

6.6.1. Translation process

The translation of the HSQ followed a predetermined protocol. The items of the HSQ were independently translated to European Portuguese by two bilingual native speakers who were also experts in the field of Psychology. The resulting translations were then combined by the first author and translated back to English by two bilingual individuals. The resulting translated items were checked and adjusted by the first author, when necessary, and a pilot-evaluation study with 10 individuals was conducted, to assure the clarity of the items and corresponding instructions. These individuals were asked to rate the questions in terms of clarity and understandability. After this, the necessary changes, resulting from their feedback, were made and the final translation of the scale was achieved.

6.6.2. Main data collection

Data collection was conducted in two stages. In the first stage, participants were requested to respond to an online questionnaire, which was composed of the following instruments: (a) the translated version of HSQ (R. A. Martin et al., 2003); (b) the Portuguese version of the Positive and Negative Affect Schedule (PANAS) to assess positive and negative affect (Galinha & Pais-Ribeiro, 2005; Watson, Clark, & Tellegen, 1988); (c) a measure of the Big Five personality dimensions, the Portuguese version of the Ten-item Personality Inventory (TIPI) scale (Nunes, Limpo, Lima, & Castro, 2018; Gosling, Rentfrow, & Swann Jr, 2003); (d) the Portuguese version of the Personal Well-Being Scale (Ribeiro & Cummins, 2008; Cummins, Mccabe, Romeo, & Gullone, 1994), and a brief socio-demographic questionnaire.

The PANAS, TIPI, and Personal Well-Being scales were used to evaluate the criterion validity of the translated HSQ. In addition, two attention-check items were included at random in the questionnaire, to guarantee that participants were paying attention. Each scale's information is presented in table 6.5.

6.6.3. Sample

Participants were 329 native Portuguese speakers ($M_{age} = 39.98$, $SD = 11.53$, $n_{female} = 210$). Of those, 107 participated in the second part of the study ($M_{age} = 39.29$, $SD = 12.13$, $n_{female} = 66$).

Participation in the first stage of the study lasted between 20 and 30 minutes.

In the second stage, and to evaluate the temporal stability of the HSQ, participants who participated in the first stage of data collection were asked to respond to the items of the HSQ again, two weeks after their initial responses. Participation in the second stage of the study lasted approximately 15 minutes.

The order of items within each scale was randomized to avoid order effects. Participants were required to complete the HSQ before the other scales. To receive an invitation to the second stage of the study, participants of the first stage were invited to provide their email address using a separate link, and to create an alpha-numerical code that was used to connect both parts of the questionnaire. After the two parts of the questionnaire were connected for each participant, the email addresses and alpha-numerical codes were deleted to ensure confidentiality.

Table 6.5. Psychometric properties of the scales used in this study.

Scale	***Sub-dimension***	***Internal consistency***	***Grand mean (SD)***	***n items***	***Response scale***	***Missing values***
PANAS (Watson, Clark & Tellegen, 1988; Portuguese adaptation by Galinha & Pais-Ribeiro, 2005)	Positive affect	.89	2.89 (0.74)	10	1 - 5	Little's MCAR test: χ^2 (233) = 250.64, p = .20
	Negative affect	.88	1.73 (.69)	10		

TIPI scale (Gosling, Rentfrow & Swann, 2003; adapted to Portuguese by Nunes, Limpo, Lima & Castro, 2018)	Extraversion	.72	4.38 (1.63)	2	1 (Completely disagree) - 7 (Completely agree)	Little's MCAR test: χ^2 (44) = 46.54, p = .37
	Openness	.48	5.18 (1.18)	2		
	Agreeableness	–	5.70 (1.16)	1		
	Consciousness	.30	5.47 (1.17)	2		
	Emotional stability	.61	4.05 (1.54)	2		

Personal Well-Being Scale (Cummins, McCabe, Romeo & Gullone, 1994; adapted to Portuguese by Ribeiro & Cummins, 2008)	Well-being	.84	8.65 (1.58)	8	0 (Completely unsatisfied) - 10 (Completely satisfied)	Little's MCAR test: χ^2 (54) = 39.85, p = .93

6.7. Results

6.7.0.1. *Data analysis strategy* Initial data analysis was conducted using IBM AMOS, v. 26 and IBM SPSS, v.28, and the program R (R Core Team, 2021) through the integrated development environment, RStudio (RStudio Team, 2021).

Scale items were grouped into their appropriate sub-dimensions according to the instructions given for each scale, and items were reversed when necessary. Participants with more than 50% of missing values were excluded from the analysis. For the remaining participants, a Little's MCR test was conducted to analyze the pattern of missing values (with p-values $> .05$ considered to be an acceptable indicator that the data is not missing at random; see table 6.5). If the values were missing at random, the value was substituted using the EM procedure. If the pattern of missing responses was not random, those participants were excluded from the study.

Pearson's r coefficient is used to calculate the correlations between scales, using effect size standards for interpretation. The skewness was measured using "sample" method (i.e., sample skewness of the distribution), and the kurtosis using "sample excess" method (i.e., sample kurtosis of the distribution with a value of 3 being subtracted) were calculated using the PerformanceAnalytics package (B. G. Peterson & Carl, 2020).

The coefficient of variation was estimated with the sjstats package (Lüdecke, 2019), and the standard error of the mean was calculated with the plotrix package (Lemon, 2006). The mode was computed by the modeest package (Poncet, 2019).

To obtain evidence about the originally proposed dimensionality of the measurement models, the CFA was used. The following goodness-of-fit indices were used: Normed Fit Index (NFI), Tucker-Lewis Index (TLI), RMSEA, SRMR, and χ^2/df.

Estimates above .95 are considered acceptable for NFI, TLI, and CFI, whereas estimates smaller than 5 are considered acceptable for χ^2/df (Hu & Bentler, 1999). Values below .08 are expected for SRMR and RMSEA (Byrne, 2010). The CFA minimum sample size was estimated via the MBESS package (Kelley, 2019). The package lavaan (Rosseel, 2012) was used to run the CFA analysis using the Weighted Least Squares Means and Variances estimator (Muthén, 1983).

This method was chosen because it does not require multivariate normality as an assumption and also because all items of the used psychometric instruments have an ordinal response scale. To assess the evidence of reliability of the first-order factors, we used the Cronbach α (Jorgensen, Pornprasertmanit, Schoemann, & Rosseel, 2021). Values of $\alpha \geq .7$, are considered indicative of acceptable reliability evidence.

The AVE was also estimated as mentioned in and Fornell and Larcker (1981). Satisfactory values were assumed for AVE $\geq .5$ (Hair, 2009). The first-order internal consistency estimates were calculated using the semTools package (Jorgensen et al., 2021).

Due to the TIPI scale exhibiting inadequate internal consistency levels across all dimensions except for extroversion, our statistical analysis focused solely on the extroversion dimension.

In all analyses, a significance level of $p < .05$ or the exclusion of zero from the confidence intervals were employed as the criteria to reject the null hypothesis.

6.7.0.2. *Hypotheses tests*

◇ *H1:* An initial CFA of the translated version of the HSQ did not replicate integrally with the original factor structure (see table A.8). Five items did not load onto any of the four factors, and only one item loaded onto the 4^{th} factor. Removing the five items and eliminating the 4^{th} factor still did not result in a well-fitting model (Model 1 (M1); see table 6.6).

An Exploratory Factor Analysis (EFA) (Model 2; M2) was conducted, from which seven factors emerged (see table A.10). The item, "Sometimes I think of something that is so funny that I can't stop myself from saying it, even if it is not appropriate for the situation." (aggressive humor style) did not load onto any of the factors and was removed. The model only converged after the removal of the 6^{th} and 7^{th} factors. Although this model presented improved results (see table 6.6), values for the CFI were still lower than expected. When analyzing the internal consistencies of the dimensions for this model, we found that Factor 4 had unacceptable levels.

Table 6.6. Model fit indicators for the models estimated through the iterative process.

Model	χ^2 ***(df)***	χ^2/df	***p***	***CFI***	***RMSEA***	***SRMSR***	***AIC***
Original	1241.80 (428)		<. 001	.72	.08	.09	1377.81
Model 1	1187.8 (296)		<. 001	.65	.10	.10	1297.79
Model 2	997.8 (367)		<. 001	.77	.07	.08	1459.94
Model 3	1181.2 (296)		<. 001	.65	.10	.10	1291.17
Model 4	1131.5 (272)		<. 001	.65	.10	.10	1237.47

A second CFA with the remaining items (see Table A.10) yielded a four factor-structure (with only one item loading onto the 4^{th} factor), and did not result in a well-fitting model (see M3 in table 6.6). The removal of the 4^{th} factor (M4) also did not result in a well-fitted model (see M4 in Table 6.6). Looking at the modification indices, no other significant alterations to the scale's arrangement resulted in a better model fit without having a detrimental effect upon the conceptual structure. Additionally, we found issues with the discriminant and convergent validity estimates for all the models estimated (see table 6.7).

◇ *H2:*

Arranged in the original configuration proposed by Martin and colleagues (2003), the dimensions of the HSQ presented poor to acceptable internal consistency values. Similar to the original scale, the lowest levels of internal consistency were observed for the Aggressive humor dimension; and the scale's dimensions presented similar patterns of intercorrelations (see Table A.11 for general correlations and internal consistencies and Table A.12 for correlations according to sex).

Table 6.7. Convergent and discriminant validity for the models estimated.

Model		***AVE***	***CR***	***MSV***
Original	1	0.39	0.83	0.32
	2	0.30	0.76	0.20
	3	0.18	0.57	0.20
	4	0.35	0.79	0.32
Model 1	1	0.34	0.86	0.41
	2	0.27	0.76	0.06
	3	0.21	0.46	0.41
Model 2	1	0.39	0.83	0.32
	2	0.40	0.83	0.32
	3	0.32	0.76	0.29
	4	0.29	0.67	0.35
	5	0.34	0.50	0.35
Model 3	1	0.31	0.86	0.87
	2	0.32	0.76	0.79
	3	0.18	0.40	0.28
Model 4	1	0.32	0.86	0.87
	2	0.32	0.76	0.79
	3	0.18	0.40	0.66

The item arrangement resulting from the initial EFA (see table A.10) presented improved levels of internal consistency for some dimensions (but not all; see table A.11 for general correlations and internal consistencies and table A.11 for correlations according to sex in supplementary materials).

The first four factors of M2 presented poor to acceptable levels of internal consistency (see table A.11). The 5^{th} factor presented unacceptable levels of internal consistency and the remaining two factors included only one item (hence, internal consistency was not calculated). For factor 2, internal consistency rose (from .74 to .75) when HSQ28 was deleted (although this change was found to be too small to justify deletion). No other item deletions in any of the other factors resulted in improved internal consistency scores.

- ◇ *H3:* We observed positive relations between the affiliative style of humor and the extraversion dimension of personality (see Table A.9). In addition, this style of humor correlated positively with positive affect and subjective well-being.
- ◇ *H4:* Positive correlations were observed between the self-enhancing style of humor and extraversion. Moreover, the self-enhancing style of humor correlated positively with positive affect (and negatively, with negative affect), and with subjective well-being (see Table A.9).
- ◇ *H5:* We did not observe significant correlations between the negative humor style and the extraversion dimension of personality.

◇ *H6:* The self-defeating style of humor was negatively correlated to the dimensions of extraversion. In addition, it was positively correlated with negative affect.

◇ *H7:* All pre and post measurements for each dimension of the HSQ were significantly correlated (see table A.13 for correlations between pre - post measurements using the original structure).

6.7.1. Reduced version

To attain an optimal scaling arrangement, we further opted to assess scale configurations delineated in previous works, which engaged samples characterized by a degree of cultural or linguistic concurrence with the demographic constituents of the Portuguese population. In particular, we examined the psychometric properties and model fit for a previous assessment of this scale's qualities in Portuguese (Fernandes, 2023), Venezuelan (Koch, 2008) and Brazilian Portuguese (de Souza, Felix, de Andrade, & dos Santos Cerqueira, 2019) samples. The resulting configurations did not present acceptable values of model fit (see table A.14).

A reduced version of the original scale was then tested. Factor loadings for the reduced version containing three items per dimension are presented in table A.15, and the standardized estimates are presented in figure 6.1. This reduced version demonstrated adequate psychometric properties (χ^2 (48) = 163.80; p < .001; CFI = 0.93; TLI = 0.90; NFI = 0.94; SRMR = 0.06; RMSEA = 0.08; p ≥ .05; 90% CI [0.06, 0.09]).

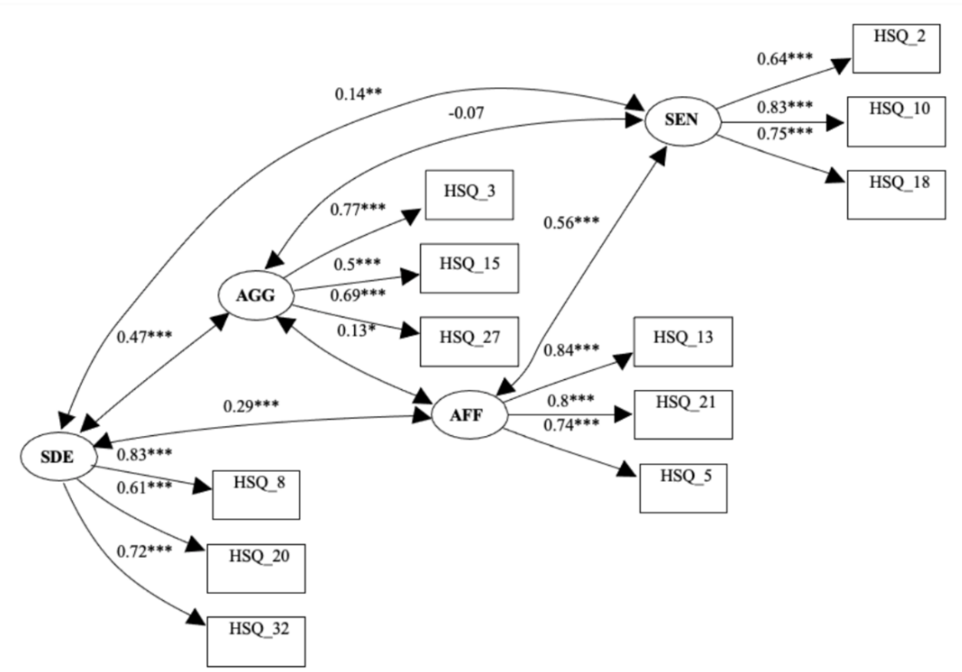


FIGURE 6.1. Standardized estimates for the model of the reduced version of the HSQ.

In the abbreviated iteration of the scale, we preserved the four-factor architecture while diminishing the count of items per dimension from 8 to 3. This reduction was achieved by singling out the trio of items manifesting the greatest factor loadings within each respective dimension. In each case, all the items included for each dimension belong to that same dimension in the original scale.

Similar to what was reported above for the scale mirroring Martin's (2003) configuration, the reduced version exhibited commendable degrees of internal consistency (with the exception of the items used for the aggressive style of humor, which remained low, but approximately within the range reported by other studies, see table 6.9).

Moreover, the reduced scale exhibited statistically significant correlations with associated constructs that aligned well with those hypothesized based on previous literature. In particular, both affiliative and self-enhancing humor were positively correlated with extraversion (.36 and .11, both $p < .05$).

Self-defeating humor was negatively correlated with extraversion (-.12, $p < .05$). No other significant correlations with personality dimensions were found. Also as expected, we found that affiliative and self-enhancing humor were positively correlated with positive affect (.25 and .29, both $p < .001$), and that self-enhancing humor was negatively correlated with negative emotional states (-.15, $p < .001$). However, we did not find any statistically significant positive correlations between negative humor styles and negative affect, nor did we find negative correlations between these humor styles and positive affect.

Regarding the association between humor styles and subjective well-being, we found that both the affiliative and self-enhancing humor styles correlated positively with participant's scores on the Personal Well-Being Index (.27 and .27, both $p < .001$), but that this index was not significantly correlated with either one of the negative humor style dimensions.

When considering their associations with psychological well-being, our findings indicate that both affiliative and self-enhancing humor were positively correlated with all domains of well-being (namely, autonomy: .17 and .15, environmental mastery: .18 and .15, personal growth: .36 and .23, positive relations with others: .51 and .35, purpose in life: .22 and .17, and self-acceptance: .32 and .30, all $p < .001$). Self-defeating humor was negatively correlated with autonomy (-.15), environmental mastery (-.18) and purpose in life (-.17, all $p < .001$).

A comparison of the correlations between the reduced version of the HSQ according to sex is presented in table 6.8.

Table 6.8. Correlations for the reduced HSQ according to sex.

	SEN	AFF	AGG	SDE	Extraversion	PANAS (pos)	PANAS (neg)	IBP	AUT	MAS	PG	PR	LG	SA
SEN	1	.58**	.33**	.63**	.15	.18	-.09	.30**	.11	.09	.24**	.39**	.10	.22*
AFF	.45**	1	.31**	.34**	.43**	.25**	.02	.32**	.26**	.14	.39**	.55**	.17	.32**
AGG	.04	.005	1	.23*	-.12	.10	.14	.17	.21*	.03	.16	.13	.06	.06
SDE	.49**	.16*	.17*	1	-.13	.05	.06	.04	-.12	-.17	.06	.18	-.18	-.04
Extraversion	.09	.30**	-.03	-.11	1	.29**	-.21*	.18	.21*	.29**	.38**	.38**	.34**	.37**
PANAS (pos)	.35**	.25**	-.11	.05	.19**	1	.09	.40**	.34**	.48**	.49**	.38**	.51**	.55**
PANAS (neg)	-.16*	-.00	.03	.14*	-.11	-.19**	1	-.30**	-.18	-.30**	-.03	-.13	-.16	-.25**
IBP	.25**	.24**	-.06	-.02	.23**	.43**	-.34**	1	.43**	.63**	.52**	.48**	.57**	.70**
AUT	.17*	.09	-.14*	-.18**	.25**	.24**	-.11	.22**	1	.59**	.52**	.39**	.59**	.54**
MAS	.19**	.20**	-.13	-.19**	.28**	.36**	-.38**	.42**	.40**	1	.49**	.51**	.75**	.71**
PG	.24**	.31**	.02	.06	.25**	.34**	-.09	.34**	.33**	.35**	1	.59**	.58**	.68**
PR	.34**	.47**	-.02	.08	.19**	.31**	-.15*	.40**	.14*	.25**	.43**	1	.52**	.59**
LG	.22**	.26**	-.12	-.16*	.36**	.48**	-.30**	.51**	.36**	.62**	.43**	.37**	1	.81**
SA	.36**	.32**	-.08	-.07	.29**	.41**	-.36**	.57**	.38**	.59**	.51**	.50**	.67**	1

Notes: AFF = Affiliative; SEN = Self-enhancing, AGG = Aggressive; SDE = Self-defeating, IBP = Index of Psychological Well-being, AUT = Autonomy, MAS = Mastery, PG = Personal Growth, PR = Positive Relations, LG = Purpose in Life and SA = Self Acceptance. Correlations for men are displayed above the diagonal, and correlations for women are displayed below the diagonal.
**Correlation is significant at the 0.01 level (2-tailed).
*Correlation is significant at the 0.05 level (2-tailed).

TABLE 6.9. Comparison of the reduced HSQ version, the original version and findings from previous literature.

Indicator	Sub-dimension	Reduced version	Martin et al. (2003) version	Range observed in previous literature
Internal consistency	AFF	.80	.80	.67 - .89
	SEN	.74	.81	.70 - .85
	AGG	.52	.77	.55 - .82
	SDE	.70	.80	.55 - .81
Test-retest reliability	AFF	.82**	–	.67 - .85
	SEN	.61**	–	.64 - .81
	AGG	.50**	–	.57 - .80
	SDE	.51**	–	.60 - .82

6.8. Discussion, limitations and conclusion

Humor is widely recognized as being an omnipresent aspect of our daily lives, with many key consequences and contributions in the ways we interact with each other and to our own personal health, well-being, and happiness. This omnipresence, and consequently, the growing recognition of its importance in our lives has led, over the past few decades, to a greater academic interest in the subject of humor.

As a result of this growing academic interest on humor, several scales intended to measure different facets of humor have been proposed and adopted by researchers, with varying degrees of success and popularity among the scientific community. In this paper, we were particularly interested in analysing the psychometric properties of the HSQ in a sample of Portuguese participants. In particular, we analysed the factorial structure of the translated scale, as well as its discriminant validity and its test-retest reliability.

In line with our hypotheses, significant positive correlations were found between the self-enhancing style of humor and extraversion. Additionally, the self-enhancing style of humor exhibited positive associations with positive affect (while displaying negative associations with negative affect) as well as subjective well-being. Regarding affiliative humor, positive relations were also observed between the affiliative style of humor and the dimensions of extraversion.

These findings are partly aligned with previous literature, which has substantiated the existence of a positive association between positive humor styles and extraversion, openness to experience and conscientiousness (Mendiburo-Seguel, Páez, & Martínez-Sánchez, 2015). This aligns with the notion that extraverts tend to derive greater overall enjoyment and find particular pleasure in social interactions. However, it appears that they do not derive enjoyment or appreciation from situations or stimuli that are aggressive or self-defeating in nature (Mendiburo-Seguel et al., 2015).

The positive overall link between positive humor styles and subjective well-being also provides further support to the idea that positive humor is associated with greater levels of subjective well-being (Oliveira, Arriaga, & Barreiros, 2023). In addition to this association to subjective well-being, and, also in line with previous literature, we observed a positive association between positive humor styles and positive affect (and a negative correlation with negative affect), as well as a positive correlation between self-defeating humor and positive affect (Cann & Collette, 2014).

However, having encountered challenges in replicating both the original structure and item arrangement of the initial HSQ, along with the inability to reproduce structures established by other researchers, we chose to develop an abbreviated iteration. This reduced version preserved the original four-factor structure while demonstrating analogous psychometric characteristics.

The dimension of the proposed version aligns with that of the sole other reduced iteration of the scale, as proposed by Scheel, Gerdenitsch, and Korunka (2016), to the best of our knowledge (see table 6.9). A shorter version of the HSQ questionnaire can provide several benefits while maintaining brevity, ensuring sustained participant engagement and attention by demanding less time for completion, which often enhances completion rates and the overall quality of responses (Yan, Conrad, Tourangeau, & Couper, 2011). In addition, the reduced version of the questionnaire maintained similar levels of temporal reliability to the levels exhibited by the scale in its original configuration, after a two-week interval (ranging between .40 and .60).

Although contrary to our hypotheses, these results are in line with a growing segment of the literature that has identified significant flaws in the scale proposed by Martin and colleagues (2003).

Namely, one study by Ruch and Heintz (2017) has identified significant issues with the construct validity of the scale, suggesting that humor was not the primary source of variance for three of the four humor styles (self-enhancing, aggressive and self-defeating) Moreover, these authors reported that, when controlling for the non-humorous contexts in the scale items, their association with personality traits and well-being was either reduced or vanished entirely (Ruch & Heintz, 2017).

In addition, more recent analyses of the response scale for the HSQ (7-point scale) suggest that this response format performs poorly in comparison to a shorter 5-point alternative (Silvia & Rodriguez, 2020). This study also highlights other aspects of the scale, which are likely to affect its quality For instance, items in the scale intended to measure positive humor styles seem to be overall easier to answer compared with the items intended to measure negative humor styles (as indexed by the degree of endorsability of the items, i.e., how easy or hard it is for respondents to express agreement with it).

The items used to measure different humor styles also present several discrepancies among themselves in regard to their discrimination properties (i.e., their ability to discriminate between different levels of a trait), with the items within the affiliative dimension presenting greater discriminative power when compared to the items within the aggressive dimension (Silvia & Rodriguez, 2020).

In summary, the affiliative subscale stands out as it offers abundant information compared to the others, but at a lower trait level. This indicates that the affiliative items are easy yet highly discerning (Silvia & Rodriguez, 2020). Consequently, the affiliative subscale effectively measures the lower range of the trait, allowing fine distinctions between very low and moderately low levels. However, it provides less insight into individuals with a high affiliative humor style. In contrast, the other three subscales exhibit typical test information functions found in typical populations, with peaks near zero. While they offer relatively less absolute information (lower peaks compared to the affiliative subscale), they cover a broader range of the trait (Silvia & Rodriguez, 2020).

CHAPTER 7

Social Robots

This is [...] what's great about people. These are world-class engineers. When they sent a rover to another planet they could have easily looked at it as just another scientific tool. But people don't do that. We can and will get emotionally attached to the most inanimate of objects. [...] And frankly Opportunity's camera mast looks like a little face with eyes and everything. So why not? So they started calling it 'her'. They nicknamed her Oppy. They told her to take a selfie not long ago.

After 15 years of Oppy flipping the double bird to her original 90 day life expectancy, when a planet-spanning dust storm finally knocked her out and she stopped responding to the engineer's wake-up messages, they started playing music for her.

And after 8 months and almost 1000 unanswered wake-up messages, when it was finally clear that Oppy was never going to wake up, the last thing these world-class NASA engineers did for their little rover on another planet

Was play her a love song.

(Unknown, n.d.)

Abstract

Humor is an inescapable part of our daily lives. Although its mainly positive effects in interpersonal interaction are well documented in literature, much less is known about how humor can affect interactions between humans and robots. To shed light on this issue, we conducted a between-subjects online study ($n = 381$), in which we presented participants a vignette describing a work-related interaction with either a human or a robot, and in which manipulated the style of humor displayed by the humorous agent. Results show that users' perceptions of robots' warmth and competence predict their future intention to interact with robots through improved perceived ease of use and usefulness and that this relation is moderated by the congruence between users' and robots' styles of humor. Moreover, improved perceptions of robots observed in the sequence of a display of humor are positively associated with their perceived social, emotional and societal value. These results support the importance of introducing humor in human-robot interactions.

7.1. Introduction and overview

Virtually everyone can recognize when something is funny, but most people have a much harder time pinpointing what makes it so. Indeed, humor is unique in this sense: it possesses very distinct features that make it easily recognizable, while at the same time being so varied and subjective that its underlying structure still escapes a concrete definition. Yet, while being unique, humor also possesses many important affinities with other psychological phenomena and processes.

Notably, humor has been explored in the context of interpersonal relations and person perception, with research returning mixed results. On one hand, humor can serve as a social lubricant, by increasing interpersonal attraction and perceived suitability (McGee & Shevlin, 2009), increasing empathic concern for others (Hampes, 2001), contributing to conflict resolution (Smith et al., 2000) and by increasing overall relationship satisfaction (Hall, 2017). On the other hand, humor can be used to discriminate against outgroups (Meyer, 2000), facilitate collusion and exclusion of others (Rogerson-Revell, 2007), and even generate conflict (Kim, Godfrey, & Eys, 2022).

These mixed results seem to be tied to two main aspects that explain how humor is received and perceived by others in different situations: the target and valence of the humor used. These two variables (i.e. target and valence) are the anchors of the model of humor proposed by Rod Martin and colleagues (2003). These authors argue for the existence of four distinct humor styles that capture the individual differences in humor usage. In their conceptualization of humor, the authors differentiate between affiliative (directed at the audience and positive), self-enhancing (directed at the author of the joke and positive), self-defeating (directed at the author of the joke and negative) and aggressive (directed at the audience and negative) humor styles.

In addition to having an impact on psychological wellbeing (Kuiper & McHale, 2009)) and being associated with different health outcomes (Oliveira & Arriaga, 2022; Schneider et al., 2018), research has produced evidence that these four humor styles also appear to influence interpersonal relationships. For example, negative humor styles have been shown to be positively associated with avoidant attachment (Luevano, Pablo, Velazquez, Chance, & Ramirez, 2021), whereas positive humor styles have been shown to be an important factor in establishing and maintaining social bonds and to be more attractive and socially desirable (R. A. Martin et al., 2003; Luevano et al., 2021).

Although the work described on this chapter, provides, to the best of our knowledge, the first exploration of how these four humor styles might benefit HRI, other previous research has already identified that humor might not provide a nominal benefit in interactions with SRs (see chapter 5). Specific content characteristics of the humor used, such as its valence and its topic or subject, seem to be important factors in determining not only how the users respond to the humor, but also the strenght of their responses, and how they come to perceive the humorous actor itself (see chapter 5).

In this chapter, we aim to investigate if the interpersonal advantages that positive humor confers in terms of interpersonal interaction among people, can be translated to their interactions with SRs by resulting in greater acceptance of this type of technology. In accordance with TAM and UTAUT, we examine how this variable (humor) is related to the robot's Perceived Usefulness (PU) and Perceived Ease of Use (PEU). Moreover, we will test if the congruence between the user's and the robot's humor style has a moderating role on the relation between the negative attitudes towards robots and participants' intentions to interact with the SR.

7.1.1. Hypothesis

Hypothesis (H) 1 will be investigated in study 1, and Hs 2-5 will be investigated in study 2. H1 is an exploratory analysis of the relationship between humor styles and the joke content. Based on previous literature, we devised the following Hs:

- ◇ ***H1***: There will be significant positive correlations between participants' humor style and their evaluation of the funniness of jokes that match their humor style.
- ◇ ***H2***: Humor performed by a human actor will be perceived as being funnier than humor performed by a SR, regardless of the humor style.
- ◇ ***H3***: The style of humor preferred by participants affects their evaluation of the humorous actor. In particular, we expect that participants will evaluate more positively agents who express congruent styles of humor than agents who express dissimilar styles of humor to their own.
- ◇ ***H4***: Improved perceptions and attitudes towards humorous robots will be positively associated with participants' perception of the social, emotional and societal value of SRs.
- ◇ ***H5***: The (a) relation between robot perception (in terms of warmth, competence and discomfort) and future intention to interact with robots will be mediated by participants' perception of ease of use and usefulness and (b) the relation between users' perception of the robot and its' ease of use and usefulness will be moderated

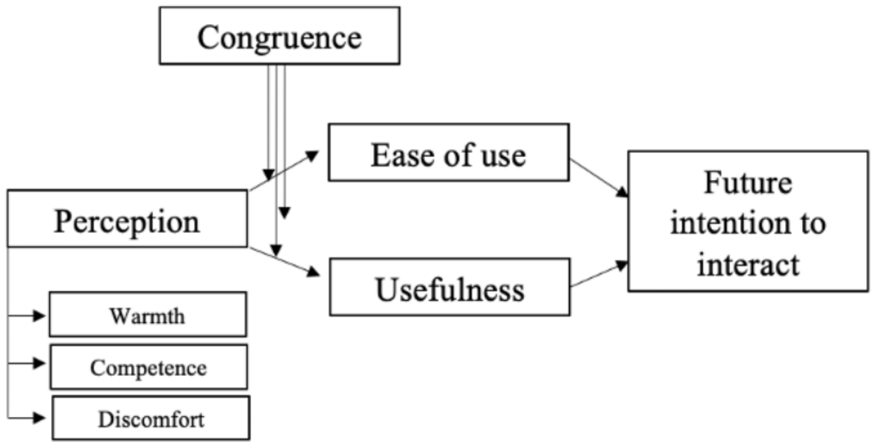


FIGURE 7.1. Main conceptual model.

by the congruence between the participants' and the robots' humor style (see fig. 7.1).

7.2. Study 1

Humor styles capture people's use of humor in everyday life according to their valence and intended target (R. A. Martin et al., 2003). Although it was not originally intended as a categorization of the content of humor, previous attempts to translate the categorization of humor styles into a model of humorous content have been successfully attempted. For example, (Chan et al., 2018) conducted a study in which they manipulated the target and the valence (e.g., *"If each of [your/my] admirers were a strand of hair, [I/you] [would be bald/ would need two heads]"*) of the jokes presented to participants and found different patterns of brain activation related to the appreciation of each humor style.

In particular, the authors observed greater patterns of activation in response to positive styles of humor than in response to negative humor, and found that each humor style was associated with activation in different areas of the brain.

However, to the best of our knowledge, there is still no consensus or direct analysis of the relationship between humor styles and humorous content. As such, we devised the present study to analyze the relation between participants' humor styles and jokes, which content reflects the humor styles devised by Martin and colleagues (2003). In addition to this goal, we also devised this study as a pre-test or validation study of the materials that we will use in the second study.

7.2.1. Sample

We recruited a sample of 131 participants. Of these 131, 23 were eliminated due to failing to answer correctly to the attention-check items, missing information regarding their age or having missing responses on more than 50% of the questionnaire. The data of the remaining 108 were used in our study. Participants were mostly female ($n = 98$), and on average 20.75 ($SD = 5.45$) years old. They were recruited through a university study' participants pool, and were rewarded with a course credit for their participation (see table A.19 in supplementary materials for a more complete description of the participants).

7.2.2. Measures

To measure humor styles, we used the HSQ proposed by Martin and colleagues (2003).

In addition, to evaluate participants' amusement with each joke, we asked them to rate their agreement with the sentence "This joke is funny" on a 7-point scale (1 - Completely disagree, 7 - Completely agree).

Moreover, for each joke participants were asked to indicate their agreement with four statements based on the definition proposed for each humor style by Martin and colleagues (2003)[1]. Namely:

Affiliative humor	When used in a social context, this joke might contribute to better relationships and it's relatively benign, reflecting self-acceptance.
Self-enhancing humor	This joke can be used to enhance the status of the person telling the joke in a tolerant and positive way.
Aggressive humor	This joke can be used to enhance the status of the person telling the joke, but does so at the expense of the joke teller's relation to the target of the joke or others.
Self-defeating humor	When used in a social context, this joke might contribute to better relationships even if it's at the expense of the person telling the joke.

This measure was used to validate if the jokes selected for each humor style, were seen by participants as being congruent with the definition offered by Martin and colleagues (2003).

Finally, participants were asked to indicate their sex and age.

7.2.3. Manipulation and Materials

To answer our questions, we used a within-subjects study design, in which participants were asked to evaluate 20 jokes (5 per each humor style). These jokes were collected by the authors from websites containing joke compilations and were chosen specifically taking into account the description of humor styles developed by (R. A. Martin et al., 2003). For instance, for affiliative humor the joke "Mentos should print little messages on their mints like "You're awesome!" and call them Complimentos." was used. For self-defeating humor, one of the jokes used included "I'm short, but it's ok. We all know the best things come in small packages.". For aggressive humor, we used jokes like "I love the sound you make... when you shut up", and for self-defeating humor, we used jokes such as "I know how batteries feel... I'm also never included in anything" (for a full list of jokes, see table A.16).

[1]The full questionnaire can be consulted here: https://www.osf.io/f39ks

7.2.4. Procedure

This study was approved by ISCTE's Ethical Commission.

Participants were recruited to participate in an online study via the Qualtrics platform. After reading the informed consent, participants responded to the HSQ (R. A. Martin et al., 2003). After, they were presented with the jokes and asked to evaluate each one, before indicating their age and sex. The order of all questions, as well as the order of the presentation of the jokes were randomized for each participant, in order to avoid order effects. In the end, participants were debriefed and thanked for their time. The questionnaire took approximately 20-25 minutes to complete.

7.2.5. Results

First, we analyzed participant's responses to the HSQ and the factorial structure of this scale. We found that, similar to the original scale, the lowest values of reliability were observed for the aggressive sub-category of HSQ.

Also, similar to the original scale, there was a significant correlation between affiliative and self-enhancing humor styles (although in our study, the correlation was lower) for women. Unlike the original scale, we did not observe significant correlations between aggressive and affiliative nor between self-defeating and aggressive styles of humor for women (see table 7.1 and table A.21).

After removing significant outliers and conducting an exploratory factorial analysis (retaining only items with loadings $\geq .50$), through an iterative process, we achieved the factorial structure presented in table A.20. At this stage, the dimension of aggressive humor was removed due to the poor loadings of its items and its deleterious effect on the structure of the remaining factors, as well as the low correlations among this humor style and the jokes tested.

Table 7.1. Correlations and reliability of HSQ dimensions.

	Self-enhancing	Self-defeating	Affiliative
Self-enhancing	.80	-.05 (p = .60)	.04 (p = .72)
Self-defeating		.81	-.01 (p = .95)
Affiliative			.80
Notes: Cronbach's α is presented in the diagonal.			

The final structure explained 59% of the variance and presented very good levels of reliability, with scale dimensions being independent from one another (see table 7.1).

To validate the jokes used, we calculated the correlations between participants' evaluation of their funniness with both their perception of each joke's congruence with the description of each humor style proposed by Martin and colleagues (2003, see table A.17 and table A.18).

After analyzing all the jokes' correlations with those two variables, we achieved the list of jokes presented in table 7.2. The other jokes tested, that did not correlate significantly with participants' humor styles, were removed.

TABLE 7.2. Correlation of the jokes selected with participants' humor styles.

		Correlation with participants' humor styles			Funniness
Humor style	***Joke***	***Affiliative***	***Self-enhancing***	***Self-defeating***	***M (SD)***
Affiliative	"Mentos packages should come with small compliments like "You're awesome" and be called Complimentos."	.23 (p = .03)	.16 (p = .11)	.07 (p = .48)	3.66 (1.80)
Self-enhacing	"I always take life with a grain of salt… and a slice of lemon… and a shot of tequila!"	.04 (p = .71)	.22 (p = .02)	−.05 (p = .63)	4.31 (1.87)
	"I like my work. It simply fascinates me. I can sit and stare at it for hours."	.05 (p = .61)	.23 (p = .02)	−.03 (p = .78)	4.19 (1.83)
	"I am short, but it's ok. Everyone knows the best things in life come in small packages."	.03 (p = .79)	.21 (p = .03)	−.06 (p = .56)	4.21 (1.80)
Self-defeating	"I know how batteries feel. I am also never included in anything."	.15 (p = .13)	.02 (p = .84)	.19 (p = .005)	4.04 (2.00)

None of the jokes presented in table A.16 correlated significantly with the descriptions of humor styles adapted from the work of Martin and colleagues (2003).

In terms of funniness, the joke considered for affiliative humor presented significant differences in terms of funniness to the other jokes, suggesting that the affiliative joke was considered to be the least funny when not taking into account participants' humor styles (see table 7.3). One of the self-enhancing joke was also considered to be funnier in comparison to the other jokes within that humor style.

7.2.6. Discussion

The goal of this study was to establish a correspondence between the evaluation of funniness of specific jokes and the participant's humor styles. This goal was established

TABLE 7.3. Paired t tests of funniness scores of the jokes included.

	Paired t tests values (n =108)					
	Joke	1	2	3	4	5
Affiliative	1. "Mentos packages should come with small compliments like "You're awesome" and be called Complimentos."	–	-3.56 (p <.001)	-3.00 (p = .003)	-3.08 (p = .003)	-2.35 (p = .02)
Self-enhacing	2. "I always take life with a grain of salt... and a slice of lemon... and a shot of tequila!"		–	0.57 (p = .29)	-2.79 (p = .006)	-1.17 (p =.25)
	3. "I like my work. It simply fascinates me. I can sit and stare at it for hours."			–	-0.14 (p = .89)	-0.67 (p =.50)
	4. "I am short, but it's ok. Everyone knows the best things in life come in small packages."				–	-0.75 (p = .45)
Self-defeating	5. "I know how batteries feel. I am also never included in anything."					–

on the assumption that humor styles could be descriptive not only of how people use humor in their daily lives, but also of the content of the humor they appreciate.

In this context, although we could identify a subset of jokes in which funniness evaluation correlated significantly with the participants' humor styles, this was not true for all of the jokes tested. In fact, the evaluation of the funniness of most jokes did not correlate significantly with any of the humor styles considered in this study. Whether this is explained by the small number of jokes tested and the characteristics of the sample or by a lack of relation between humor styles and humor content remains to be examined in future research.

More interestingly, we also could not find any significant correlations between the humor styles considered and the descriptions of humor styles proposed by (R. A. Martin et al., 2003). Previous research has noted issues regarding the content validity of the HSQ

(Heintz & Ruch, 2015), which might contribute to explaining this lack of results. More research examining the link between humor styles and humor content is needed.

The limitations of this study include the use of a single item to measure the funniness of jokes. In addition, the sample used is also limited in terms of its representativeness, being composed mostly by female college students. Given the existence of already known sex effects in humor styles (R. A. Martin et al., 2003), the dominance of women in the sample might hinder the generalization of the results of this study.

In addition to these limitations, and in similar to limitations pointed out by other authors (Ruch & McGhee, 2014; Silvia & Rodriguez, 2020), the original configuration of the HSQ did not present satisfactory psychometric properties. As such, to achieve a satisfactory factorial structure, some scale items were removed. This affected primarily the aggressive (which was removed from consideration here due to poor psychometric performance) and the affiliative humor styles dimension.

7.3. Study 2

In this study we analyzed the effects of humor styles (and the congruence between the humor style of the participant and that of the robot), and the author of the humor (SR or human) on user's perception and future intention to interact with the SR. The goals of this study are: (1) analyze the effects of the humorous actor (actor, human) on the perception of jokes; (2) explore the effects of the humor styles on user's perception of (a) the actor, (b) the SRs' ease of use,(c) the vs' usefulness, (d) the SRs' value, and (d) the willingness to interact in the future with SRs.

7.3.1. Sample

Using a power analysis and considering an effect size of .30 and an error probability of .05, we estimated a necessary minimum sample size of 281 participants. We collected data from 448 respondents. Of those, we removed 67 participants due to incompleteness of the questionnaire and failure to respond correctly to the attention-check items, thus reaching a valid sample of 381 participants. These participants were on average 24.57 years old (SD = 5.91). Most of them were women (74.9%) and students (54.7%). Only a small minority of participants reported having interacted with SRs before (8.4%), and only one participant reported having interacted before with a specific SR - a Pepper robot (for a detailed distribution of participants per study conditions and their sociodemographic characteristics see table A.22 and A.23, respectively). Participants reported paying a lot of attention while doing the study (M = 6.78, SD = .65, min = 4, max =7) and also found the scenario depicted in the vignettes to be very realistic (M = 5.52, SD = 1.47, min = 1, max = 7).

7.3.2. Measures

To measure the participants' humor styles we used the HSQ (R. A. Martin et al., 2003), which we have described in Study 1.

To measure the perceived humor in each sentence we considered three dimensions: (a) level of funniness ("How funny was the joke told by the robot/human / Quão engraçada foi a piada contada pelo robô/por esta pessoa?"), (b) originality ("How original was the joke told by the robot/human / Quão original foi a piada contada pelo robô/por esta pessoa?") and (c) appropriateness ("How appropriate was the joke told by the robot/human / Quão apropriada foi a piada contada pelo robô/por esta pessoa?"). Participants responded to these questions using a 7-point scale, in which higher values indicated more of the variable being measured (i.e. the content was perceived as being funnier, more original, or more appropriate).

Participants' perception of the humorous actor were measured using the RoSAS. The RoSAS include 18 items distributed equally among three dimensions: warmth, competence and discomfort (Carpinella et al., 2017). Each item of the scale is an adjective (e.g., social, competent) and participants are asked to rate how well each of the adjectives is associated with their perceptions of robots on a 9-point scale, ranging from 1 (definitely not associated) to 9 (definitely associated).

Participants also responded to two scales measuring perceived ease of use and usefulness (adapted from Davis, 1989). Each of these scales is composed of 14 items. Participants were asked to rate their level of agreement-disagreement with a set of statements about their expectations about the interaction with SRs on a scale ranging from 1 (completely disagree) to 7 (completely disagree).

To evaluate the perceived value of robots, we used the scale developed by (Sweeney & Soutar, 2001). This scale measures four dimensions of value: quality, price, emotional, and social. For the purpose of this work, we only measured the emotional (5 items) and social dimensions (4 items). The emotional dimension is related to the potential of products (in our case, SRs) to generate positive emotional gains to users; whereas the social dimension relates to the social outcomes that result from ownership of SRs. Participants were asked to read each item and rate their level of agreement with each item on a 7-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree). All sub-scales presented very good levels of reliability (ranging between .82 and .91).

In this study, we were also interested in evaluating peoples' perception of societal value, i.e. the extent to which humorous robots add value to society in general. As such, we constructed an ad hoc scale with three items to measure individuals' perception of the societal contributions of this type of technology. These items included "Social robots would add value to society in general", "Society would be better if we had more social robots", and "Society would be better if social robots had never been invented" (reversed coded).

Future intention to interact with robots was measured in two ways. First, participants were asked to rate their level of agreement with each of the following three statements: using a 7-point scale. The statements presented to participants were (a) "I would like to interact with social robots more often"; (b) "If I'm given an opportunity to interact with social robots in the future, I will take it" and (c) "If I see a social robot somewhere, I will likely leave the place or attempt to avoid it" (reverse scored item).

Second, participants were told that the researchers were organizing a new study in which participants would have the opportunity to interact with the SRs shown during the study. In addition, they were told that if they wanted to participate, they could indicate their contact (e-mail). We recorded information regarding the number of participants that stated they would like to indicate their e-mail (although their actual e-mail was never collected for privacy reasons). To consult the full questionnaire, the vignette and the photos used for the manipulation, see the annex 1 and 2 and table 7.4 and A.16 of the supplementary materials.

7.3.3. Manipulation and materials

Participants were shown a text-based vignette, in which they were told about an organization that just acquired a new SR. The goal of this SR is to guide people through the halls and to fetch and deliver items employees might need. In this context, participants were asked to imagine they were new employees of that company and that one day they stopped the robot to ask for directions. After giving them the directions, the robot decided to tell a joke (see table 7.4 for the vignettes used, and table A.1 in supplementary materials for the photos used), and then said goodbye and left.

In this context, we conducted a 2 (actor: robot, human) x 4 (humor styles: affiliative, self-enhancing, self-defeating, neutral) online experiment, in which both the actor and the humor styles were manipulated as between-subjects. In the control condition, participants were exposed to neutral sentences.

In addition to the written vignette, participants were shown a picture of the robot Pepper. In the human condition, participants were shown a smiling female face retrieved from the FACES database (picture group a, face ID 140; (Ebner, Riediger, & Lindenberger, 2010)).

Participants were recruited to participate in an online study via the Qualtrics platform. After reading the informed consent, participants responded to the HSQ (R. A. Martin et al., 2003). After that, they were presented a text-based vignette accompanied by the photo of a human or of a Pepper robot depending on the condition they were assigned to.

After reading the vignette, participants were asked to put themselves in the shoes of the protagonist of the story depicted on the vignette, and to respond to a questionnaire containing the aforementioned materials.

The order of all questions, as well as the order of the presentation of the jokes was randomized for each participant to avoid order effects. In the end, participants were debriefed and thanked for their participation. The questionnaire took approximately 15 minutes to complete, and participants were compensated for their time with class credits or €3.

TABLE 7.4. Vignette used for the manipulation of the main independent variable.

Actor	***Vignette (Original)***	***Vignette (Translated)***
Robot	Imagine que foi contratado/a para trabalhar na empresa Jota. Esta empresa é um dos líderes no seu sector e recentemente decidiu adquirir robôs sociais para ajudar os seus colaboradores. Para este efeito, a empresa adquiriu a Ana, cuja fotografia pode ver abaixo. A função da Ana é auxiliar os colaboradores da empresa Jota a encontrar diferentes localizações dentro dos escritórios da empresa e ajudá-los, indo buscar ou entregar diferentes objetos aos colaboradores. No seu primeiro dia na empresa, você aproxima-se da Ana para conseguir localizar o seu novo escritório. Enquanto a Ana o/a leva à localização pretendida, começam a conversar e a Ana conta a seguinte piada: [PIADA] (ver tabela 2). Depois de chegarem à localização final, a Ana despede-se e continua a fazer as suas outras tarefas.	Imagine you were hired to work at company Jota. This company is one of the leaders in its sector and has recently decided to acquire SRs to help its employees. To achieve this goal, the company acquired Ana, whose photograph you can see below. Ana's function is to help the employees of Jota company to find different locations inside the company's offices and help them by fetching or delivering different items to employees in need. In your first day working at the company, you approach Ana seeking help in locating your new office. While Ana takes you to your destiny, you start talking and she tells the following joke: [JOKE] (see table 2). After arriving at your final destination, Ana says goodbye and continues doing her other tasks.

Human	Imagine que foi contratado/a para trabalhar na empresa Jota. Esta empresa é um dos líderes no seu sector e recentemente decidiu contratar uma assistente para ajudar os seus colaboradores. Para este efeito, a empresa contratou a Ana, cuja fotografia pode ver abaixo. A função da Ana é auxiliar os colaboradores da empresa Jota a encontrar diferentes localizações dentro dos escritórios da empresa e ajudá-los, indo buscar ou entregar diferentes objetos aos colaboradores. No seu primeiro dia na empresa, você aproxima-se da Ana para conseguir localizar o seu novo escritório. Enquanto a Ana o/a leva à localização pretendida, começam a conversar e a Ana conta a seguinte piada: [PIADA] (ver tabela 2). Depois de chegarem à localização final, a Ana despede-se e continua a fazer as suas outras tarefas.	Imagine you were hired to work at company Jota. This company is one of the leaders in its sector and has recently decided to hire an assistant to help its employees. To achieve this goal, the company hired Ana, whose photograph you can see below. Ana's function is to help the employees of Jota company to find different locations inside the company's offices and help them by fetching or delivering different items to employees in need. In your first day working at the company, you approach Ana seeking help in locating your new office. While Ana takes you to your destiny, you start talking and she tells the following joke: [JOKE] (see table 2). After arriving at your final destination, Ana says goodbye and continues doing her other tasks.

7.3.4. Procedure

7.3.5. Results

7.3.5.1. *Data analysis strategy* Data analysis was conducted using JASP (v. 0.16.3) and IBM SPSS (v. 28).

The psychometric properties of all scales were calculated and items in each scale were reversed, when necessary, and grouped in dimensions according to their original proposed structure.

A dummy variable for the congruence between participants' humor styles and the humor styles exhibited by the robot was created by averaging participants' scores in each dimension of the HSQ and then, by comparing the highest scoring dimension for each participant to the humor style presented in the vignette shown in the condition assigned to them (congruent or incongruent). Another variable was computed to reflect the interaction term between our two main independent variables (i.e., humor styles and humorous agent).

After removing participants who failed to answer the attention-check item correctly and participants who did not respond to at least 50% of the questionnaire, the remaining missing values which were found to not be missing at random (Little's MCAR $>$ .005) were substituted using expectation–maximization imputation. To test H2 and H3, we conducted multivariate Analysis of Variance (ANOVA)s. In both cases, post-hoc analyses were computed using a Bonferroni correction to the p value.

Three moderated mediation models (i.e., one for each dimension of the robots' perception; see Figure 2) were tested using a bootstrapping approach to assess the significance of the indirect effects at different levels of the moderator (i.e., congruence between the participants' style of humor and the style of humor exhibited by the robot; Hayes, 2013). Robot perception (i.e., warmth, competence, and discomfort) were inserted in the model as the predictor variables, with ease of use and usefulness as the mediator variable. The outcome variable was participants' future intention to interact with robots in the future. Moderated mediation analyses test the conditional indirect effect of a moderating variable (i.e., congruence in humor styles) on the relationship between a predictor (i.e., perception of the robots' warmth, competence, and discomfort) and an outcome variable (i.e., future intention to interact with robots in the future) via potential mediators (i.e., ease of use and usefulness).

The PROCESS macro, model 8, v. 4.1, developed by Hayes (2013) with bias-corrected 95% confidence intervals (n = 5000) was used to test the significance of the indirect (i.e., mediated) effects moderated by the congruence in humor styles, i.e., conditional indirect effects.

For all statistical hypotheses testing procedures, an $\alpha < .05$ or the absence of zero within the confidence intervals were considered as sufficient evidence to reject the null hypotheses.

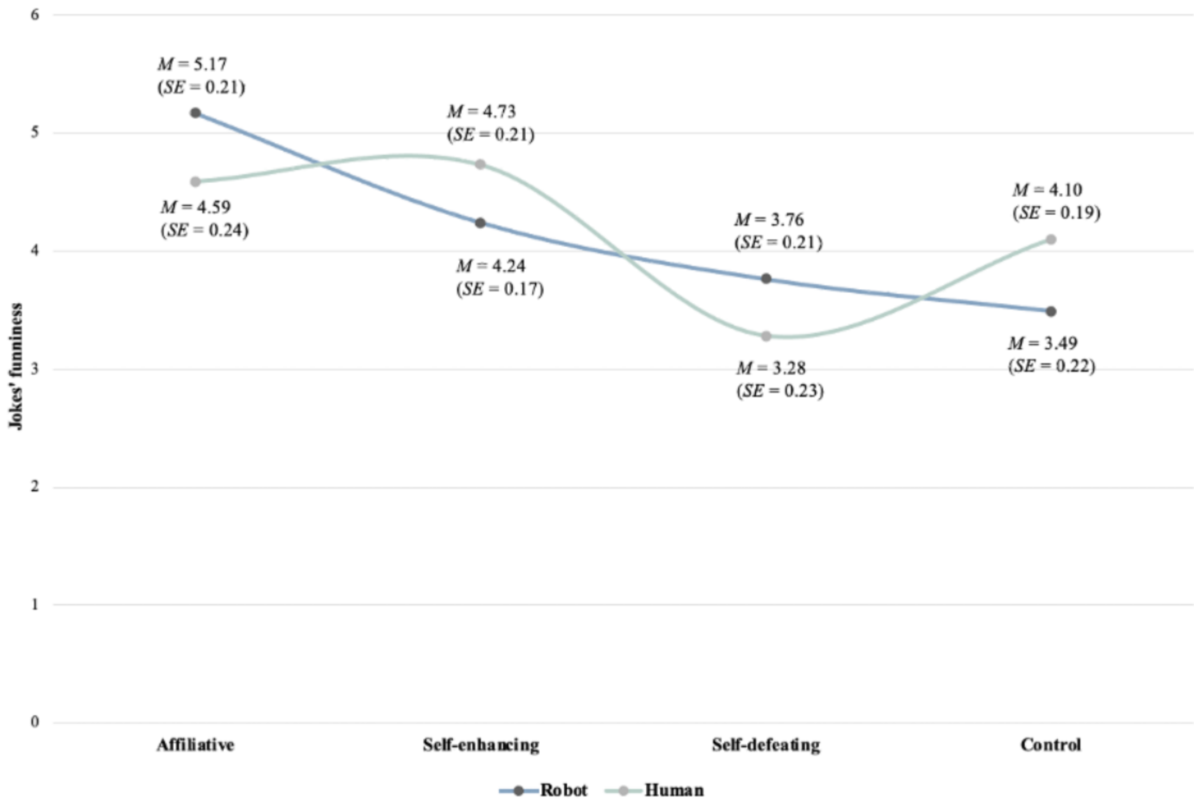


FIGURE 7.2. Interaction between the humor styles of the jokes and humorous agents (human vs. robot) on participants' evaluations of the jokes' funniness.

7.3.6. Hypotheses testing

7.3.6.1. *Joke Perception (H2)* When controlling participants' own styles of humor, we found an interaction effect between the humor styles of the jokes and the humorous actor on the participants' perception of the joke's funniness ($F(379) = 4.43$; $p = .004$; ηp2 $= 0.034$). No similar effect was observed on participants' perceptions of the jokes' offensiveness or appropriateness (all p $>$ .05).

However, we found a main effect of the jokes' portrayed humor style on participants' perception of their level of offensiveness ($F(379) = 18.99$; p $<$ .001; η= 0.13) and appropriateness ($F(379) = 12.76$; $p <$ 001; $\eta = 0.09$).

In particular (although all jokes were scored below the middle point of the scale in terms of offensiveness), affiliative humor was perceived as being less offensive ($M = 1.26$; $SE = 0.15$) when compared to self-enhancing humor ($M = 1.59$; $SE = 0.16$) or SD ($M = 1.97$, $SE = 0.16$).

When examining participants' perception of the level of appropriateness of the jokes to the context depicted in the vignette, self-enhancing humor was perceived as being the most appropriate ($M = 4.50$; $SE = 0.16$), followed by affiliative humor ($M = 4.28$; $SE = 0.18$), the absence of humor (i.e., the control condition, $M = 4.05$; $SE = 0.17$) and self-defeating humor ($M = 3.07$; $SE = 0.18$).

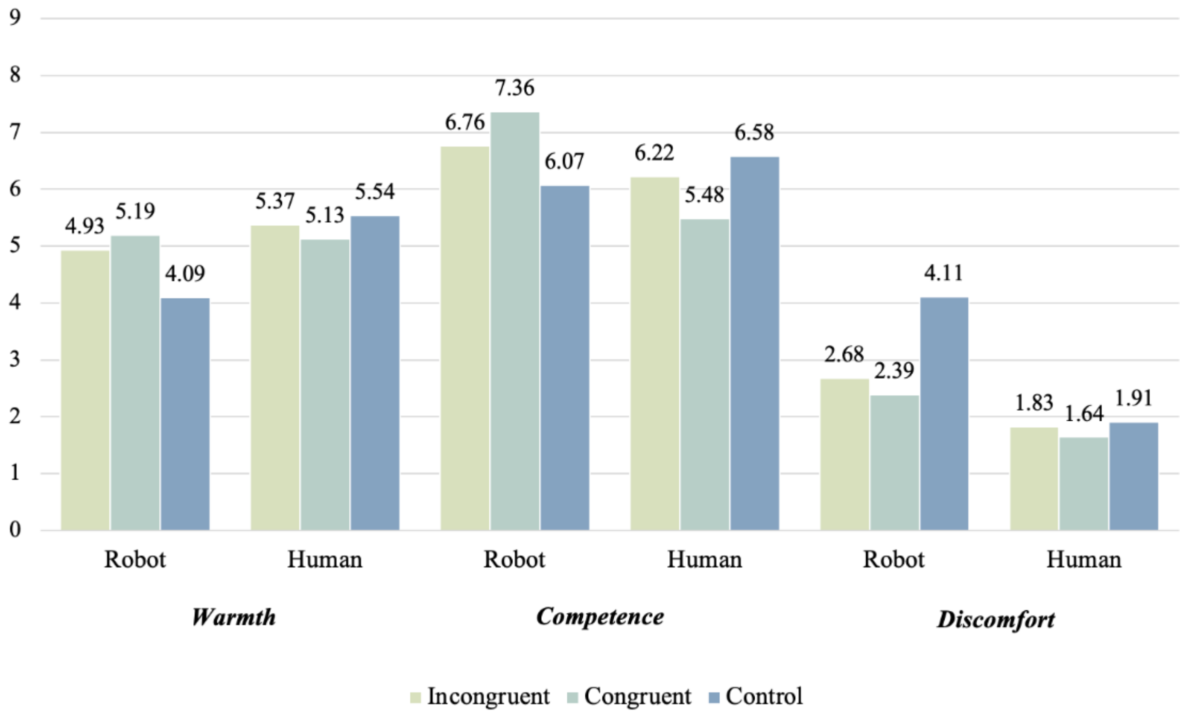


FIGURE 7.3. Participants' mean evaluations of the humorous actors (human vs. robots) across the main dimensions of perception (warmth, competence, and discomfort) according to the existence (congruence) or absence (incongruence) of a match between their preferred humor styles and the humor styles displayed by the humorous agent.

7.3.6.2. *Humor styles and humor and agent perceptions (H3)* We found a main effect of the congruence between participants' own humor styles and the style of humor displayed by the robot on their perception of the agents' warmth ($F(379) = 5.89$; $p = .003$), competence ($F = 8.80$; $p < .001$) and discomfort ($F(379) = 16.86$, $p < .001$). When the humorous actor was a human, there was only a main effect of their humor style on their perceived level of competence ($F(379) = 3.97$; $p = .02$).

Post hoc tests revealed that when the style of humor exhibited by the robot was congruent with that of the participants, robots were perceived as being more warm ($F(146) =$; $M = 5.19$, $SD = 1.97$), more competent ($M = 7.36$, $SD = 1.73$) and as causing less discomfort ($M = 2.39$, $SD = 1.08$) than when it was incongruent ($M = 4.93$, $SD = 1.54$; $M = 6.76$, $SD = 1.37$ and $M = 2.68$, $SD = 1.57$, respectively).

7.3.6.3. *Humor Styles, Robot Perception and Value (H4)* Improved perceptions (in particular, higher perceptions of warmth and competence and lower perceptions of discomfort) of humorous robots were positively associated with participants' perception of the social, emotional, and societal value of SRs (see table 7.5).

No differences in the perception of social, emotional, or societal value were observed when comparing participants whose humor style matched that of the robot with participants with differing humor styles. However, the presence of humor resulted in improved

Table 7.5. Pearson Correlations between the main components of robot perception (warmth, competence and discomfort and the participants' perception of emotional, social, and societal value of social robots.

	Emotional value		Social value		Societal value	
	r	p	r	p	r	p
Warmth	.50	<. 001	.20	.007	.36	<. 001
Competence	.44	<. 001	.27	<. 001	.49	<. 001
Discomfort	-.40	<. 001	-.16	.03	-.54	<. 001

perceptions of societal and emotional value when compared to the control condition (all $p < .001$).

When investigating the association between participants' humor styles and their perception of the value of the robots, we found that both styles of positive humor (Affiliative and self-enhancing) were positively correlated with greater perceptions of societal ($r = .20$, $p < .001$ and .46, $p < 001$, respectively) and emotional value ($r = .21$, $p < .001$ and .36, $p < 001$, respectively). No other significant correlations were observed.

7.3.6.4. *Robot perception, ease of use, usefulness, humor styles and future intention to interact (H5)* As can be observed in table 7.6, each of the moderated mediation models estimated for the three dimensions of robot perception (warmth, competence, and discomfort) were significant and contributed to explaining between 61% and 63% observed in participants' future intention to interact with robots.

With the exception of the path between discomfort, ease of use and future intention to interact with robots (in the condition in which participants' style of humor differed from that presented by the robot), all paths were found to be significant (see table 7.7).

7.3.6.5. *Exploratory analysis* Price Evaluation. On average, participants priced the Pepper robot at 1859,86€ ($SD = 268, 02$€; on a scale ranging between 1 and 2000€). Participants who saw the Pepper robot displaying any type of humor estimated it costed approximately 46€ more than participants in the control condition ($M = 1870, 18$€ ($SD = 369, 13$€) and $M = 1870, 18$€ ($SD = 231, 18$€), respectively). Both perceived emotional and social value were positively correlated with participants' price evaluation of the robot ($Pearson'sr = .19$, $p < .001$ and .20, $p < .001$, respectively). Female participants estimated Pepper's price to be more than 200€ higher when compared to male participants.

Future intention to interact Although the majority of participants reported a high intention of interacting with SRs again in the future ($M = 5.38$; $SD = 1.57$; mode = 7; 25th percentile = 4.67, 50th percentile = 6.00 and 75th percentile = 6.67 on a scale of 1-7), when offered an opportunity to do so, less than 2/3 of participants agreed to provide their contact information to do so (58.10%, $n(female) = 90$ and $n(male) = 21$).

7.3.7. Discussion

Humor is an important aspect of our daily lives, and the beneficial effects it has on our relationships with others justify that importance. Our study sought to understand

TABLE 7.6. Moderated mediations of the effects of robot perception (warmth, competence, and discomfort) on future intention to interact with robots (dependent variable).

Model 1: Predictor	Coefficient	SE	t	p	LLCI	ULCI
Constant	-3.38	1.01	-3.34	.001	-5.39	-1.38
Warmth	.43	.14	3.09	.002	.15	.70
Usefulness	.52	.08	6.26	<.001	.36	.69
Ease of use	.79	.12	6.41	<.001	.55	1.04
Congruence	1.25	.52	2.41	.02	.22	2.27
Warmth x congruence	-.23	.10	-2.43	.02	-.42	-.04
		R2 = .63, F (5, 142) = 47.69, p <.001				
Model 2	Coefficient	SE	t	p	LLCI	ULCI
Constant	-3.71	1.37	-2.71	.001	-6.42	-1.01
Competence	.27	.16	1.73	.09	-.04	.59
Usefulness	.57	.09	6.63	<.001	.40	.74
Ease of use	.84	.13	6.61	<.001	.59	1.09
Congruence	1.56	.82	1.91	.06	-.05	3.17
Competence x congruence	-.20	.11	-1.85	.07	-.42	.014
		R2 = .61, F (5, 142) = 43.96, p <.001				
Model 3	Coefficient	SE	t	p	LLCI	ULCI
Constant	-.51	.78	-.65	.51	-2.06	1.03
Discomfort	-.50	.18	-2.78	.006	-.86	-.15
Usefulness	.59	.09	6.78	<.001	.42	.76
Ease of use	.82	.16	5.21	<.001	.51	1.14
Congruence	-.86	.41	-2.12	.04	-1.66	-.06
Discomfort x congruence	.38	.16	2.41	.02	.07	.70
		R2 = .62, F (5, 142) = 46.22, p <.001				

what are the effects of humor in HRI and to understand how users' own humor styles can have an effect on our perceptions, evaluations and future intentions to interact with SRs in the future.

In this context, this study confirmed our hypothesis that humor styles have an effect both on the perception of the humorous author and of the humorous material (H2 and H3). Namely, we found that affiliative and self-defeating humor were perceived as being funnier when performed by a robot than when performed by a human. Conversely, self-enhancing humor was perceived as being funnier when displayed by a human than when displayed by a robot.

In addition, as expected, we also found that robots that display humor styles congruent with that of the user are perceived more favorably in terms of warmth, competence and discomfort; and that these improved perceptions are positively correlated with greater perceptions of social, emotional and societal value of robots. For human humorous actors, this effect was only evident in terms of their perception of competence.

More interestingly, our study revealed that improved perceptions of robots have an impact on users' future intentions to interact with SRs through improved perceptions of

Table 7.7. Moderated mediation paths according to the congruence between the participants' style of humor and the style of humor displayed by the robot.

Path	Congruence	Effect	SE	LLCI	ULCI
Warmth - Ease of use - Future intention to interact	No	.08	.03	.02	.15
	Yes	.30	.10	.12	.49
Warmth - Usefulness - Future intention to interact	No	.10	.04	.03	.18
	Yes	.23	.06	.14	.38
Competence - Ease of use - Future intention to interact	No	.12	.04	.05	.21
	Yes	.36	.10	.17	.57
Competence - Usefulness - Future intention to interact	No	.12	.05	.03	.22
	Yes	.30	.07	.18	.45
Discomfort - Ease of use - Future intention to interact	No	-.15	.06	-.28	-.05
	Yes	-.67	.32	-1.42	-.20
Discomfort - Usefulness - Future intention to interact	No	.03	.04	-.04	.10
	Yes	-.34	.13	-.65	-.15

their ease of use and usefulness, and this relationship is moderated by the congruence between the styles of humor of the users' and those displayed by the robots. This finding suggests that the personalization of humorous interactions in HRI can lead to beneficial outcomes in terms of future intention to interact with SRs, and it is to the best of our knowledge, the first application of the TAM to HRI considering hedonic variables.

Important limitations to consider in the interpretation and generalization of the results observed in this study include the lack of real interaction between humans and robots, as well as the very limited scope of the situation presented in the vignette. In particular, past research has emphasized the importance of aspects such as social presence and anthropomorphism on robots' perception and users' future intention to interact with them and we hypothesize that those factors might also impact users' perceptions of the humor displayed by them.

Moreover, although humor can occur in different situations, the type of situation in which it occurs might impact the perception of its appropriateness, funniness and offensiveness. In this study, the scenario presented to participants involved a work-related interaction, which given its formal nature, might have had a negative impact on how the humorous interaction was perceived and received by participants.

7.3.8. Conclusion and future research

The study of how humor affects HRI is still at its infancy, but early explorations, in which we include this paper, present promising results. Given the inescapability of humorous interactions with SRs - which tend to emerge naturally- it becomes important to analyze its consequences in the interaction, perception and future intention to interact with SRs more thoroughly.

In this context, we would like to emphasize the need of conducting future research with robots in the context of humorous interactions. Past research has consistently emphasized the importance of the social presence and other aspects conveyed by the robots' embodiment (such as anthropomorphism) on users' perception and interaction with SRs; and understanding how those aspects influence the perception of humor displayed by SRs provides an interesting avenue for future research.

Moreover, we would also like to call for more research investigating the impacts of personalized humorous interactions in the specific context of entertainment interactions among humans and robots. As these situations tend to be more playful and informal, users' perceptions of humor displayed by SRs in these contexts might differ from their perceptions of humor in more formal and work-related contexts such as the one presented in the vignette. Finally, we would also like to emphasize the importance of collecting data regarding users' responses to humorous SRs using a greater variety of measures, which can include behavioral observation and observation of physiological responses. This methodological diversity can provide a greater insight into the effects of humor in HRI.

CHAPTER 8

Humor in Social Robotics

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-It´s a machine!

-A false dichotomy. It's all electricity. Does it make you laugh? Does it make you weep?

-Yes.

-What's more human?

(Nolan & Plageman, 2011–2016)
Season 3, Episode 12, 43:00

Abstract

As AI technology continues to pervade our lives, humor may emerge as a vital element in our interactions with it. Despite this, the existing research on how humor impacts users' perceptions, evaluations, and responses to social agents is insufficient. To address this gap, we conducted a within-subjects study ($n = 57$) in which we manipulated the robot's expression of humor during an entertainment group scenario, and analyzed users' perceptions, evaluations, physiological responses, and behavioral reactions towards the robots. Results suggest that the funny robot was perceived as being warmer and more competent than the unfunny robot. Additionally, the display of humor also contributed to greater perceptions of the emotional value offered by the robot and resulted in greater intentions to interact with it again in the future. Additionally, behavioral data indicates that participants smiled more frequently and gazed during longer periods of time at the funny robot when compared to its unfunny counterpart. These results provide evidence that supports the importance of considering humor in Human-Robot interactions.

8.1. Introduction and overview

In the context of its numerous positive associations, prior research has endeavored to create and examine a variety of humor-based applications that can effectively exploit the benefits of humor and laughter. Among them are therapeutic interventions that utilize humor to promote better health, as well as others that employ humor to promote healthy development, adjustment and coping skills for both children and adults on a variety of different contexts that include schools, organizations and care facilities, among others (Foot, 2017; McGhee & Frank, 2014).

More recent applications have included the use of technology to leverage the benefits of humor for increasing user adoption of new technologies, promoting healthy behavior and incentivizing improved learning experiences (Shoda & Yamanaka, 2021; Y.-C. Wang et al., 2020; L. C. Lee & Hao, 2015). However, more recent advances on embodied social technology have opened the door to new types of humor-based applications.

In this study, we were particularly interested in investigating the effects of verbal humor (i.e., jokes) in the context of group HRI in an entertainment scenario. In particular, we investigated if the presence of humor could positively influence participants' perceptions of the robots, their perceived value as a commercial product, and the participants' intention to interact with robots in the future.

To achieve that goal, we validated a set of humorous sentences (Study 1) and devised a humor-based card-game in which a human participant interacted with two robots (one funny and one unfunny); and collected information regarding users' perceptions, evaluations and attitudes towards SRs (Study 2). Additionally, we recorded the interactions of participants with the robots and coded their behavioral responses, as well as their physiological responses while interacting with the robots.

8.1.1. Goals and Hypotheses

The main goals of this study were to investigate if verbal humor displayed by a SR in a group entertainment setting had an effect on participants' perceived ease of use and enjoyment of the task and of the robots (self-reported data). Moreover, we investigated if participants self-reported enjoyment of the task correlated with their physiological responses (during the course of the interaction; and if the display of humor had an effect on participants' behavioral responses towards the robots. Consequently, based in previous literature, we devised the following hypotheses (H):

8.1.1.1. *Self-reported data:*

- ◇ ***H1:*** Participants will perceive the funny robot to be more warm and competent than the unfunny robot.
- ◇ ***H2:*** Participants will assign greater emotional, social and societal value to the funny robot when compared to the unfunny robot.
- ◇ ***H3:*** Both hedonistic (enjoyment) and utilitarian variables (PEU and PU) will be significant predictors of participant's future intention to interact with the robots.

8.1.1.2. *Physiological data:*

- ◇ ***H4:*** Participants will experience decreases in both time (rMSSD) and frequency (HF) domain indicators of HRV, and these metrics will be positively correlated with participant's enjoyment of the game and of the robots.

8.1.1.3. *Behavioral data:*

- ***H5:*** Participants will look more often towards the funny robot compared to the unfunny robot.
- ***H6:*** Participants will direct more behavioral cues of enjoyment (in particular, laughter and smiles towards the funny robot when compared to the unfunny robot.

8.2. Study 1

Since the main goal of this article is to investigate how humor affects interactions with SRs in entertainment scenarios, we devised an interaction scenario involving a 3-players (two robots, and one human) card-game. This game was based on the popular game CAH and required players to generate humorous statements by combining pieces of text presented in the game cards.

In this context, since one of the main limitations that has been observed in humor research, both in Psychology (Oliveira & Arriaga, 2022) and HRI (Oliveira, Arriaga, Axelsson, & Paiva, 2021) has been the lack of validated humorous material that can be used consistently across humor research, we conducted an online validation study of the humorous material (i.e. jokes), which will then be used in Study 2.

8.2.1. Game mechanics, material and procedure

After agreeing to the informed consent, participants were asked to play an online card-game developed in Unity, JB, inspired by the CAH card game. The game involves two types of cards: white and black. The black cards contain questions or fill-in-the-blanks statements and the white cards contain pieces of text that can be used to answer the questions or fill in the blanks. The cards selected for use in the validation study were retrieved from family-friendly versions of CAH, and were pre-screened to remove any potentially offensive or inappropriate content.

At the beginning of each round, a white card is drawn from the deck and participants must select which (of their eight) white cards generates the funniest and unfunniest combination when paired with the black card.

Participants played a total 20 rounds (corresponding to 20 black cards and 160 white cards) which took approximately 15 minutes; and were compensated for their time with 3€.

This study received approval by the Ethical Commission (15/2020).

8.2.2. Measures

After finishing the game, participants were asked to respond to a brief questionnaire that included the following variables:

- ◇ Funniness: After selecting the funniest and unfunniest cards to match with the black card, participants were asked to indicate how funny and unfunny were the combinations they created on Likert-like scale ranging from 1 to 5.
- ◇ Sociodemographic characteristics: Participants were asked to indicate their nationality, native tongue, sex, age and occupation.

An attention-check item was added in which participants were asked to select a specific value of the scale. Participants took approximately 15 minutes to complete the questionnaire. In the end, participants were debriefed and thanked for their participation.

8.2.3. Participants

Fifty-eight Portuguese-speaking participants with ages ranging from 19 to 35 (M = 27.26, SD = 4.68) participated in this study. Most of the participants were women (n = 32, 55.20%), and worked a full-time job (n = 36, 62.10%), the remaining were students (n = 12, 20.70%) or were unemployed (n = 10, 17.20%).

8.2.4. Data analysis strategy and joke evaluation

For each black card, the presented set of eight white cards was ranked according to the number of times that each white card was elected as being the funniest and unfunniest match. Funniness average scores, medians and standard deviations were also calculated for each card combination and used as a disambiguation factor when at least two card combinations were paired the same number of times.

8.2.5. Results

The funniest and unfunniest card pairings for each black card are presented in table 8.1.

TABLE 8.1. Evaluation of the mean funniness (M (F)), mean unfunniness (M(UF) and median (Med) funinness score attributed to the jokes.

Black card	***White card***	***M (F)***	***Med (F)***	***Pairings***	***M (UF)***	***Med (UF)***	***Pairings***
. . . ENORME! . . . ASSUSTADOR! . . . !	(a) são feijões!	3.67 ± 1.08	4.00	7	1.23 ± 0.60	1.00	13
	(b) comer um rolo inteiro de papel higiénico.	3.71 ± 1.05	4.00	6	2.00 ± 1.41	2.00	2
	(c) despejar-me pela sanita abaixo.	3.64 ± 1.07	5.00	3	1.20 ± 0.45	1.00	8
	(d) o burro do meu irmão mais velho	3.69 ± 1.08	4.00	35	1.20 ± 0.45	1.00	2
	(e) porco	3.00 ± 0	3.00	1	1.71 ± 1.07	1.00	14
	(f) ser esmagado por um piano	3.00 ± 0	3.00	1	1.43 ± 0.79	1.00	7
	(g) tocar trompete para o presidente da câmara.	3.67 ± 1.08	3.50	2	1.33 ± 0.82	1.00	6
	(h) explodir em chamas.	–	–	–	1.67 ± 1.15	1.00	3
	Total						55
A maneira mais fácil de me distinguirem da minha irmã gémea é que eu tenho uma sarda na bochecha e ela ...	(a) cem macacos a gritar.	3.25 ± 0.96	3.50	4	1.31 ± 0.60	1.00	16
	(b) é uma velha sábia sem dentes e olhos esbranquiçados.	3.44 ± 1.13	3.00	9	1.00 ± 0	1.00	2

	(c) flutua através do vazio do espaço e do tempo.	4.33 ± 1.15	4.00	3	1.33 ± 0.58	1.00	3
	(d) fugiu de casa.	3.56 ± 1.21	4.00	16	1.93 ± 1.28	1.00	15
	(e) grita numa lata de Pringles.	3.67 ± 1.51	4.00	7	1.00 ± 0	1.00	4
	(f) regressa do mundo dos mortos.	2.67 ± 1.53	3.00	4	1.80 ± 1.10	1.00	5
	(g) um verme espacial devorador de plantas chamado 'Raquel'.	4.27 ± 0.91	4.00	11	2.25 ± 0.96	2.50	4
	(h) usa roupas de campanha chinesas.	3.50 ± 0.58	3.00	4	1.71 ± 0.76	2.00	7
	Total						56
CHEGA! Não vou deixar que .... destrua esta família!	(a) esmagar uma banana no umbigo.	4.00 ± 0.63	4.00	6	2.00 ± 1	2.00	3
	(b) o Batman.	4.00 ± 0.71	4.00	9	1.60 ± 1.12	1.00	15
	(c) o sistema opressivo do capitalismo.	3.60 ± 1.52	4.00	5	1.50 ± 0.73	1.00	16
	(d) organizadores completamente bêbados.	3.00 ± 1.63	3.00	4	1.00 ± 0	1.00	5
	(e) ser esbofeteado com um peixe.	5.00 ± 0	5.00	2	1.67 ± 0.58	2.00	3
	(f) um cocó tão grande como a mãe.	3.89 ± 1.67	4.00	9	2.00 ± 1	2.00	9
	(g) uma boneca que mija de verdade.	3.94 ± 0.99	4.00	18	2.33 ± 1.53	2.00	3

	(h) uma criança falsa feita de madeira.	3.00 ± 0.82	3.00	4	1.67 ± 0.58	2.00	3
	Total						57
Curva-te diante de mim, pois sou a Rainha ...!	(a) a ter um bebé.	4.00 ± 0	4.00	3	1.92 ± 1.24	1.00	12
	(b) atingida na sanita.	3.33 ± 1.53	3.00	3	1.25 ± 0.46	1.00	10
	(c) baby boomer.	3.22 ± 1.09	3.00	9	1.00 ± 0	1.00	3
	(d) com o cérebro no corpo de um tigre.	3.17 ± 0.99	3.50	6	1.00 ± 0	1.00	3
	(e) da barba com mais de 30 centímetros.	3.40 ± 1.06	4.00	15	2.00 ± 1.41	2.00	2
	(f) de gritar e gritar e nunca acordar.	1.67 ± 1.54	1.00	3	1.50 ± 0.85	1.00	15
	(g) que questiona a autoridade.	3.20 ± 1.09	4.00	5	1.30 ± 0.67	1.00	10
	(h) Shrek.	3.91 ± 1.22	4.00	11	1.43 ± 0.53	1.00	7
	Total						55
Ei, crianças! Sou o Sensei Todd! Hoje vou ensinar-vos a defenderem-se contra	(a) libertar um peido preso no rabo.	3.79 ± 1.32	4.00	19	2.33 ± 0.58	2.00	3
	(b) má paternidade.	3.89 ± 0.93	4.00	11	1.75 ± 0.96	1.50	4
	(c) o mal.	3.00 ± 0	3.00	4	1.38 ± 0.92	1.00	21
	(d) o respeito dos limites pessoais.	4.00 ± 1.55	4.50	6	1.57 ± 1.14	1.00	7
	(e) ser super sério agora.	4.00 ± 0	4.00	1	2.25 ± 1.89	1.50	4

	(f) ter um cabelo comprido a crescer de uma verruga.	4.11 ± 0.78	4.00	7	1.33 ± 0.58	1.00	3
	(g) urinar na caixa de areia do gato.	3.20 ± 0.84	3.00	5	2.00 ± 0.82	2.00	4
	(h) viver na lixeira.	4.00 ± 0	4.00	1	1.50 ± 0.76	1.00	8
	Total						54
ESTOU COM FOME! EU QUERO ....!	(a) andar por aí a farejar os sovacos das pessoas.	3.83 ± 0.83	4.00	12	1.00 ± 0	1.00	1
	(b) bater em toda a gente.	3.83 ± 1.33	4.00	6	1.67 ± 1.32	1.00	9
	(c) homens feministas.	4.00 ± 1.15	4.00	4	1.50 ± 0.93	1.00	8
	(d) o Baby Yoda.	3.20 ± 1.03	3.50	10	1.63 ± 0.92	1.00	8
	(e) poupar os meus macacos do nariz durante dez anos e depois construir o maior macaco do nariz do mundo.	4.18 ± 0.98	4.00	11	1.40 ± 0.52	1.00	10
	(f) sentar-me num bolo.	3.67 ± 0.78	4.00	12	1.00 ± 0	1.00	5
	(g) nunca tomar banho.	–	–	–	1.78 ± 0.97	1.00	9
	(h) ter uma cabeça muito grande.	–	–	–	1 ± 0	1.00	5
	Total						55
Miúdos, o pai está a tentar algo novo esta semana. Chama-se	(a) alguma privacidade.	3.40 ± 1.34	4.00	5	1.44 ± 0.73	1.00	9
	(b) beber da sanita e comer lixo.	3.33 ± 0.82	3.50	6	1.00 ± 0	1.00	3
	(c) cobrir-me com ketchup e mostarda porque sou um cachorro-quente.	$4.21 + 0.83$	4.00	14	1.86 ± 1.07	2.00	7
	(d) drogas ilegais.	3.50 ± 0.85	3.00	10	1.57 ± 0.98	1.00	7
	(e) homens enormes e peludos.	4.00 ± 1	4.00	13	1.33 ± 0.58	1.00	3

	(f) pernas.	4.33 ± 0.58	4.00	3	1.45 ± 1.04	1.00	11
	(g) stock secreto do governo de marijuana confiscada.	4.40 ± 1.01	4.00	5	1.67 ± 0.89	1.50	12
	(h) não ter ossos.	–	–	–	2.50 ± 1.73	2.50	4
	Total						56
Não é fantástico, querida? Só tu, eu, as crianças e	(a) a enorme e estúpida lua.	3.00 ± 0	3.00	2	2.00 ± 1	2.00	9
	(b) beber gasolina para ver qual é o sabor.	3.38 ± 1.19	3.50	8	1.67 ± 0.41	1.00	6
	(c) café.	3.33 ± 1.31	3	6	1.89 ± 1.10	2.00	19
	(d) derrubar o governo.	2.67 ± 1.53	3.00	3	1.00 ± 0	1.00	5
	(e) entrar em modo 'besta'.	3.67 ± 0.82	3.50	6	1.00 ± 0	1.00	4
	(f) não ter amigos.	4.00 ± 0	4.00	1	1.25 ± 0.50	1.00	4
	(g) o divórcio.	4.14 ± 1.03	4.00	29	1.57 ± 1.14	1.00	7
	(h) ser atropelado por um comboio.	4.50 ± 0.71	4.50	2	3.00 ± 2	3.00	3
	Total						57
Não sei qual é o trabalho da minha mãe, mas acho que tem algo a ver com	(a) calças enormes.	2.33 ± 1.53	2.00	3	1.71 ± 0.76	2.00	7
	(b) dedos com cheetos.	3.67 ± 0.82	3.50	6	2.00 ± 1	2.00	5
	(c) esquecer-se de vestir roupa interior.	3.72 ± 1.01	4.00	11	1.50 ± 0.55	1.00	5
	(d) incendiar coisas.	4.18 ± 0.87	4.00	11	1.60 ± 0.97	1.00	10
	(e) lasers espaciais.	2.50 ± 1	3.00	4	1.83 ± 1.17	1.50	6
	(f) o estúpido namorado da minha irmã.	3.00 ± 0	3.00	2	1.83 ± 1.19	1.50	12
	(g) transformar-se lentamente em queijo.	3.77 ± 1.24	3.00	13	2.33 ± 1.53	2.00	3

	(h) um buraco negro.	3.40 ± 1.14	3.00	5	1.00 ± 0	1.00	7
	Total						55
Nunca temam! O Capitão .... está aqui!	(a) Alergias horríveis.	3.00 ± 1.41	3.00	2	2.00 ± 1.63	1.00	10
	(b) Farejador do rabo de um cão.	4.67 ± 0.82	5.00	6	1.50 ± 0.71	1.50	2
	(c) Grande, grande serpente.	5.00 ± 0	5.00	1	1.63 ± 0.74	1.50	8
	(d) Homem do Lixo.	3.50 ± 1.29	3.50	4	2.33 ± 1.21	2.50	6
	(e) Maionese.	3.57 ± 0.81	4.00	21	1.40 ± 0.89	1.00	5
	(f) Que lambe pensos usados.	3.41 ± 1.18	4.00	17	1.50 ± 1.08	1.00	10
	(g) Que se tornou presidente.	2.67 ± 0.58	3.00	3	1.55 ± 0.82	1.00	11
	(h) Saladas e ovos mexidos.	3.50 ± 2.12	3.50	2	1.75 ± 1.50	1.00	4
	Total						56
O meu livro favorito é: 'As Incríveis Aventuras de ....'.	(a) fugir de casa.	1.50 ± 0.71	1.50	2	2.33 ± 1.15	3.00	3
	(b) homens feministas.	3.60 ± 1.06	3.00	15	1.80 ± 1.10	1.00	5
	(c) matracas.	3.60 ± 0.89	3.00	5	1.17 ± 0.41	1.00	6
	(d) pessoas más.	3.50 ± 0.71	3.50	2	1.43 ± 0.79	1.00	7
	(e) roubar o dinheiro das pessoas e ir para a cadeia.	3.38 ± 0.92	4.00	8	1.10 ± 0.32	1.00	10
	(f) ser adotado.	3.33 ± 1.61	3.50	12	2.50 ± 2.12	2.50	2
	(g) um buraco negro.	3.83 ± 0.94	4.00	12	1.00 ± 0	1.00	2

	(h) Harry Potter.	–	–	–	1.52 ± 0.75	1.00	21
	Total						56
O meu nome é Peter Parker. Fui mordido por uma aranha radioativa e agora	(a) esta cabra, é minha amiga.	4.40 ± 0.70	4.50	10	1.50 ± 0.84	1.00	6
	(b) estou a florescer num belo jovem.	3.75 ± 0.96	3.50	4	2.50 ± 0.71	2.50	2
	(c) estou a sangrar.	3.50 ± 0.94	4.00	14	1.54 ± 1.13	1.00	14
	(d) libertou-se um demónio do inferno que quer destruir· o nosso mundo.	1.50 ± 0.71	1.50	2	1.40 ± 0.55	1.00	5
	(e) sou o meu pai, que é uma morsa.	3.50 ± 1.38	4.00	6	1.00 ± 0	1.00	2
	(f) sou presidente.	3.25 ± 1.71	3.50	4	1.80 ± 0.92	1.50	10
	(g) sou um gigante invisível que faz cocós gigantes e visíveis.	3.64 ± 1.43	4.00	11	1.13 ± 0.35	1.00	8
	(h) uma planta devoradora espacial chamada 'Raquel'.	3.67 ± 0.58	4.00	3	1.43 ± 0.79	1.00	7
	Total						54
O meu pai e eu gostamos de.... juntos.	(a) cair num poço de waffles.	3.50 ± 0.55	3.50	6	1.71 ± 0.76	2.00	7
	(b) cheirar a cebolas.	3.25 ± 1.14	3.50	12	1.57 ± 0.79	1.00	7

	(c) curtir num armário.	3.50 ± 0.76	3.00	8	1.25 ± 0.50	1.00	4
	(d) dar linguados.	3.60 ± 1.14	4.00	5	1.64 ± 1.12	1	11
	(e) ensinar uma galinha a matar.	4.00 ± 0.63	4.00	11	2.40 ± 1.34	3.00	5
	(f) ferir os sentimentos das pessoas.	4.27 ± 1.01	5.00	11	1.67 ± 1.23	1.00	12
	(g) prender o polvo na minha cara.	5.00 ± 0	5.00	2	1.33 ± 0.58	1.00	3
	(h) ser famosos no YouTube.	4.00 ± 1	4.00	3	1.11 ± 0.33	1.00	9
	Total						58
Olá pessoal! Só quero dizer a todos os meus seguidores que estão com dificuldades ....: VAI melhorar!	(a) a chorar na casa de banho.	3.80 ± 0.84	4.00	5	1.67 ± 1.03	1.00	6
	(b) a depilar as costas dos pais.	3.86 ± 1.01	4.00	21	1.00 ± 0	1.00	1
	(c) a gastar o dinheiro que os meus pais ganharam com dificuldade.	3.20 ± 1.48	3.00	5	1.73 ± 1.22	1.00	15
	(d) com a polícia.	3.00 ± 0	3.00	1	1.23 ± 0.60	1.00	13
	(e) com chapéus de festa elegantes.	3.00 ± 1	3.00	3	1.14 ± 0.38	1.00	7

	(f) com cheetos super picantes.	3.63 ± 1.19	4.00	8	1.86 ± 0.90	2.00	7
	(g) em beber uma lâmpada de lava.	3.50 ± 0.55	3.50	6	1.33 ± 0.52	1.00	6
	(h) em morder uma pessoa rica.	4.33 ± 0.82	4.50	6	–	–	–
	Total						55
Olha para a minha banda! Chamamos-nos 'Xutos e ....'.	(a) borbulhas grandes e suculentas.	3.38 ± 1.12	3.00	13	1.67 ± 1.15	1.00	3
	(b) explodir a lua.	3.00 ± 0	3.00	1	1.43 ± 0.53	1.00	7
	(c) explodir o meu professor de matemática ao sol.	3.25 ± 0.50	3.00	4	1.11 ± 0.33	1.00	9
	(d) lendas urbanas.	2.86 ± 1.07	3.00	7	1.67 ± 1	1.00	9
	(e) não usar calças.	2.40 ± 1.34	3.00	5	1.71 ± 0.76	2.00	7
	(f) o cocó no relvado do vizinho.	3.37 ± 0.90	3.00	19	1.40 ± 0.89	1.00	5
	(g) ser atingido na sanita.	2.67 ± 0.58	3.00	3	1.00 ± 0	1.00	3
	(h) toda a família.	3.33 ± 1.15	4.00	3	1.33 ± 0.65	1.00	12
	Total						55

Perdi o braço num acidente	(a) ao casar.	3.83 ± 1.47	4.00	12	1.80 ± 1.03	1.50	10
	(b) ao debater a lógica dos desenhos animados.	3.80 ± 1.14	4.00	10	1.50 ± 0.71	1.51	2
	(c) com lança-chamas.	3.14 ± 0.38	3.00	7	1.62 ± 0.87	1.00	13
	(d) com milhares de lasanha.	3.25 ± 1.26	3.00	4	1.83 ± 0.98	1.50	6
	(e) com os pelos do peito.	3.64 ± 1.21	4.00	11	2.00 ± 1.41	2.00	2
	(f) com pizza.	2.50 ± 0.71	2.50	2	1.18 ± 0.41	1.00	11
	(g) por viver num ananás debaixo do mar.	3.17 ± 0.98	3.50	6	1.40 ± 0.55	1.00	5
	(h) Um gato super zangado que encontrei lá fora.	4.00 ± 0.63	4.00	6	1.22 ± 0.44	1.00	9
	Total						58
Pessoal, parem! Não há nada de engraçado	(a) em andar à caranguejo desde a sanita para ir buscar mais papel higiénico.	3.86 ± 1.01	4.00	28	1.50 ± 1	1.00	4
	(b) nas bebidas femininas.	4.00 ± 0.82	4.00	4	1.50 ± 0.71	1.51	2
	(c) no lixo.	3.50 ± 0.71	3.50	2	1.21 ± 0.54	1.00	19

	(d) nos idiotas.	4.00 ± 0.93	4.00	8	1.50 ± 0.84	1.00	6
	(e) num pássaro a fazer cocó na cabeça do presidente.	3.20 ± 1.48	3.50	10	1.33 ± 0.58	1.00	3
	(f) numa pintura com uma senhora nua.	2.67 ± 1.15	2.00	3	1.75 ± 1.50	1.00	4
	(g) com cerveja.	–	–	–	1.25 ± 0.46	1.00	8
	(h) com tubarões.	–	–	–	1.33 ± 0.71	1.00	9
	Total						55
Polícia! Prendam este homem! Ele . . .	(a) é um bebé com um bigode comprido.	3.94 ± 0.85	4.00	16	4.00 ± 0	4.00	1
	(b) é um pai que berra no futebol.	3.67 ± 0.89	4.00	12	1.67 ± 1.21	1.00	6
	(c) está a beber o frasco inteiro do molho de salada.	3.40 ± 0.84	3.00	10	1.00 ± 0	1.00	4
	(d) está a construir um bunker nuclear na casa dos meus pais.	3.00 ± 1	3.00	3	1.83 ± 1.17	1.50	6
	(e) está a roer as unhas.	3.33 ± 0.58	3.00	3	1.54 ± 1.20	1.00	13
	(f) está a subirpara o rabo de uma vaca.	3.44 ± 1.59	4.00	9	1.67 ± 1.03	1.00	6
	(g) tem sopa.	3.25 ± 1.71	3.50	4	1.25 ± 0.45	1.00	12

	(h) está nos medias sociais.	–	–	–	1.44 ± 1.01	1.00	9
	Total						57
Sra. Presidente, estamos a ficar sem tempo. A única opção é	(a) correr à velocidade máxima contra uma parede.	3.90 ± 0.83	4.00	11	2.50 ± 1.76	2.00	6
	(b) tatuar uma caveira.	3.00 ± 0.89	3.00	6	2.10 ± 1.10	2.00	10
	(c) um dedo do pé de aparência estranha.	3.80 ± 0.45	4.00	5	1.80 ± 0.84	2.00	5
	(d) são as alteraçõesclimáticas.	3.00 ± 1.87	4.00	5	1.38 ± 0.74	1.00	8
	(e) são calções de voleibol.	3.67 ± 0.82	3.50	6	1.00 ± 0	1.00	5
	(f) um cigarro.	3.00 ± 0	3.00	1	1.46 ± 0.78	1.00	13
	(g) Pokemons.	3.91 ± 1.08	4.00	23	1.50 ± 0.71	1.51	2
	(h) a pressão dos pares.	–	–	–	1.38 ± 1.06	1.00	8
	Total						57
Uma nação, sob Deus, indivisível com liberdade e .... para todos.	(a) assaltar lojas.	4.00 ± 0	4.00	3	1.58 ± 0.67	1.50	12
	(b) beijos de língua.	3.87 ± 0.92	4.00	15	2.50 ± 0.71	2.50	2

(c) embebedar-se.	3.11 ± 1.05	3.00	9	1.33 ± 0.58	1.00	3
(d) esmurrar um tipo através da parede.	3.00 ± 0.82	3.00	4	2.00 ± 0.82	2.00	4
(e) facas.	3.75 ± 0.50	4.00	4	1.69 ± 0.87	1.00	16
(f) ficar nu.	4.00 ± 1.15	4.00	7	1.80 ± 1.10	1.00	5
(g) Poseidon, Senhor do Mar.	4.00 ± 1.15	4.00	4	1.33 ± 0.62	1.00	15
(h) usar balões como mamas.	3.50 ± 1.17	4.00	12	2.00 ± 0	2.00	1
Total						58

8.2.6. Discussion

Although humor is a universal and desirable trait, the perception of what is and is not humorous can be highly personal and subjective. This personal and subjective nature gives rise to many important challenges in humor research.

In particular, the reliance on a sample that was mostly comprised of younger adults might hinder the generalization of these results to older segments of the population as age seems to play an important role in humor comprehension (Schaier & Cicirelli, 1976) and appreciation (Ruch, McGhee, & Hehl, 1990).

Furthermore, this study did not account for important aspects that have been observed to have an effect on the perception of jokes in previous literature. Namely, previous studies have demonstrated that the format in which the joke is delivered (i.e., written or spoken) can have an impact on joke perception (Norrick, 2004). As the appreciation of spoken jokes comprises a number of external variables related to the performance and to the characteristics of the actor of the joke, they tend to be perceived as being more funnier when compared to written jokes (Norrick, 2004).

Moreover, in the specific context of social robotics, previous research has suggested that the perception of the joke attributes can vary depending on the author of the joke (human vs. robot; (Tay et al., 2016). Given that, in the case of this validation study, no indication was provided to participants in regards to the joke performer, their evaluation of the humorous material might differ from how they would have evaluated the same jokes performed by different actors.

8.3. Study 2

Humor is associated with many important benefits at the level of interpersonal relationships. Research connected to the CASA paradigm has widely supported the thesis that people's responses to computers (and other interactive technologies, such as SRs) are fundamentally social (J.-E. R. Lee & Nass, 2010). In other words, once a computer or computerized agent expresses cues of human-like behavior in the course of an interaction with a person, that person is likely to respond in a way that is similar to the way they would respond to another person (Nass, Takayama, & Brave, 2015; Nass & Moon, 2002).

This happens, according to what is argued by the CASA paradigm, because people often respond mindlessly to computers and other media agents, relying on their learned social scripts (i.e., mental schema of how they would interact with another human in a similar situation) to respond to the behavior of a computerized agent that presents sufficient social and human-like cues, even when they are *"... inappropriate for human-computer interaction, essentially ignoring the cues that reveal the essential asocial nature of the computer"* (Nass & Moon, 2002, p. 83).

The assumptions made by the CASA paradigm, originally proposed by Nass and colleagues (L. C. Lee & Hao, 2015; J.-E. R. Lee & Nass, 2010; Nass & Moon, 2002; Nass et al., 1996) in the 90s and early 00s, have found widespread empirical support in the research conducted in the intervening decades. Additionally, even as significant strives forward were made in the past three decades in the development of new technologies, the assumptions put forward by the CASA paradigm have been shown a high predictive reliability across a wide range of different technological interfaces, including anthropomorphic interfaces (J.-E. R. Lee & Nass, 2010), embodied agents (Hoffmann, Krämer, Lam-Chi, & Kopp, 2009), and voice-based navigation systems (K.-M. Lee & Nass, 2009).

In this context, humor has the potential to play an important role. On one hand, because, being a characteristically human behavior, its display by a robot can contribute to a greater perception of human likeness of the robot, and thus elicit social interactions that are more naturalistic and responses that are more akin to how users would respond to another human (Belanche, Casaló, & Schepers, 2021; Zhang, Gursoy, Zhu, & Shi, 2021).

On the other hand, as discussed in the introduction, humor has been shown to be an important factor in acceptance of new technologies and user's engagement with it. Within the framework of models of technology acceptance, humor provides value to the extent that it provides an outlet to engage with technology that is anchored around hedonistic motivations, and thus increases user's engagement, enjoyment and immersion with new technologies (Tourinho & de Oliveira, 2020; Ramírez-Correa, Grandón, & Órdenes, 2020).

8.3.0.1. *Game, mechanics, material and procedure* Participants played the JB game on a tablet (for their personal choices) with a horizontal screen in a table (to show the shared game state) with the two robots. The level of funniness of the robots was manipulated through the white cards they were assigned to play in each round. More specifically, the funny robot was assigned the funniest white card for that round's black card; whereas the unfunny robot was assigned the least funny card (both as indexed by the n of pairings in the study 1). The participant was assigned the six middle cards.

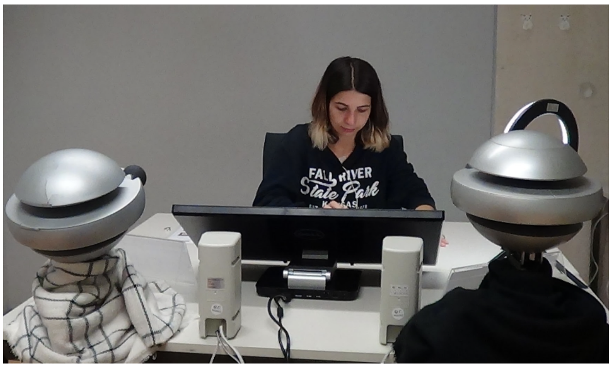
After each round, players were asked to vote on the funniest combination (given that each player could not vote on him/herself). The funniest robot always voted for the participant; whereas the unfunny robot distributed its vote randomly between the other two players.

After all players voted, all the white cards appeared on the screen again, identified with the name of the player to whom they belonged. The score was presented both at the end of each round and at the end of the game.

The robots were programmed to intervene verbally with the participant during the game at key game events, namely at the beginning of the game (when they introduce themselves and explained the rules of JB), during and after the voting stage, and at the end of the game.

For this experiment, we used two Emys robotic heads, which were identified to participants with different names (see fig. 8.1).

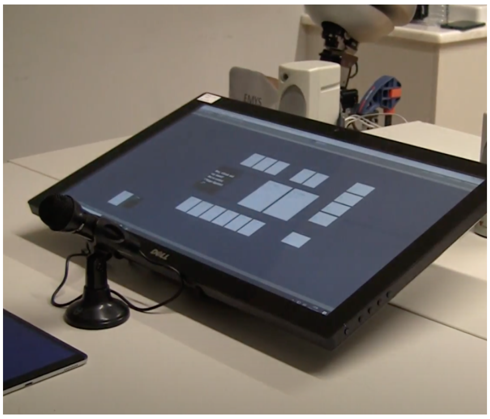
8.3.0.2. *Measures* This study was analyzed and approved by the university's Ethical Commission (15/2020).



(A) Participant playing and interacting with the game.

(B) Emys robotic head used in the experiment.

(C) BIOPAC system used to collect physiological responses.



(D) Game interface.

FIGURE 8.1. Study setup and materials.

A convenience sample of participants was collected from a university' participants pool and through word-of-mouth. Most of the participants were compensated for their time (approximately 30-45 minutes) with course credits or vouchers (10€).

Upon arriving at the lab and agreeing to the informed consent, participants filled in a pre-questionnaire. The pre-questionnaire[1] included the following instruments:

[1]The full questionnaire can be consulted here: https://www.osf.io/ndsvm

- ◇ The NARS (Nomura et al., 2006; Piçarra et al., 2015)) is a 12-item scale in which participants are asked to rate their agreement with the statements presented ("1- Disagree Completely" and "7- Agree Completely") that was developed to measure psychological reactions to robots. The Portuguese version NARS is divided into two main sub-dimensions: NATIR and NARHT. In this study, NATIR presented an acceptable level of internal consistency, unlike NARHT which presented suboptimal levels of internal consistency (Cronbach $\alpha = .78$ and .64 respectively).

In addition, participants were asked to indicate their sex, age and occupation. For all questionnaires, the order of the questions was randomized. An attention-check item was included, in which participants were asked to select a specific value of the scale.

After responding to the initial questionnaire, participants entered the game room and a researcher proceeded to place the sensors to record their physiological responses. For the physiological measures, prior to starting the experiment, we recorded a three-minute baseline in which the participants were instructed to remain as relaxed as possible. When participants signed up to participate in the experiment (which occurred at least 48 hours before participation) they were also instructed to wear adequate clothing and footwear (that would allow the placement of the sensors) and to not drink coffee at least 30-40 minutes before their participation was scheduled to begin.

To measure HRV, we used an adjusted version of lead II placement, in which electrodes were placed under the right midclavicular line (between the first intercostal space and the clavicle), and the right and left ankles (over the saphenous vein).

Participants' skin was cleaned with alcohol in the spots where the sensors were attached in order to remove grease and debris that could deteriorate the quality of the signal obtained. Finally, participants completed the post questionnaire. This questionnaire measured the following variables:

- ◇ Enjoyment with the robots and with the task was measured with 9 ad-hoc items. In particular, participants were asked to rate their agreement with the following statements in a 7-point Likert-like scale ("1- Disagree Completely" and "7- Agree Completely") regarding their amusement with the robots (questions were asked for each robot separately): "The robot was amusing", "The card combinations played by the robot were funny" and "I had fun interacting with the robot". Regarding the game, participants were asked to rate their agreement with the following statements (using the same scale): "The game I played was fun", "I was entertained by the game" and "If I had the chance, I would play this game again". These items presented good levels of internal consistency (Cronbach α ranged between .78 - .89).
- ◇ Robot perception was evaluated using the Portuguese version of the RoSAS (originally developed by Carpinella, Wyman, Perez & Stroessner (2017) and validated to European Portuguese by Oliveira, Arriaga, Stroessner & Paiva, 2021). The

translated scale includes 12 items divided into three categories: warmth (emotional, sentimental, empathic and happy), competence (competent, interactive and responsive) and discomfort (dangerous, strange, aggressive and scary).

Participants were asked to indicate how much each adjective described well or poorly each of the robots on a 7-point Likert scale. All 3 dimensions of the scale presented good levels of internal consistency (Cronbach α = .86, .78 and .75 for the funny robot and Cronbach α = .88, .87 and .78 for the unfunny robot).

- ◇ Robots' perceived value was measured using the scale developed by Sweeney & Soutar (2001). This scale includes 19 items divided into 4 categories: emotional, social, quality/performance and price/value for money. In this study, we considered only the items regarding emotional (e.g., "Using this robot would make me feel good") and social (e.g., "Using this robot would improve the way I am perceived") value, which both presented excellent levels of internal consistency (Cronbach α = .90 - .96). In addition, we added three ad-hoc items to measure participants' perception of the societal value of the robots. These items were: "Social robots like Emys/Glin would add value to the society in general", "Society would be better if we had more social robots like Emys/Glin" and "Society would be better off if robots like Emys/Glin were never invented" (reversely scored). The last item was removed from the analysis to improve internal consistency. After removing this item, this dimension presented good levels of internal consistency (Cronbach α = .89).
- ◇ Future intention to interact was evaluated using 3 ad-hoc items. Namely, participants were asked to rate their agreement with the following statements: "I would like to interact with this robot more often", "If I were given the opportunity to interact with this robot again in the future, I would take it" and "If I found a robot like this somewhere, I would probably leave or would try to avoid interacting with it" (reversely scored). The items presented acceptable to good levels of internal consistency (Cronbach α = .77 - .87, the scale was presented twice-once for each robot).
- ◇ PEU and Usefulness PU were evaluated using the scales proposed by Davis (1989) based on the TAM. In particular, PEU was evaluated using 14 items (scored on a scale of 1 to 7), in which participants were asked to rate the likelihood of a set of events, such as "Learning to operate Emys/Glin would be easy for me", "My interaction with Emys/Glin would be clear and understandable" and "I would find Emys/Glin easy to use". PU was measured using 14 items in a similar way to PEU, including statements such as "Using robots like these would make it easier to do my job", "Using robots like these in my job would enable me to accomplish tasks more quickly" and "I would find robots like these useful in my job". Both scales presented acceptable to excellent levels of internal consistency (Cronbach α = .74 - .95).

After responding to the post-questionnaire, participants were thanked for their participation and left the laboratory. The questionnaires used in this study are presented in the supplementary materials.

8.3.1. Results

8.3.2. Participants

Fifty seven Portuguese-speaking individuals participated in this study (70% women, 26.7% men and 3.3% that would rather not say), with ages ranging from 18 to 49 years old (M = 23.07, SD = 6.55). Most of the participants were full or part-time students (82.2% and 14.3%, respectively); the remaining were full-time workers.

8.3.3. Data analysis strategy

- ◇ Self-reported data: Data was analyzed using IBM SPSS (v.28). Scale items were grouped and averaged according to the original sub-dimensions proposed by their authors to create composite variables. The scores of some items were reversed due to their phrasing, according to the instructions in the original scales. Scale's internal consistency was evaluated using Cronbach α as being excellent if $\alpha \leq$ .90, good if .90 ¿ $\alpha \leq$ .80, acceptable if .80 ¿ $\alpha \leq$ .70, questionable if .70 ¿ $\alpha \leq$ .60, poor if .60 ¿ $\alpha \leq$ .50 and unacceptable if α ¡ .50.

  The data contained no missing values as participants were required to answer all questions before moving forward.

  We also conducted a manipulation verification to ensure that the humor introduced in the robots was perceived as being funny and resulted in more enjoyable and amusing interactions. A paired t-test revealed that participants found the funny robot (M = 5.04, SD = 1.40) to be more enjoyable than the unfunny robot overall (M = 3.63, SD = 1.51, $t(56)$ = 5.36, $p < .001$). Participants found the funny robot (M = 5.19, SD = 1.55) to be more funny than the unfunny robot (M = 3.54, SD = 1.72, $t(56)$ = 5.84, $p < .001$), and also thought that the card combinations played by the funny robot (M = 5.05, SD = 1.54) were significantly funnier than those played by the unfunny robot (M = 4.09, SD = 1.81, $t(56)$ = 3.75, $p < .001$). Participants reported greater levels of amusement when interacting with the funny robot (M = 4.88, SD = 1.58) compared to the unfunny robot (M = 3.26, SD = 1.64, $t(56)$ = 4.73, $p < .001$).

  For all statistical analyses, p-values below .05 were considered to be sufficient to reject the null hypotheses.
- ◇ Observational data:

  All interactions with the robots were video and audio-recorded. The resulting observational data was analyzed by two independent coders who scored each video based on the coding scheme presented in table 8.2. According to guidelines and previous research, one of the coders coded all the material (57 videos), while the second coded a random sample equivalent to 30% (17 videos) of the total material.

This process was completed using Observer XT software (v.11.5) developed by Noldus.

The engagement behaviors coded towards the robots (i.e., smiling and laughter) were also distinguished in terms of intensity (low, medium and high). In addition, we transcribed the verbal interactions that participants directed towards the robots during the course of the interaction, and analyzed its content.

Overall agreement, both when calculated based on the duration and sequence of events (ranging from 97% to 100%) and when calculated based on the frequency and sequence of events (ranging from 90% to 98%) was excellent. In both cases, a 2 seconds tolerance interval was allowed. An excellent inter-rater reliability was also achieved across all dependent variables, as indicated by Kappa scores ($M = .99$ and $M = .92$, respectively). The codifications collected provided information both regarding the overall frequency and duration of behaviors. Because game sessions varied greatly in duration ($M = 14.32$, $SD = 3.26$, $min = 4.56$, $max = 26.27$), we calculated the rate of behaviors by dividing each behavior's frequency and duration by the total session duration for that participant.

A summary of the number of occurrences of each behavior is presented in table 8.2.

Out of the 8492 behaviors observed, 68% consisted of gaze behaviors, which were the only behaviors observed consistently across all participants. Socioemotional behaviors (positive and negative) accounted for approximately 12% of the remaining behaviors and were observed in at least 15 and at most 50 of the interactions. Smiling (13%) was almost twice as frequent than laughter (7%). Smiling was observed at least in 2 and at most in 43 of the interactions. Laughter was observed at most in 36 of the interactions.

◇ Physiological data:

We used the BIOPAC MP150 system (developed by BIOPAC Systems, Inc., Camino Goleta, CA) for the continuous recording of physiological data of participants' cardiac autonomic function using electrocardiogram (ECG).

The software Kubios (version 3.5, Kubios Oy, Kuopio, Finland) was used to analyze the ECG and extract information about the HRV. We used the default preprocessing settings (i.e., interpolation rate of 4 Hz and a smoothness priors detrending with a Lambda = 500, a with a cutoff frequency 0.035Hz) and the automatic detection algorithm of the software (Lipponen & Tarvainen, 2019). Visual inspection of the peaks in the QRS wave, also using low thresholds for artifact corrections allowed the correction of peaks (bellow 2%). For HRV, the square root of the mean squared difference of successive R-R intervals rMSSD and HF power were calculated.

Table 8.2. Frequency of the behaviors observed.

Behavior	Target	Intensity	Number of occurrences	Number of behaviors observed	% of this type of behavior	% of all behaviors
Gaze	Funny	–	57	1524	26.27	17.95
	Unfunny	–	57	1305	22.49	15.37
	Screen	–	57	2335	40.24	27.50
	General	–	57	638	11	7.51
	Total			5802	100	68.32
Positive	Funny	–	27	93	34.57	1.10
	Unfunny	–	22	84	31.23	0.99
	Screen	–	23	42	15.61	0.49
	General	–	20	50	18.59	0.59
	Total			269	100	3.17
Negative	Funny	–	32	70	9.82	0.82
	Unfunny	–	15	23	3.23	0.27
	Screen	–	50	468	65.64	5.51

	General	–	34	152	21.32	1.79
	Total			713	100	8.40
Smiling	Funny	Low	41	136	11.98	1.60
		Medium	12	31	2.73	0.37
		High	6	15	1.32	0.18
	Unfunny	Low	34	74	6.52	0.87
		Medium	14	27	2.38	0.31
		High	2	2	0.18	0.02
	Screen	Low	43	369	32.51	4.35
		Medium	28	154	13.57	1.81
		High	14	48	4.23	0.57
	General	Low	43	198	17.44	2.33
		Medium	21	54	4.76	0.64
		High	13	27	2.38	0.32
	Total			1135	100	13.37
Laughter	Funny	Low	26	62	10.99	0.73
		Medium	6	7	1.22	0.08
		High	3	7	1.22	0.08
	Unfunny	Low	22	50	8.73	0.59
		Medium	4	8	1.40	0.09
		High	0	0	0	0
	Screen	Low	36	268	46.77	3.16
		Medium	17	91	15.88	1.07
		High	6	18	3.14	0.21
	General	Low	24	50	8.73	0.59
		Medium	10	12	2.09	0.14
		High	0	0	0	0
	Total			573	100	6.75
Total				8492	100	100

8.3.4. Hypotheses testing

- ◇ ***H1:*** Participants (a) perceived the funny robot as being more warm ($t(56) = 1.84$, $p = .04$, $M = 4.49$, $SD = 1.99$ and $M = 3.87$, $SD = 1.97$), and (b) more competent than the unfunny robot ($t(56) = 3.02$, $p = .002$, $M = 5.77$, $SD = 1.81$ and $M = 4.81$, $SD = 2.23$). No differences were observed between both robots in terms of (c) perceived discomfort ($t(56) = .25$, $p = .40$), with both the funny ($M = 2.56$, $SD = 1.50$) and unfunny robot ($M = 2.61$, $SD = 1.44$) causing similarly low levels of discomfort.
- ◇ ***H2:*** The funny robot was perceived as (a) providing greater emotional value when compared to the unfunny robot ($t(56) = 2.39$, $p = .01$, $M = 3.74$, $SD =$

1.69 and $M = 3.30$ and $SD = 1.55$, respectively). However, no differences were observed in terms of perceived social ($t(56) = .50$, $p = .31$, $M = 2.59$, $SD = 1.41$ and $M = 2.53$, $SD = 1.21$, respectively) or societal value ($t(56) = 0.54$, $p = .30$, $M = 3.23$, $SD = .99$ and $M = 3.16$, $SD = 1.09$, respectively).

◇ ***H3:*** A linear regression analysis considering the role of PEU, PU, enjoyment with the robot and with the task accounted for 55% of the variance in user's future intention to interact with the funny robot ($F(2, 52) = 18.49$, $p < .001$), with all having significant explanatory roles except for PU (see table 8.3). The same model, however, accounted only for 39% of the variance in participant's future intention to interact with the unfunny robot, with the only variables having a significant explanatory role being the user's PEU of the robot and their enjoyment while interacting with it ($F(2, 52) = 10.09$, $p < .001$).

TABLE 8.3. Regression analysis summary for the role of humor and their enjoyment levels, PEU and PU.

Robot	Variable	***B***	**95% CI**	***Beta***	***t***	***p***
Funny	Constant	-2.47	4.65, -.28	-	-2.26	.03
	Enjoyment of the robot	.50	.23 - .77	.45	3.67	<.001
	Enjoyment of the task	.28	.01 - .54	.25	2.08	.04
	Usefulness	-.01	-.25 - .22	-.01	-.12	.91
	Ease of use	.68	.19 - 1.17	.27	2.8	.007
	Variable	***B***	***95% CI***	***Beta***	***t***	***p***
Unfunny	Constant	-2.49	-4.89 - -.09	-	-2.09	.04
	Enjoyment of the robot	.30	.08 - .51	.31	2.76	.008
	Enjoyment of the task	.22	-.02 - .47	.21	1.82	.07
	Usefulness	.15	-.10 - .41	.13	1.22	.23
	Ease of use	.82	.29 - 1.35	.34	3.13	.003

◇ ***H4:*** Participants displayed lower levels of rMSSD during the task compared to the baseline (see table 8.4). Participants' LF/HF ratio increased during the task compared to baseline. These variables were not correlated with their enjoyment of the game or of their interactions with the robots.

◇ ***H5:*** Participants gazed longer at the funny robot when compared with the unfunny robot (see table 8.6). No differences were observed in the frequency of participants gaze at either of the robots.

Additionally, we did not observe any differences between the socioemotional positive or negative behaviors directed at either of the robots (see table 8.6).

TABLE 8.4. Paired t tests for heart activity metrics.

Metric	Paired t test ($df = 53$)	p (2-tailed)	Baseline (M, SD)	Task (M, SD)
rMSSD	3.47	.001	43.71, 17.84	39.68, 14.07
HF	-.73	.47	.09, .03	.09, .02

TABLE 8.5. Pearson correlations between enjoyment of the game and of the robots and heart activity metrics (calculated based on the mean difference values between HRV measures during the task and the baseline periods).

	Enjoyment		
Heart activity metric	Game	Funny robot	Unfunny robot
rMSSD	-.20 (p = .14)	-.09 (p = .51)	-.20 (p = .16)
LF	-.07 (p = .63)	-.17 (p =.22)	.11 (p = .42)

TABLE 8.6. Paired t tests for the behavioral metrics.

Variable		***Hypotheses tests***			***Funny***	***Unfunny***
		t	df	p	$M \pm SD$	$M \pm SD$
Gaze	Frequency	1.94	53	.06	1.66 ± .86	1.45 ± .74
	Duration	4.96	53	<.001	.04 ± .03	.02 ± .02
Socioemotional positive	Frequency	-.18	21	.86	.21 ± .24	.23 ± .23
	Duration	-.91	21	.37	.0001 ± .0001	.0002 ± .0008
Socioemotional negative	Frequency	1.61	14	.13	.17 ± .19	.09 ± .06
	Duration	-.66	14	.52	.0001 ± .0001	.0002 ± .0007
Smile	Frequency	2.22	33	.03	.28 ± .28	.17 ± .11
	Duration	-.79	33	.43	.006 ± .004	.008 ± .01
Laughter	Frequency	-.26	21	.80	.16 ± .08	.15 ± .14
	Duration	-.50	21	.62	.000 ± .000	.0001 ± .0001

◇ ***H6:*** Participants smiled more frequently towards the funny robot when compared to the unfunny robot (see table 8.6). When analyzing differences between the intensity of smiling behaviors towards the robots, we found that participants directed more low intensity smiles towards the funny robot when compared to the unfunny one ($t(33) = 2.28$, $p = .03$). No other differences were observed.

8.3.5. Discussion

Humor emerges naturally in our interactions with others, and engaging in these humorous interpersonal interactions contributes both to one's well-being and to the establishment and maintenance of social bonds. In this study, we sought to investigate if the introduction of humor in a mixed group entertainment involving two robots and one human could enhance the users' perception of the robots, and thus, result in greater future intention to interact with them in the future.

Our results suggest that humorous robots are perceived more favorably in terms of warmth, and emotional (H1 and H2). These results are in line with our hypotheses and with past research suggesting that the introduction of humor can promote more favorable perceptions of SRs (Oliveira et al., 2021).

Additionally, our results show that the humorous robot was perceived as being more competent than its humorless counterpart. This positive effect of humor on competence can be explained both by the fact that we deliberately employed an entertainment-oriented task, and by the fact that performance on that task was directly tied to one's ability to produce humorous interactions.

More interestingly, however, our results show that enjoyment, when coupled with PEU, is an important predictor of user's intention to interact with humorous SRs in the future, accounting for 55% of the variance in this latter variable. When considering the unfunny robot, these variables explained only 39% of the variance in future intention to use. Furthermore, we found that PU, when integrated in a wider model including PEU and enjoyment, did not play a significant role in explaining future intention to use SRs. These findings are in line with our hypothesis (H3), and with previous research that suggest that hedonic motivations (such as engagement) are significant predictors of intention to use, being more closely related to variables pertaining to ease of use and effort expectancy, than with more goal-oriented variables like usefulness (Tamilmani et al., 2019). When considered in the context of other previous studies that suggest that found enjoyment to be an important predictor of actual use of SRs (De Graaf & Allouch, 2013), our results provide additional emphasis to the importance of considering humor, as well as other variables related to hedonic motivations that might promote greater levels of enjoyment as key factors in HRI.

Regarding participant's physiological responses, our findings indicate that participants displayed lower levels of rMSSD, but a higher LF/HF ratio during the task compared to baseline (H4). Additionally, these variables were not correlated with their enjoyment of the game or of the robots. While previous literature has noted significant inconsistencies in the impact of humor and laughter on rMSSD levels, our findings contradict the decreases in frequency-domain HRV measures, such as LF/HF metrics, more consistently observed in response to humor (Oliveira & Arriaga, 2022).

As the impact of humor on physical health is thought to be mediated by the effect of laughter on the respiratory muscles, and these muscles have reciprocal influences on certain aspects of cardiovascular functioning, such as blood pressure regulation, the absence of the expected effects of humor on these variables might be attributed to the low frequency of outward laughter displayed by participants during the experiment.

Indeed, as the participants reported finding the funny robot humorous and amusing (manipulation verification), we hypothesize that participants might have perceived that the robots used had a low degree of awareness of the participants' physical responses. Because laughter is a form of social communication, they might have perceived this lack of awareness as signaling that laughter would not be a necessary or effective way to communicate with said robots.

This hypothesis is further supported by our analysis of the behavioral responses of participants during the game, as we found that few participants interacted with the robots by smiling, and even fewer by laughing, suggesting that they might not have thought that the robots were equipped with visual abilities that would allow them to detect and respond to these expressions of amusement (H6).

Similarly, in the interactions recorded between participants and robots during the game, we noted an overall low number of verbal interactions, no differences regarding the socioemotional content of the interactions directed at either one of the robots', and no task-oriented interactions. The SRs used in the experiment reported in this article did not possess the verbal abilities to engage with participants in a conversational manner, as they only performed a set of pre-scripted utterances. We hypothesize that, upon recognizing this, participants gave up on attempts to further verbally engage with the SRs.

Although the use of pre-scripted verbal interactions is a common practice in HR, our findings provide a compelling case for the need to integrate enjoyment-promoting variables in SRs as a part of a wider set of interactive abilities that support reciprocal social interactions more akin to those we have with other people. This is likely to generate more engaging and naturalistic interactions, as the SR would be better able to partake in the humorous interaction as a mutual participant, rather than in the more performative, and one-sided fashion achieved in this experiment. Further research is also needed to gain further comprehension that reciprocity might have in leveraging or explaining the positive interpersonal effects associated with humor and laughter.

Additionally, these findings are also in line with a growing amount of research that hints at user's disengagement when interacting with SRs. For example, in a study conducted by Kanda and colleagues (2010) in which a robotic shop assistant was deployed in a shopping mall, it was observed that, out of 162 participants, less than half decided to interact with the robot more than twice. In another study conducted by Gockley and colleagues (2005), the authors introduced a receptionist robot in a university hall and observed student's and university's staff interactions with it. Findings demonstrated that, although many users kept interacting daily with the robot, over time, few participants interacted with the robot for more than 30 seconds. Another study involving a robot placed in a similar scenario reports further compelling results. Out of 1500 people who walked by and took notice of the robot, fewer than half chose to approach the robot to interact with it. Out of these, little more than half (54%) reciprocated the robot's greetings.

This provides evidence that supports that, even when repeated interactions occur at a higher rate in naturalistic environments, they appear to shrink in duration (and thus substance) over time (Leite, Martinho, & Paiva, 2013). As familiarity with the robot has been linked to improved user perceptions and greater overtime intentions to interact, the lack of familiarity and novelty of the robots, might have, in the case of this study, also contributed to a lower number of interactions (Leite et al., 2013).

In terms of the interactions that occurred, we observed that, although no differences were found regarding laughter behavior, participants smiled more often towards the funny robot compared to its humorless counterpart. Although the former result was expected, the absence of significant differences in laughter directed at the robots in this study is in line with the aforementioned lack of engagement with the robots.

Additionally, some elements related to the environment in which the experiment was conducted might have also contributed to lower levels of comfort, thus leading to an interaction that was less relaxed, naturalistic and engaging. These elements include the sensors that were used to measure the physiological variables and the video camera.

The fact that we employed a within-subjects study design also did not allow us to compare directly the physiological responses directed at each one of the robots, which would have provided a vital contribution towards a better understanding of how the display of humor by the robots might have influenced participant's cardiac activity during the interaction.

Although explorations of physiological responses in HRIare still rare, the few that exist show that relying on these measures (Yannakis, Hallam, & Lund, 2008; Kulic & Croft, 2007) might be a promising avenue to infer user engagement and approximate user's affective states. As such, future research directed at further exploring the physiological changes participant's experience when interacting with SRs in entertainment contexts is still warranted. The main contributions of this study include the investigation of humor in a mixed group entertainment scenario. This contrasts with the existing research due to its particular focus on group interactions (Oliveira et al., 2021, as opposed to one-on-one interactions). Additionally, we also present a novel entertainment scenario that focuses on hedonic aspects of HRI, in addition to task-related aspects.

Our study is also, to the best of our knowledge, the first to consider the importance of users' perception of the (emotional, social, and societal) value provided by the robots as a predictor of their intention to interact again with SRs in the future. Additionally, we also contribute to the literature by providing validated material (i.e., jokes) that can be used in future studies contributing to the standardization of humor manipulations and thus, the improvement of the methodological quality of the research (see chapter 5).

Some of the limitations to be considered in the interpretation of our results include the fact that the majority of the participants were women, and that previous research has found that women tend to perceive SRs more positively in terms of competence-related variables than males in experiments involving humor (Oliveira et al., 2021). Moreover, given that most participants reported never having interacted with robots, our results might have been influenced by the novelty effect (Gockley et al., 2005).

In addition, despite taking steps towards the validation of the humorous material used in this study regarding its comedic value, we did not evaluate that material in terms of its appropriateness or offensiveness. These variables have been demonstrated to be able to affect both the perception of the humorous material, but also that of its' author both in (Oliveira et al., 2021) and in interactions with other people (Bitterly, Brooks, & Schweitzer, 2017); and thus this fact must be taken into consideration when generalizing the results of this study.

Additionally, although our specific goal was to investigate the role of humor in the context of entertainment (or, in other words, hedonistically motivated interactions) the scenario used in this study did not allow for independent measurements of competence. This is due to the fact that, being a humor-based game, performance (or competence) in the game used was dependent on participants' perceptions of the funniness of the content employed by the robots. This opens the gap for future research that seeks to evaluate the effects of humorous interactions in the context of other entertainment-based interactions with SRs.

CHAPTER 9

Final considerations

The greatest of thinkers, from Aristotle downwards, have tackled this little problem, which has a knack of baffling every effort, of slipping away and escaping only to bob up again, a pert challenge flung at philosophic speculation. Our excuse for attacking the problem in our turn must lie in the fact that we shall not aim at imprisoning the comic spirit within a definition. We regard it, above all, as a living thing. (...). Maybe we may gain from this prolonged contact, for the matter of that, something more flexible than an abstract definition,–a practical, intimate acquaintance, such as springs from a long companionship. And maybe we may also find that, unintentionally, we have made an acquaintance that is useful. For the comic spirit has a logic of its own, even in its wildest eccentricities. It has a method in its madness. It dreams, I admit, but it conjures up, in its dreams, visions that are at once accepted and understood by the whole of a social group. Can it then fail to throw light for us on the way that human imagination works, and more particularly social, collective, and popular imagination?

(Bergson, Brereton, & Rothwell, 1914)

9.1. General discussion

Humor, with its inherent challenges and complexities, presents a captivating and stimulating area of research. Its pervasive nature as a human behavior contrasts with its relatively limited exploration in the scientific literature, particularly in the context of its potential applications in technology-based domains.

In pursuit of advancing this field, this thesis delved into the existing literature to investigate the beneficial impacts of humor on physical health, well-being, and interactions with SRs. Additionally, we endeavored to bridge gaps by translating and evaluating the psychometric properties of scales concerning daily humor use and SRs perception. Moreover, our research involved validating humorous material, serving as the foundation for two empirical studies. The two resulting studies sought to shed light on the intricate interplay between humor and HRI, investigating crucial variables linked to acceptance, perception, and the intention to adopt and use SRs.

Through our contributions, as summarized in Table 9.1, we aimed to advance the development of SRs capable of navigating complex social environments and engaging with individuals in a manner that harnesses the interpersonal and intrapersonal benefits of humor. Given the rapid proliferation of social robots in recent years and the anticipated growth in the future, we propose that the establishment of methods for fostering and sustaining humorous and positive interactions with SRs can make valuable long-term contributions to the domains of health and well-being (SDG 3) as well as industry, innovation, and infrastructure (United Nations General Assembly, 2015, SDG 9).

Table 9.1. Summary of the main contributions of this thesis.

Chapter	***Main goals***	***Summary of main contributions***
2	-To identify the main humor theories and to summarize their contributions to the academic study of humor.	-Humor, as a captivating and multidimensional field of study, presents inherent challenges in terms of its research, conceptualization, and formalization, as evidenced by the multitude of definitions and theoretical perspectives that have emerged over time.

3	-To identify the association between humor and key health-related variables (cardiovascular and well-being indicators).	-Although humor is associated with decreases in BP for some groups in pre and post-comparisons, we could not find sufficient evidence to suggest an effect of humor in BP in experimental or quasi-experimental studies with control groups; -In regards to well-being, our review reveals a consistent and positive correlations between various conceptualizations of humor and psychological well-being. While the evidence supporting the association between humor and social and emotional well-being is predominantly positive, it is comparatively limited. Further investigation is warranted to elucidate the relationship between humor and physical well-being.
4	-To summarize the literature regarding the role of hedonistic variables in technology acceptance	- Traditional models of technology acceptance tend to focus on utilitarian variables to predict and explain user's intentions to adopt new technologies; -As technology continues to evolve and pervade different facets of our lives, there is a need to account for the role of hedonistic variables that can explain technology adoption in entertainment (rather than work-oriented) settings.
5	-To identify how humor has been employed in the context of HRI and determine its interaction outcomes.	-While humor appears to positively influence the user's perception of the robot and their evaluation of the interaction, the existing studies have certain limitations in their approach to robotic humor that must be addressed for a conclusive assessment of its value.

6	-To translate and evaluate the psychometric properties of instruments both related to humor and to robot perception.	-In relation to the RoSAS scale, a positive correlation was found between the warmth and competence, and a shortened version of the scale with 11 items was achieved maintaining the original three-factor structure, despite exhibiting suboptimal temporal reliability. -Regarding the HSQ, the translated version demonstrated moderately acceptable internal consistency, with the affiliative humor style scale showing the highest consistency and the aggressive humor style scale showing the lowest. However, the proposed four-factor model for the translated scale was not supported by confirmatory factor analysis, and test-retest correlations ranged from moderately strong to weak, suggesting that further refinement of the scales is recommended.
7	-To validate humorous material (i.e., written jokes) and to evaluate the association between humor styles and preference towards specific humorous content; -To test the role of humor in an imagined interaction with a SR in the context of a non-entertaining interaction.	-This study revealed that users' perceptions of a robot's warmth and competence have a significant impact on their intention to interact with the robot, through improved perceived ease of use and usefulness. This relationship is further influenced by the congruence between users' and robots' humor styles. Additionally, positive associations are observed between improved perceptions of robots following a display of humor and their perceived social, emotional, and societal value, underscoring the importance of incorporating humor in human-robot interactions.

8	-To validate humorous material (i.e., verbal jokes); -To test the role of humor in a entertainment-based interaction with SRs in a group scenario (in terms of participant's self-reported, behavioral and physiological responses).	The funny robot was perceived as warmer and more competent compared to the unfunny robot, while also generating greater perceptions of emotional value and increased intentions for future interactions. Behavioral data further revealed that participants smiled more and maintained longer periods of gaze towards the funny robot compared to the unfunny robot. These results provide compelling evidence highlighting the significance of incorporating humor in human-robot interactions.

Within the realm of Psychology, this thesis offers a dual contribution. Firstly, it enriches the field of humor research by synthesizing existing literature, shedding light on the role of humor in promoting enhanced cardiovascular health and overall well-being. We also undertook the task of translating and assessing the psychometric properties of the widely utilized HSQ.

We anticipate that these contributions will serve as catalysts for advancing humor research, laying a solid groundwork to support forthcoming investigations into the advantages of humor. Furthermore, our validation of the HSQ furnishes researchers exploring the Portuguese-speaking population with a valuable tool, enabling them to conduct more systematic, reliable, and valid studies. In doing so, we contribute not only to the body of knowledge concerning the HSQ, but also to a broader understanding of its application and significance.

Secondly, our research has contributed to the field of Psychology by investigating the impact of humor as a hedonistic factor in individuals' interactions with SRs. This expansion of existing literature, which predominantly emphasizes utilitarian aspects, illuminates the significance of hedonistic variables in shaping user acceptance of social technology. By integrating additional variables like price and perceived value, we have expanded the scope of these models to encompass other barriers to technology adoption that have been comparatively overlooked. This exploration opens up exciting new avenues for future research in this field.

In our latest chapter, we introduced a novel dimension to our research by incorporating physiological and behavioral indicators of engagement, thereby enhancing the reliability of our findings. Additionally, the game platform we developed and made freely available in chapters 7 and 8 (i.e., JB) presents an innovative interaction paradigm that holds promise for investigating group dynamics within mixed groups of humans and SRs. This platform offers a valuable tool for future studies in exploring the intricacies of interaction within these diverse settings.

Furthermore, the accessibility of the materials pertaining to this research, along with their dissemination in esteemed journals, serves as a driving force behind the progress and ingenuity of applied research in the domains of HRI, humor, and technology acceptance. By embracing an open-access approach, we foster transparency and reproducibility, inviting the wider community to scrutinize and engage with our work, thus ensuring its relevance and impact.

9.2. Limitations and future directions

As often happens in academia, the pursuit of a seemingly straightforward question—in this instance about humor, robots, and technology acceptance—morphed into a captivating cascade of new and intriguing inquiries. The emergence of these thought-provoking questions springs not solely from the endeavors carried out and documented in this thesis but also from an encompassing grasp of the broader domain.

First, we must acknowledge that the conspicuous absence or shortage of humor research as a tool to foster acceptance of new technologies, although quiet, speaks loudly about the many challenges that are at its roots. For example, although there are a few studies that seek to evaluate the effects of humor in the context of social technologies, a large portion of them is conducted online - lacking good levels of external validity that can support its generalizability -, regarding robots with which users have not interacted with yet - thus being potentially biased by novelty effects - and involving mostly canned or pre-scripted jokes (Oliveira et al., 2021).

The leap to studies conducted in settings that allow for greater ecological validity, although a necessity, is hindered by several factors. These include, but are not limited to, the challenges involved in developing effective humor generation algorithms tailored for human-robot interactions. These challenges encompass the intricate nature of humor, the need for flexibility to accommodate the unique dynamics of HRI, and the desire for seamless and natural interactions between humans and robots. (discussion on this topic is expanded below).

In this thesis, we tackled this issue by framing the HRI within a gaming context. Games are particularly good in this regard, as they present a narrow interaction setting, with pre-defined rules and events which are possible to predict and allow for a more interactive programming. These advantages have been noted by other authors before, and games have served as the paradigm for many other studies investigating the dynamics of HRI (Rato, Correia, Pereira, & Prada, 2023; Gonzalez-Pacheco, Ramey, Alonso-Martín, Castro-Gonzalez, & Salichs, 2011).

Nevertheless, it is important to acknowledge that the utilization of such interaction platforms imposes certain limitations on the scope of conclusions and generalizations that can be made. Specifically, in the context of the game developed for the study detailed in chapter 8, the competence of each robot was closely linked to their capacity for humor, potentially blurring the distinction between the influence of humor and the perceived increase in competence on user acceptance and enjoyment of the SR. In other words, being good (competent) at the game meant being funny, and being bad (incompetent) at the game meant being unfunny - thus, making it difficult to disentangle the effects of humor and perceived competence on participant's perceptions and interactions with the SRs. This issue warrants further research and consideration as it is one that is relevant both in entertainment and formal interactions.

Within formal interactions, the role of humor is multifaceted, with research indicating its potential as a double-edged sword. Skillful use of humor can enhance social status and influence, allowing individuals to fortify their position in the social hierarchy (Bitterly, 2022; Bitterly et al., 2017). Conversely, when humor is perceived as offensive or inappropriate, individuals may experience a loss of status. This suggests that the impact of humor within formal contexts necessitates a delicate balance to navigate its potential rewards and risks (Bitterly, 2022; Bitterly et al., 2017).

These findings hold important implications for the development of humorous HRI as they shed light on the intricate relationship between humor and robot perception. More specifically, while humor has shown consistent benefits for interpersonal relationships, it is crucial to recognize that not all attempts at humor yield success (Bitterly, 2022; Bitterly et al., 2017).

Failed humor, and more broadly, the unsuccessful interpersonal management of positive affect, can not only prevent the realization of potential benefits such as helpful and prosocial behavior, improved decision-making, and creativity (Fredrickson, 2001), but it can also lead to negative affect, diminished self-esteem, and a reluctance to persist in efforts to regulate affect (M. Williams & Emich, 2014; Isen, 2008). In this sense, the emergence of a joke within a specific context plays a pivotal role in shaping its reception and its impact on interpersonal dynamics. When a joke is perceived as inappropriate, it diminishes the perceived status and competence of the joke-teller (Bitterly et al., 2017). This effect is further magnified when the joke fails to elicit laughter, highlighting the significance of crafting effective and successful humorous HRIs. By understanding these nuances, we can strive to create engaging and impactful interactions that foster positive experiences and maintain a balanced sense of competence and enjoyment in HRIs.

In addition to suggesting that the context in which humor is expressed is likely to affect the way it is received, literature has also identified several user-related variables that might have an impact in this relationship. More specifically, previous research has suggested that the impact of humor in work-related computer-mediated communications on perceived competence is moderated by gender, such that male employees perceived humorous female managers as more competent, while female employees perceived humorous male managers as less competent (Brender-Ilan & Reizer, 2021).

However, humor can also impact human-robot communication in other ways that are relevant in both formal and entertainment-based interactions. Namely, in formal contexts, the use of some styles of humor is likely to reduce people's perception of the sincerity of the information communicated by the joke-teller (Béal & Grégoire, 2022; H. Shin & Larson, 2020). This is also true in interactions involving SRs, which can be particularly harmful when considering the context of said interactions, thus highlighting the importance of using humor in a careful manner (Yang, Xu, Zhang, Liang, & Lyu, 2022).

Some research delving into these issues in HRI has found support for these considerations. For instance, in a study investigating the impact of humor on enhancing customer's evaluation following a failure committed by a SR, the authors found that humor is effective in low-severity robot failure situations, but counterproductive in high-severity robot failure situations. Additionally, perceived insincerity and humor appreciation play a key mediating role in how users respond to humor in high-severity robot failure situations, whereas the level of anthropomorphism of the robot plays a moderating role (Yang et al., 2022).

The insights derived from these findings are highly relevant to the studies conducted within this thesis, as they shed light on crucial factors that must be considered in the implementation of humor in HRI. They not only provide valuable guidance for the development of successful humor in HRI, but also highlight potential areas for improvement in our own research, thereby paving the way for future investigations in this domain.

Most notably, although both of the SRs used in our studies (Pepper and Emys head) differ significantly in terms of embodiment - presenting different colors, expressive and locomotive abilities, they both present similar humanlikeness scores (Phillips, Zhao, Ullman, & Malle, 2018, 42.17 and 40.52, respectively, on a scale from 1 to 100). More specifically, in both cases, they score slightly below the middle point of the scale indicating intermediary levels of humanlikeness.

Considering previous research indicating that the level of anthropomorphism, or humanlikeness, can influence the impact of humor on users' evaluation of their interactions with SRs, it becomes intriguing to explore how humor can facilitate the acceptance of robots with varying degrees of resemblance to humans (Yang et al., 2022). Given that greater levels of humanlikeness can allow the robot to express facial expressions congruent with mirth more realistically, we hypothesize that using this type of robots can enhance the relational effects of humor in HRI.

Delving into the impact of humanlikeness on humorous HRI offers, thus, a dual opportunity for significant advancements. Firstly, it can enhance the interactivity and realism of the interaction, elevating the overall user experience. Secondly, it opens the door for developers and researchers to finely tune and tailor humor delivery, ensuring its acceptability within specific contexts.

More specifically, as it can be noted in the last study, although participants reported perceiving the jokes as being funny in the pre-test, they used humorous behavioral responses (i.e., smile and laughter) sparingly during their interaction with the SRs.

Additionally, although we did not consider in our studies participant's perception of the acceptability or appropriateness of the joke, past research has suggested that anthropomorphism can have an impact on how humor is received and interpreted. Across the two studies reported in chapters 7 and 8 this variable might have yielded interesting insights on two levels.

First, it can yield practical insights on how to choose the adequate robot for social use in different contexts. For example, past research has suggested that more humanlike SRs can be beneficial in service and hospitality settings, as as following failure, the expression of humor is conducive to greater levels of satisfaction, without hindering its perceived sincerity. It is yet unclear how humanlikeness affects humorous HRI in entertainment settings, however, its potential to avoid active acts of robot destruction (e.g., robot bullying), and enhance the robot's popularity (as it has been observed to occur with other technologies) is a worthy avenue for future research (Barta, Belanche, Fernández, & Flavián, 2023; Babel, Kraus, & Baumann, 2022; Iivari, Kinnula, Kuure, & Keisanen, 2020; Y. Wang, 2020).

Second, more humanlike behaviors and expressions might be better at evoking the contagious nature of humor through increased social and facial mimicry. Namely, a large breath of literature has acknowledged that humor and laughter are contagious in human interactions, often being sufficient stimuli to induce laughter in others (M. Weber & Quiring, 2019; Gervais & Wilson, 2005; Robinson & Smith-Lovin, 2001; Provine, 1992). In groups, humor plays an important role in determining the overall atmosphere and shapes (and is shaped by) the group dynamics, both in formal and entertainment tasks alike (Thomas et al., 2020; Curseu & Fodor, 2016; Romero & Pescosolido, 2008). Introducing humanlike robots in these settings for entertainment interactions can facilitate people's own expressions and reactions to the humor, thus creating more lively and engaged interactions.

Furthermore, it is also crucial to acknowledge that the manifestation of humor extends beyond mere verbal jokes. The effective communication of humor necessitates the integration of other elements such as laughter and non-verbal cues like facial expressions, which serve to convey the intent behind the verbal expression. Additionally, equipping the robot with the capability to recognize humorous expressions from individuals it interacts with and respond accordingly (e.g., laughing at someone's jokes) is equally important. In this context, although a growing number of methods for multimodal generation has been proposed in recent years, many are difficult to implement and require the use of hardware (such as cameras, microphones) and software (such as emotion recognition software) that might make its implementation costly, inaccessible for those unfamiliar with these types of technologies and ultimately, less naturalistic for the user (Vásquez & Aslan, 2021; Hasan et al., 2021).

Furthermore, as discussed above in chapter 4, the metrics used for technology acceptance in this work -although largely mirroring those of previous authors - present only an approximation to the concept they seek to capture. In particular, although self-report measures used in the two empirical studies reported in this thesis hint at positive effects of humor on participant's perceptions, evaluations and engagement with the SRs, the behavior observed and coded through their interactions with the SRs while playing JB was largely apathetic, with few verbal interactions and an unspecified pattern of psychophysiological responses. These limitations are also shared with humor research. Although our analysis of participant's behavioral responses to SRs was intended to serve as a triangulation metric for their humorous responses, smile and laughter are themselves, only poor approximations for humor. This problem has been recognized before (LaFrance, 1983, p. 2):

> As to its [laughter] presence or absence, high inter-observer reliability seems assured, and as to its measurement qualities, a number of objective indices are possible including timed latency and duration, as well as amplitude and intensity. The same applies to smiling.
>
> What then seems to be the problem? The problem is one of validity. Although people laugh when they find something funny, they also laugh when a "joke" is seen to be anything but funny. Moreover, people can be very straight-faced in a truly humorous situation, giving little sign of felt mirth. In fact, many would argue as Tomkins (1980) has that *"facial behavior ... is as ambiguous in its meanings as any other behavior, and we interpret such behavior at its 'face' value at our peril"* (p. 160).

In future research, the integration of additional indicators of enjoyment and engagement beyond the behavioral and subjective measures employed in this thesis could enhance the methodological triangulation. Drawing on previous studies, an intriguing metric to consider is participants' perceived time perception, which examines their subjective experience of time passage—whether it is perceived as faster or slower (Sucala, Stefan, Szentagotai-Tatar, & David, 2010). This metric has the potential to offer valuable insights into participants' levels of enjoyment and engagement during the game and interaction. Existing research suggests that time is perceived to elapse more swiftly when individuals are engaged in enjoyable or entertaining activities, as opposed to situations that induce boredom or lack of enjoyment (Sackett, Meyvis, Nelson, Converse, & Sackett, 2010; Agarwal & Karahanna, 2000).

Similarly, as previous research has used the time passed interacting with a technology as a metric of user's engagement with it, future research might consider using the number of games (or repeated interactions), or the amount of time participants willingly choose to keep interacting with SRs as a measurement of their engagement with it (Leite et al., 2013). This would require the development and implementation of more open-ended HRI formats than those that were used in this thesis.

Another significant hurdle in the pursuit of creating humorous technologies and evaluating their impact on user variables resides in the inherent multidisciplinary nature of such endeavors. It is evident that the abundance of diverse and occasionally conflicting definitions of humor, which attests to both its captivating allure and the challenge of operationalizing the concept, contributes to the complexity of these efforts. The limited comprehension of humor's essence, its mechanisms, and its execution adds an intricate layer of intricacy to interdisciplinary discussions revolving around humor.

Additionally, although, as illustrated in this thesis, the development of computational efforts that can automatically recognize and produce humor is challenging, it is only a part of the problem. Indeed, even if the problem of humor recognition and humor is resolved, many other adjacent problems remain. For instance, in order to add humor to an existing text, it might be necessary to consider the meaning of the text in order to select humorous content that is consistent with the context in which it is embedded - thus requiring some metric of semantic similarity (Mihalcea & Strapparava, 2005). In addition to the semantic meaning of the context in which humor is to be embedded, one must also consider the affective context in which humor is being inserted in order to determine when humor is and is not appropriate, thus requiring the use of some metric of semantic affective orientation (Mihalcea & Strapparava, 2005).

As humor generation has been described in the past as the final frontier in artificial intelligence, we must recognize that there is more to humor than telling jokes and that, in addition to humor, being funny requires a set of other similarly complex abilities (Nijholt, 2018b, 2018a). For instance, the ability to improvise, read the room and choose adequate jokes, not only for the situation, but also for the users with whom it is interacting and the context of the task in which in they are involved, are important abilities to devise successful humorous social technologies.

Once all of these challenges have been resolved - and perhaps even on the path to achieve that - the many promises of humor lie in their multiple applications. For instance, research conducted in psychology shows that humor can be an instrument that facilitates learning by improving memory retention, making the learning process more enjoyable and reducing tension associated with test-taking (McCartney Matthews, 2011). If future research shows that the same phenomenon occurs in learning experiences involving SRs, integrating humor into this type of technology can provide a fairly straightforward, risk- and cost-free option to improve the interaction and maximize the desired outputs. In this context, instead of constituting the goal of the interaction by itself, humor can be added to existing applications that involve HRI.

9.3. Ethical considerations

Throughout the course of this thesis, ethical considerations remained steadfast and paramount in guiding our research endeavors. Their significance became apparent not only in practical terms, where adherence to data protection protocols and safeguarding participant rights were essential, but also in a broader and more abstract context that considered the far-reaching implications of our work, and that played a crucial role in shaping the trajectory and outcomes of our research.

In this sense, as an interaction feature, humor has the potential to make interactions with SRs more enjoyable, and by doing so, to leverage the benefits that humor offers in intrapersonal and interpersonal domains. However, the key strength of humor in what pertains to interpersonal relations - the fact that it can be used to to attract others, to develop and nurture bonds, to increase persuasion and foster emotional connections, requires that its application in HRI pays particular attention to ethical and transparent design guidelines.

This transparency in the way humor is employed in HRI serves the purpose to avoid its use as part of a dark design pattern. Dark design patterns are a set of strategies based on behavioral psychology that can be embedded in technology with the goal of deceiving or misguiding (actively or passively) the user into taking a desired action (Lacey & Caudwell, 2019, e.g., using emotionally negative language to make the user feel bad for declining an offer or unsubscribing from a service).

This transparency also plays a crucial role in enhancing the realism of expectations and cognitive frameworks surrounding SRs during human interactions. By providing clear information about the level of agency possessed by an SR, two significant outcomes can be achieved. Firstly, it enhances the explainability of the SR, enabling users to better comprehend its actions and decision-making processes. Secondly, it empowers users to effectively manage the emotional connections they establish with these technological artifacts. This aspect gains particular significance in light of recent research highlighting the tendency of some users, particularly children and the elderly, to develop excessive emotional attachments to SRs.

A second relevant issue that emerged during different stages of this thesis surrounds some people's appreciation of negative and derogatory humor. For those readers who might be familiar with the card-game which served as an inspiration for JB, what is meant here by "negative" humor must be evident. The original game Cards Against Humanity is famously a game that involves a great amount of jokes that might be perceived as offensive to a great segment of the population (including, for example, racist, sexist, scatological jokes). For ethical reasons, we have used only used in our experiments what we came to refer as "clean jokes", i.e., jokes that were exempt of any offensive content or connotations. Although making this decision allowed us to make a game that could be played by anyone, it removed the main component that many argue is responsible for the funniness of the game - the offensiveness of its content. This was something that was relayed to me by several participants throughout data collection of the studies reported in this thesis.

Despite the ethical considerations involved in the potential use of this type of material, there is no doubt that some individuals exhibit a great appetite and enjoyment of more negative types of humor. This was evidenced both by some (limited) past research and by the proliferation of comedians and humorous games (such as Cards Against Humanity) that rely largely on what can be perceived as offensive humor; and draws an important challenge and limitation for this thesis, and the wider field of humor research. By striving to create a game that appeals to "everyone", we encounter the inherent challenge that personal preferences and individual inclinations vary greatly. In this pursuit, we risk loosing sight of the unique perspectives and nuanced appreciation of humor that each individual possesses, shaped by their distinct experiences and worldviews. In essence, the one-size-fits-all approach fails to capture the intricacies of individual preferences and their alignment with specific humor content.

Another important factor to consider while reading this thesis is that, although it might tell us some noteworthy things about how young, caucasian, educated users might perceive and react to humorous SRs, these findings cannot be assumed to hold true for a population that is more diverse. Like the wider focus on WEIRD (Western, Educated, Industrialized, Rich, and Democratic) observed across social sciences, this particular inclination towards convenient demographic groups of participants that are themselves, in a sense, outliers, hinders our ability to gain insightful knowledge about important topics. This tendency is also larger than any one thesis or research subject. In the field of HRI, a recent review has demonstrated that most research participants are caucasian American adults between the ages of 18 and 45 (90%), male (70%), with at least some degree of university education (many of which in technical or STEM fields). Additionally, although a significant portion of studies does not report on participants' occupations (44%), of those that did, most reported their participants were students or university staff (69%). Ninety percent of these studies did not report to have been subject to review by an Ethics Commission (Oliveira, under review).

These worrisome findings draw attention to the importance of developing and establishing concrete and transparent reporting guidelines, as well as the need to prioritize data collection methods that encompass a broader spectrum of participants, thus ensuring more representative and inclusive research outcomes.

9.4. Conclusion

I have little else to add, aside from the simple acknowledgment that what I learned over the past four years far exceeds what can be captured within the confines of these pages. As it has been (hopefully) made clear thus far, a great part of those learnings were anchored around topics that are central to doing good research (study design, data analysis and collection, and critical thinking, among others). These have allowed me to develop a toolbox of skills, resources, and self-confidence that made this research possible.

A much larger part of my knowledge gains, however, was centered around something far more important: *how to be a good researcher, a good professional and a good teacher*. These skills are considerably more intricate to attain, as they cannot be simply derived from a formula or a preconceived blueprint. Instead, they are acquired through socialization and the continual refinement of one's expectations, routines, and work methodologies. In all earnestness, this transformative journey necessitates the collective support and collaboration of a diverse community—a true embodiment of the saying, *"It takes a village"*.

Throughout this remarkable journey, a wealth of knowledge about humor and technology has been thoroughly conducted, examined, and reported in great detail in this thesis. From this comprehensive body of work, there are four key focal points that deserve special recognition for their profound influence on the entire investigative process that culminated in this thesis.

First, existing research highlights the fact that humor has not lent itself easily to experimental inquiries. The fact that humor is interpersonally and contextually subjective means that the social technology used to display it must have vast interactive abilities in order to support the execution of humor in social situations successfully. Thus far, this obstacle has been overcome by relying on pre-scripted or canned jokes, in studies involving rigid and often staged interactions with social technologies that do not benefit the ecological validity of its findings (Oliveira et al., 2021). Additionally, the large focus placed on verbal jokes (which are often pre-scripted) has left the community with many unanswered questions about how other types of humor might benefit the interaction between people and social technologies, including situational humor and the many visual-based humor forms that have been growing in popularity in recent years (Vásquez & Aslan, 2021, such as memes and gifs).

Second, interdisciplinary communication is important. For it to happen, it must be sustained by models of humor that provide concrete, operationalizable definitions of humor that can be understood, translated, and applied not only within psychology, but also in other relevant fields, such as linguistics and computer science. This will help guide the development of theory-based models of humor (and simultaneously, provide an opportunity to test those models).

Third, in empirical research involving applied studies, systematization is key. Although, as mentioned earlier, many of the existing research relies on pre-scripted or canned jokes, often times the material used in studies is not openly made available, nor retrieved from a pre-validated corpus, which ostensibly hinders its replicability (Oliveira et al., 2021). Future research must thus, focus, not only on developing and validating datasets of humorous material that can be employed to increase the quality and reproducibility of humor research, but also in extending the empirical evaluations of the many settings involving social technologies to which it can be applied.

Lastly, but most certainly not least, responsible research stands as the paramount criterion for ensuring high-quality research across all fields. In this context, responsible research encompasses not only adherence to standards of integrity, ethical principles, and transparency, but also other often-neglected factors. These factors include maintaining a healthy work-life balance, showing respect for others' time, effort, and dedication, and embracing the dual objective of investigating both the determinants of well-being and the factors that propel societal progress, *while also embodying those principles in our own research practices.* The embodiment of these principles emerges as a profound pedagogical tool, presenting itself as one of the most influential resources at our disposal (and one that

I wished was better utilized and recognized for the importance it has). By exemplifying these principles through socialization, we establish a standard of work that fosters and facilitates collaboration. In my personal experience, this approach has enabled me to engage in captivating multidisciplinary endeavors, and extend my knowledge in different (sometimes unexpected) ways that have made me a better researcher. It also generates a ripple effect within the academic community, contributing to the cultivation and positive acceptance of healthier work methodologies.

The significance of these matters resonated with me not only through introspection on my own experiences but also by recognizing their impact on others. It was only when I witnessed aspects of my own journey mirrored in the experiences of others that the problem became glaringly evident. I realized that the multitude of factors in academia, which formed the perfect petri dish for the proliferation of mental illness, discomfort, and unhappiness, were not isolated occurrences but rather systemic patterns. As a community, I believe it is our collective responsibility to ensure that the effects of these factors are contained. We should strive to prevent the loss of potentially valuable researchers, teachers, and community members who become disillusioned and frustrated with academia and science—pursuits that I consider to be among the most noble ones.

Most importantly, the embodiment of these principles recognizes that intellectual endeavors thrive not under the burden of relentless quantitative productivity pressures, which often result in overwhelming workloads, but rather in an environment conducive to producing high-quality work. And that there is no such thing as "quality research" that does not involve and is anchored around the utmost care for the well-being of all of those involved (participants and researchers alike), a curiosity and acceptance of their points of view, and a will to debate, change our minds, take note of (and actively confront) our own biases, to explore, to be wrong (and occasionally, to be right) and, above all, to have the humility to learn.

Embracing and internalizing these principles has proven to be one of the most challenging aspects of my doctoral journey, yet unquestionably one of the most valuable. It is my sincere hope that, by embodying these principles (even - and *especially* - when they were not convenient for me), I have made someone else's path a little easier, their burdens a little lighter, and themselves a little less lonely.

References

Abel, M. H. (2002). Humor, stress, and coping strategies. *HUMOR: International Journal of Humor Research*, *15*(4), 365–381. https://doi.org/10.1515/humr.15.4.365

Agarwal, R., & Karahanna, E. (2000). Time flies when you're having fun: Cognitive absorption and beliefs about information technology usage. *MIS Quarterly*, 665–694. https://doi.org/10.2307/3250951

Ajzen, I. (1980). *Understanding attitudes and predicting social behavior*. Prentice-Hall.

Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. In J. Kuhl & J. Beckmann (Eds.), *Action-control: From cognition to behavior* (pp. 11–39). Berlin/Heidelberg: Springer.

Ajzen, I., & Fishbein, M. (1975). A bayesian analysis of attribution processes. *Psychological Bulletin*, *82*(2), 261–277. https://doi.org/10.1037/h0076477

Ajzen, I., & Kruglanski, A. W. (2019). Reasoned action in the service of goal pursuit. *Psychological Review*, *126*(5), 774–786. https://doi.org/10.1037/rev0000155

Anlı, G. (2021). Reliability and validity studies of the turkish version of humor styles questionnaire for children. *Current Psychology*, *40*(9), 4416–4426. https://doi.org/10.1007/s12144-019-00387-7

Anzalone, S. M., Boucenna, S., Ivaldi, S., & Chetouani, M. (2015). Evaluating the engagement with social robots. *International Journal of Social Robotics*, *7*(4), 465–478. https://doi.org/10.1007/s12369-015-0298-7

Appiah, B., Burdine, J. N., Aftab, A., Asamoah-Akuoko, L., Anum, D. A., Kretchy, I. A., & Bates, I. (2018). Determinants of intention to use mobile phone caller tunes to promote voluntary blood donation: cross-sectional study. *JMIR mHealth and uHealth*, *6*(5), e9752. https://doi.org/10.2196/mhealth.9752

Apte, M. L. (1985). *Humor and laughter: An anthropological approach*. Cornell University Press.

Arthur, W. B. (2009). *The nature of technology: What it is and how it evolves*. Simon & Schuster.

Attardo, S. (2010). *Linguistic theories of humor* (Vol. 1). De Gruyter Mouton. https://doi.org/10.1515/9783110219029

Attardo, S. (2017). *The routledge handbook of language and humor*. Taylor & Francis.

Attardo, S., Hempelmann, C. F., & Maio, S. D. (2002). Script oppositions and logical mechanisms: Modeling incongruities and their resolutions. *HUMOR: International Journal of Humor Research*, *15*(1), 3–46. https://doi.org/10.1515/humr.2002.004

Attardo, S., & Raskin, V. (1991). Script theory revis(it)ed: Joke similarity and joke representation model. *HUMOR: International Journal of Humor Research*, *4*(3-4), 293–348. https://doi.org/10.1515/humr.1991.4.3-4.293

Averill, J. R. (1969). Autonomic response patterns during sadness and mirth. *Psychophysiology*, *5*(4), 399–414. https://doi.org/10.1111/j.1469-8986.1969.tb02840.x

Babel, F., Kraus, J., & Baumann, M. (2022). Findings from a qualitative field study with an autonomous robot in public: Exploration of user reactions and conflicts. *International Journal of Social Robotics*, *14*(7), 1625–1655. https://doi.org/10.1007/s12369-022-00894-x

Bagozzi, R. P. (2007). The legacy of the technology acceptance model and a proposal for a paradigm shift. *Journal of the Association for Information Systems*, *8*(4), 7. https://doi.org/10.17705/1jais.00122

Bagozzi, R. P., & Dholakia, U. (1999). Goal setting and goal striving in consumer behavior. *Journal of marketing*, *63*(4_suppl1), 19–32. https://doi.org/10.2307/1252098

Bagozzi, R. P., & Edwards, E. A. (1998). Goal setting and goal pursuit in the regulation of body weight. *Psychology and Health*, *13*(4), 593–621. https://doi.org/10.1080/08870449808407421

Bagozzi, R. P., & Kimmel, S. K. (1995). A comparison of leading theories for the prediction of goal-directed behaviours. *British Journal of social psychology*, *34*(4), 437–461. https://doi.org/10.1111/j.2044-8309.1995.tb01076.x

Bainbridge, W. A., Hart, J., Kim, E. S., & Scassellati, B. (2008). The effect of presence on human-robot interaction. In *Ro-man 2008 - the 17th ieee international symposium on robot and human interactive communication,* (pp. 701–706). https://doi.org/10.1109/ROMAN.2008.4600749

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*, 191–215. https://doi.org/10.1037/0033-295X.84.2.191

Bandura, A. (1986). Social foundations of thought and action. *Englewood Cliffs, NJ*, *1986*(23-28).

Barta, S., Belanche, D., Fernández, A., & Flavián, M. (2023). Influencer marketing on tiktok: The effectiveness of humor and followers' hedonic experience. *Journal of Retailing and Consumer Services*, *70*, 103149. https://doi.org/10.1016/j.jretconser.2022.103149

Bartneck, C., & Forlizzi, J. (2004). A design-centred framework for social human-robot interaction. In F. Harashima, M. Okubo, A. Gofuki, & H. Ishishari (Eds.), *Ro-man 2004. 13th ieee international workshop on robot and human interactive communication* (pp. 591–594). https://doi.org/10.1109/ROMAN.2004.1374827

Bartneck, C., Kulić, D., Croft, E., & Zoghbi, S. (2009). Measurement instruments for the anthropomorphism, animacy, likeability, perceived intelligence, and perceived safety of robots. *International Journal of Social Robotics*, *1*(1), 71–81. https://doi.org/10.1007/s12369-008-0001-3

Bazzini, D. G., Stack, E. R., Martincin, P. D., & Davis, C. P. (2007). The effect of reminiscing about laughter on relationship satisfaction. *Motivation and Emotion*, *31*(1), 25–34. https://doi.org/10.1007/s11031-006-9045-6

Béal, M., & Grégoire, Y. (2022). How do observers react to companies' humorous responses to online public complaints? *Journal of Service Research*, *25*(2), 242–259. https://doi.org/10.1177/1094670521989448

Beattie, J. (1779). *Essays. on poetry and music, as they affect the mind. on laughter, and ludicrous composition. on the utility of classical learning.* E. &C. Dilly.

Bechade, L., Duplessis, G. D., & Devillers, L. (2016). Empirical study of humor support in social human-robot interaction. In N. Streitz & P. Markopoulos (Eds.), *International conference on distributed, ambient, and pervasive interactions* (pp. 305–316). https://doi.org/10.1007/978-3-319-39862-4_28

Belanche, D., Casaló, L., & Schepers, J. (2021). Examining the effects of robots' physical appearance, warmth, and competence in frontline services: The humanness-value-loyalty model. *Psychology & Marketing*, *28*(12), 2357–2376. https://doi.org/10.1002/mar.21532

Bennett, M. P., & Lengacher, C. (2008). Humor and laughter may influence health: Iii. laughter and health outcomes. *Evidence-based Complementary and Alternative Medicine*, *5*(1), 37–40. https://doi.org/10.1093/ecam/nem041

Berger, J., Wilson, D., Potts, L., & Polivka, B. (2014). Wacky wednesday: Use of distraction through humor to reduce preoperative anxiety in children and their parents. *Journal of Perianesthesia Nursing*, *29*(4), 285–291. https://doi.org/10.1016/j.jopan.2013.06.003

Bergson, H., Brereton, C. S. H., & Rothwell, F. (1914). *Laughter: An essay on the meaning of the comic.* Macmillan.

Berlyne, D. E. (1972). Humor and its kin. In J. H. Goldstein & P. E. McGhee (Eds.), *The psychology of humor* (pp. 43–60). New York, NY: Academic Press.

Binsted, K., et al. (1995). Using humour to make natural language interfaces more friendly. In *Proceedings of the ai, alife and entertainment workshop, intern. joint conf. on artificial intelligence.*

Bitterly, T. B. (2022). Humor and power. *Current Opinion in Psychology*, *43*, 125–128. https://doi.org/10.1016/j.copsyc.2021.06.017

Bitterly, T. B., Brooks, A. W., & Schweitzer, M. E. (2017). Risky business: When humor increases and decreases status. *Journal of Personality and Social Psychology*, *112*(3), 431. https://doi.org/10.1037/pspi0000079

Blascovich, J. J., & Katkin, E. S. (1993). *Cardiovascular reactivity to psychological stress & disease.* American Psychological Association. https://doi.org/10.1037/10125-000

Blue, C. L. (1995). The predictive capacity of the theory of reasoned action and the theory of planned behavior in exercise research: An integrated literature review. *Research in nursing & health*, *18*(2), 105–121. https://doi.org/10.1002/nur.4770180205

Boehm, J. K., & Kubzansky, L. D. (2012). The heart's content: The association between positive psychological well-being and cardiovascular health. *Psychological Bulletin*, *138*(4), 655. https://doi.org/10.1037/a0027448

Bonani, M., Oliveira, R., Correia, F., Rodrigues, A., Guerreiro, T., & Paiva, A. (2018). What my eyes can't see, a robot can show me: Exploring the collaboration between blind people and robots. In F. Hwang, J. McGrenere, & D. Flatla (Eds.), *Assets '18: Proceedings of the 20th international acm sigaccess conference on computers and accessibility* (pp. 15–27). https://doi.org/10.1007/978-3-319-15672-9_4

Boone, T., Hansen, S., & Erlandson, A. (2000). Cardiovascular responses to laughter: A pilot project. *Applied Nursing Research*, *13*(4), 204–208. https://doi.org/10.1053/apnr.2000.7656

Booth-Butterfield, S., & Booth-Butterfield, M. (1991). Individual differences in the communication of humorous messages. *Southern Journal of Communication*, *56*(3), 205–218. https://doi.org/10.1080/10417949109372999

Boyd, B. (2004). Laughter and literature: A play theory of humor. *Philosophy and Literature*, *28*(1), 1–22. https://doi.org/10.1353/phl.2004.0002

Boyd, B., & Wandersman, A. (1991). Predicting undergraduate condom use with the fishbein and ajzen and the triandis attitude-behavior models: Implications for public health interventions 1. *Journal of Applied Social Psychology*, *21*(22), 1810–1830. https://doi.org/10.1111/j.1559-1816.1991.tb00506.x

Breazeal, C. (2004). *Designing sociable robots*. MIT press.

Brender-Ilan, Y., & Reizer, A. (2021). How do we perceive a humorous manager? manager humor, impression management, and employee willingness to work with the manager. *Frontiers in Psychology*, *12*, 628350. https://doi.org/10.3389/fpsyg.2021.628350

Bressler, E. R., Martin, R. A., & Balshine, S. (2006). Production and appreciation of humor as sexually selected traits. *Evolution and Human Behavior*, *27*(2), 121–130. https://doi.org/10.1016/j.evolhumbehav.2005.09.001

Brill, A. (1911). Freud's theory of wit. *The Journal of Abnormal Psychology*, *6*(4), 279–316. https://doi.org/10.1037/h0074494

Brislin, R. (1973). Questionnaire wording and translation. *Cross-cultural Research Methods*, 32–58.

Broadie, S., & Rowe, C. (2002). *Aristotle: Nicomachean ethics*. Oxford University Press.

Brosschot, J. F., & Thayer, J. F. (2003). Heart rate response is longer after negative emotions than after positive emotions. *International Journal of Psychophysiology*, *50*(3), 181–187. https://doi.org/10.1016/s0167-8760(03)00146-6

Butland, M. J., & Ivy, D. K. (1990). The effects of biological sex and egalitarianism on humor appreciation: Replication and extension. *Journal of Social Behavior and Personality*, *5*(4), 353–359. https://doi.org/10.1177/147470491501300

Butzer, B., & Kuiper, N. A. (2008). Humor use in romantic relationships: The effects of relationship satisfaction and pleasant versus conflict situations. *The Journal of Psychology*, *142*(3), 245–260. https://doi.org/10.3200/JRLP.142.3.245-260

Byrne, B. M. (2010). *Structural equation modeling with AMOS: Basic concepts, applications, and programming* (2nd ed.). Routledge.

Cann, A., Calhoun, L. G., & Banks, J. S. (1997). On the role of humor appreciation in interpersonal attraction: It's no joking matter. *HUMOR: International Journal of Humor Research*, *10*(1), 77–89. https://doi.org/10.1515/humr.1997.10.1.77

Cann, A., & Collette, C. (2014). Sense of humor, stable affect, and psychological well-being. *Europe's Journal of Psychology*, *10*(3), 464–479. https://doi.org/10.5964/ejop.v10i3.746

Canty-Mitchell, J., & Zimet, G. D. (2000). Psychometric properties of the multidimensional scale of perceived social support in urban adolescents. *American Journal of Community Psychology*, *28*(3), 391–400. https://doi.org/10.1023/A:1005109522457

Capio, C. M., Sit, C. H., & Abernethy, B. (2014). Physical well-being. In C. Michalos A (Ed.), *Encyclopedia of quality of life and well-being research* (pp. 4724–4728). Springer. http://dx.doi.org/10.1007/978-94-007-0753-5_2166

Carbelo, B., & Jáuregui, E. (2006). Positive emotions: Positive humour. *Papeles del Psicólogo*, *27*(1), 18–30.

Carpinella, C. M., Wyman, A. B., Perez, M. A., & Stroessner, S. J. (2017). The robotic social attributes scale (rosas) development and validation. In B. Mutlu, M. Tscheligi, J. E. Young, & A. Weiss (Eds.), *Proceedings of the 2017 acm/ieee international conference on human-robot interaction* (pp. 254–262).

Carr, A., Cullen, K., Keeney, C., Canning, C., Mooney, O., Chinseallaigh, E., & O'Dowd, A. (2021). Effectiveness of positive psychology interventions: A systematic review and meta-analysis. *The Journal of Positive Psychology*, *16*(6), 749–769. https://doi.org/10.1080/17439760.2020.1818807

Carrell, A. (2008). Historical views of humor. In V. Raskin (Ed.), *The primer of humor research* (pp. 303–332). Mouton de Grutyer Berlin (GER). https://doi.org/10.1515/9783110198492.303

Chan, Y.-C., Hsu, W.-C., Liao, Y.-J., Chen, H.-C., Tu, C.-H., & Wu, C.-L. (2018). Appreciation of different styles of humor: An fmri study. *Scientific Reports*, *8*(1), 1–12. https://doi.org/10.1038/s41598-018-33715-1

Chang, A. (2012). Utaut and utaut 2: A review and agenda for future research. *The Winners*, *13*(2), 10–114. https://doi.org/10.21512/tw.v13i2.656

Chang, C., Tsai, G., & Hsieh, C.-J. (2013). Psychological, immunological and physiological effects of a laughing qigong program (lqp) on adolescents. *Complementary Therapies in Medicine*, *21*(6), 660–668. https://doi.org/10.1016/j.ctim.2013.09.004

Chang, M.-K. (1998). Predicting unethical behavior: A comparison of the theory of reasoned action and the theory of planned behavior. *Journal of Business Ethics*, *17*, 1825–1834. https://doi.org/10.1023/A:1005721401993

Chida, Y., & Steptoe, A. (2008). Positive psychological well-being and mortality: A quantitative review of prospective observational studies. *Psychosomatic Medicine*, *70*(7), 741–756. https://doi.org/10.1097/PSY.0b013e31818105ba

Chinery, W. (2007). Alleviating stress with humour: A literature review. *Journal of Perioperative Practice*, *17*(4), 172–182. https://doi.org/10.1177/175045890701700403

Choi, S. O., & Kim, B. C. (2012). Voter intention to use e-voting technologies: security, technology acceptance, election type, and political ideology. *Journal of Information Technology & Politics*, *9*(4), 433-452. https://doi.org/10.1080/19331681.2012.710042

Chuttur, M. (2009). Overview of the technology acceptance model: Origins, developments and future directions. *All Sprouts Content*, *290*.

Cialdini, R. B., Reno, R. R., & Kallgren, C. A. (1990). A focus theory of normative conduct: Recycling the concept of norms to reduce littering in public places. *Journal of personality and social psychology*, *58*(6), 1015. https://doi.org/10.1037/0022-3514.58.6.1015

Cialdini, R. B., Van Lange, P., Kruglanski, A., & Higgins, T. (2012). Handbook of theories of social psychology. In P. Van Lange, A. Kruglanski, & T. Higgins (Eds.), . SAGE Publications Ltd.: London, UK.

Colina, S., Marrone, N., Ingram, M., & Sánchez, D. (2017). Translation quality assessment in health research: A functionalist alternative to back-translation. *Evaluation & the Health Professions*, *40*(3), 267–293. https://doi.org/10.1177/0163278716648191

Compeau, D. R., & Higgins, C. A. (1995). Application of social cognitive theory to training for computer skills. *Information Systems Research*, *6*(2), 118–143. https://doi.org/10.1287/isre.6.2.118

Connolly, T. M., Boyle, E. A., MacArthur, E., Hainey, T., & Boyle, J. M. (2012). A systematic literature review of empirical evidence on computer games and serious games. *Computers & Education*, *59*(2), 661–686. https://doi.org/10.1016/j.compedu.2012.03.004

Correia, F., Mascarenhas, S. F., Gomes, S., Arriaga, P., Leite, I., Prada, R., … Paiva, A. (2019). Exploring prosociality in human-robot teams. In J. Kim, D. Sirkin, A. Tapus, M. Jung, & S. Kwak (Eds.), *2019 14th acm/ieee international conference on human-robot interaction (hri)* (pp. 143–151). https://doi.org/10.1109/HRI.2019.8673299

Cowan, R. S. (1976). The" industrial revolution" in the home: Household technology and social change in the 20th century. *Technology and culture*, 1–23. https://doi.org/10.2307/3103251

Crawford, S. A., & Caltabiano, N. J. (2011). Promoting emotional well-being through the use of humour. *The Journal of Positive Psychology*, *6*(3), 237–252. https://doi.org/10.1080/17439760.2011.577087

Criley, J. M., Blaufuss, A. H., & Kissel, G. L. (1976). Cough-induced cardiac compression:

Self-administered form of cardiopulmonary resuscitation. *JAMA*, *236*(11), 1246–1250.

Cuddy, A. J., Fiske, S. T., & Glick, P. (2008). Warmth and competence as universal dimensions of social perception: The stereotype content model and the bias map. *Advances in Experimental Social Psychology*, *40*, 61–149. https://doi.org/10.1016/S0065-2601(07)00002-0

Cummins, R. A., Mccabe, M. P., Romeo, Y., & Gullone, E. (1994). Validity studies the comprehensive quality of life scale (comqol): Instrument development and psychometric evaluation on college staff and students. *Educational and Psychological Measurement*, *54*(2), 372–382. https://doi.org/10.1177/0013164494054002011

Curran, T., Janovec, A., & Olsen, K. (2021). Making others laugh is the best medicine: humor orientation, health outcomes, and the moderating role of cognitive flexibility. *Health Communication*, *36*(4), 468–475. https://doi.org/10.1080/10410236.2020.1821577

Curseu, P. L., & Fodor, O. C. (2016). Humor and group atmosphere: Development of a short scale for evaluating affiliative and aggressive humor in groups. *Team Performance Management*, *22*(7/8), 370–382. https://doi.org/10.1108/TPM-04-2015-0022

Dautenhahn, K. (2007). Socially intelligent robots: Dimensions of human–robot interaction. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *362*(1480), 679–704. https://doi.org/10.1098/rstb.2006.2004

Davis, F. D. (1985). *A technology acceptance model for empirically testing new end-user information systems: Theory and results* (Unpublished doctoral dissertation). Massachusetts Institute of Technology.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, *13*(3), 319–340. https://doi.org/10.2307/249008

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1992). Extrinsic and intrinsic motivation to use computers in the workplace 1. *Journal of Applied Social Psychology*, *22*(14), 1111–1132. https://doi.org/10.1111/j.1559-1816.1992.tb00945.x

Davis, M. S. (1995). The sociology of humor: A stillborn field? *Sociological Forum*, *10*(2), 327–339. (https://www.jstor.org/stable/684994)

Deacon, T. W. (1997). What makes the human brain different? *Annual Review of Anthropology*, *26*(1), 337–357.

De Graaf, M. M., & Allouch, S. B. (2013). Exploring influencing variables for the acceptance of social robots. *Robotics and Autonomous Systems*, *61*(12), 1476–1486. https://doi.org/10.1016/j.robot.2013.07.007

Dennett, D. (1991). *Consciousness explained*. Boston: Little Brown.

de Pascual-Teresa, S., Moreno, D. A., & García-Viguera, C. (2010). Flavanols and anthocyanins in cardiovascular health: A review of current evidence. *International Journal* *of Molecular Sciences*, *11*(4), 1679–1703. https://doi.org/10.3390/ijms11041679

de Souza, A. M., Felix, B., de Andrade, A. M., & dos Santos Cerqueira, A. (2019). Humor at work: A study about the relationship between humor styles, satisfaction with management and individual job performance. *Revista de Administração da Universidade Federal de Santa Maria*, *12*(4), 803–820.

Devillers, L., Rosset, S., Duplessis, G. D., Sehili, M. A., Béchade, L., Delaborde, A., ... others (2015). Multimodal data collection of human-robot humorous interactions in the joker project. In *2015 international conference on affective computing and intelligent interaction (acii)* (pp. 348–354). https://doi.org/10.1109/ACII.2015.7344594

Diener, E., Oishi, S., & Lucas, R. (2002). Swb: The science of happiness and life satisfaction. In C. R. Snyder & S. J. Lopez (Eds.), *Handbook of positive psychology* (pp. 63–73). Oxford, England: Oxford University Press.

Dillon, A., & Morris, M. G. (1996). User acceptance of new information technology: theories and models. In M. E. Williams (Ed.), *Annual review of information science and technology* (Vol. 14, p. 3-32). Information Today. http://hdl.handle.net/10150/105584

Dionigi, A., Duradoni, M., & Vagnoli, L. (2021). Humor and anxiety: The relationship between the comic styles, worry and general well-being. *Personality and Individual Differences*, *181*, 111028. https://doi.org/10.1016/j.paid.2021.111028

Dogan, M. D. (2020). The effect of laughter therapy on anxiety: A meta-analysis. *Holistic Nursing Practice*, *34*(1), 35–39. https://doi.org/10.1097/HNP.0000000000000363

Dolgoff-Kaspar, R., Baldwin, A., Johnson, M. S., Edling, N., & Sethi, G. K. (2012). Effect of laughter yoga on mood and heart rate variability in patients awaiting organ transplantation: A pilot study. *Alternative Therapies*, *18*(4), 53–58.

Doll, H. A., Petersen, S. E., & Stewart-Brown, S. L. (2000). Obesity and physical and emotional well-being: Associations between body mass index, chronic illness, and the physical and mental components of the sf-36 questionnaire. *Obesity Research*, *8*(2), 160–170. https://doi.org/10.1038/oby.2000.17

Dunbar, R., & Mehu, M. (2008). Naturalistic observations of smiling and laughter in human group interactions. *Behaviour*, *145*(12), 1747–1780. https://doi.org/10.1163/156853908786279619

Duncan, W. J., Smeltzer, L. R., & Leap, T. L. (1990). Humor and work: Applications of joking behavior to management. *Journal of Management*, *16*(2), 255–278. https://doi.org/10.1177/014920639001600203

Ebner, N. C., Riediger, M., & Lindenberger, U. (2010). Faces—a database of facial expressions in young, middle-aged, and older women and men: Development and validation. *Behavior Research Methods*, *42*(1), 351–362. https://doi.org/10.3758/BRM.42.1.351

Edwards, A., Edwards, C., Westerman, D., & Spence, P. R. (2019). Initial expectations, interactions, and beyond with social robots. *Computers in Human Behavior*, *90*, 308–314. https://doi.org/10.1016/j.chb.2018.08.042

Edwards, K. R., & Martin, R. A. (2014). The conceptualization, measurement, and role of humor as a character strength in positive psychology. *Europe's Journal of Psychology*, *10*(3), 505–519. https://doi.org/10.5964/ejop.v10i3.759

Egmond, C., & Bruel, R. (2007). *Nothing is as practical as a good theory: Analysis of theories and a tool for developing interventions to influence energy behaviour* (Scientific Reports Produced within the BEHAVE Project). Europe: Evaluation of Energy Behavioural Change Programmes Intelligent Energy – Europe (IEE).

Electrophysiology, T. F. o. t. E. S. o. C. t. N. A. S. o. P. (1993). Heart rate variability: Standards of measurement, physiologic interpretation, and clinical use. *Circulation*, *93*(5), 1043–1065. https://doi.org/10.1161/01.CIR.93.5.1043

Elshakry, M. (2010). When science became western: Historiographical reflections. *Isis*, *101*(1), 98–109. https://doi.org/10.1086/652691

Eshg, Z. M., Ezzati, J., Nasiri, N., & Ghafouri, R. (2017). Effects of humor therapy on blood pressure in patients undergoing hemodialysis. *Journal of Research in Medical and Dental Science*, *5*, 85–88.

Eysenck, H. J. (1972). The dangers of the new zealots. *Encounter*, *39*(12), 79–91.

Ferguson, M. A., & Ford, T. E. (2008). Disparagement humor: A theoretical and empirical review of psychoanalytic, superiority, and social identity theories. *HUMOR: International Journal of Humor Research*, *21*(3), 283–312. https://doi.org/10.1515/HUMOR.2008.014

Fernandes, R. P. C. (2023). *Psychometric evidence of the humor styles questionnaire (hsq) in a portuguese working sample* (Unpublished doctoral dissertation). Universidade Autónoma de Lisboa, Lisboa. (Unpublished doctoral dissertation or master's thesis)

Fishbein, M., & Ajzen, I. (2010). *Predicting and changing behavior.* Psychology Press. https://doi.org/10.4324/9780203838020

Fong, T., Nourbakhsh, I., & Dautenhahn, K. (2003). A survey of socially interactive robots. *Robotics and Autonomous Systems*, *42*(3-4), 143–166. https://doi.org/10.1016/S0921-8890(02)00372-X

Foot, H. (2017). *Humor and laughter: Theory, research and applications.* Routledge.

Ford, T. E., Lappi, S. K., & Holden, C. J. (2016). Personality, humor styles and happiness: Happy people have positive humor styles. *Europe's Journal of Psychology*, *12*(3), 320. https://doi.org/10.5964/ejop.v12i3.1160

Forgas-Coll, S., Huertas-Garcia, R., Andriella, A., & Alenyà, G. (2022). How do consumers' gender and rational thinking affect the acceptance of entertainment social robots? *International Journal of Social Robotics*, *14*(4), 973–994. https://doi.org/10.1007/s12369-021-00845-y

Fredrickson, B. L. (2001). The role of positive emotions in positive psychology: The broaden-and-build theory of positive emotions. *American Psychologist*, *56*(3), 218–226. https://doi.org/10.1037//0003-066x.56.3.218

Fredrickson, B. L. (2004). The broaden–and–build theory of positive emotions. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences*, *359*(1449), 1367–1377. https://doi.org/10.1098/rstb.2004.1512

Fredrickson, B. L. (2013). Positive emotions broaden and build. *Advances in Experimental Social Psychology*, *47*, 1–53. https://doi.org/10.1016/B978-0-12-407236-7.00001-2

Fredrickson, B. L., & Joiner, T. (2002). Positive emotions trigger upward spirals toward emotional well-being. *Psychological Science*, *13*(2), 172–175. https://doi.org/10.1111/1467-9280.00431

Fredrickson, B. L., Mancuso, R. A., Branigan, C., & Tugade, M. M. (2000). The undoing effect of positive emotions. *Motivation and Emotion*, *24*(4), 237–258. https://doi.org/10.1023/a:1010796329158

Freud, S. (1961). Humour. In S. Freud, J. Strachey, A. Freud, A. Strachey, & A. Tyson (Eds.), *The standard edition of the complete psychological works of sigmund freud, volume xxi (1927-1931): The future of an illusion, civilization and its discontents, and other works* (pp. 159–166). The Hogarth Press : The Institute of Psycho-Analysis.

Fuchs, S., Rathcke, T., Ginzburg, J., & Pelachaud, C. (2018). Laugh is in the air? physiological analysis of laughter as a correlate of attraction during speed dating. *Frontiers in Communication*, *7*, 21. https://doi.org/10.3389/fcomm.2022.909913

Gagnon, M.-P., Godin, G., Gagne, C., Fortin, J.-P., Lamothe, L., Reinharz, D., & Cloutier, A. (2003). An adaptation of the theory of interpersonal behaviour to the study of telemedicine adoption by physicians. *International Journal of Medical Informatics*, *71*(2-3), 103–115. https://doi.org/10.1016/S1386-5056(03)00094-7

Galinha, I. C., & Pais-Ribeiro, J. L. (2005). Contribuição para o estudo da versão portuguesa da positive and negative affect schedule (panas): Ii–estudo psicométrico. *Análise Psicológica*, 219–227. Retrieved from `http://hdl.handle.net/10400.12/180`

Gallois, C., & Callan, V. J. (1985). The influence of ethnocentrism and ethnic label on the appreciation of disparagement jokes. *International Journal of Psychology*, *20*(1), 63–76. https://doi.org/10.1002/j.1464-066X.1985.tb00014.x

Garland, E. L., Gaylord, S. A., & Fredrickson, B. L. (2011). Positive reappraisal mediates the stress-reductive effects of mindfulness: An upward spiral process. *Mindfulness*, *2*(1), 59–67. https://doi.org/10.1007/s12671-011-0043-8

Geisler, F. C., Vennewald, N., Kubiak, T., & Weber, H. (2010). The impact of heart rate variability on subjective well-being is mediated by emotion regulation. *Personality and Individual Differences*, *49*(7), 723–728. https://doi.org/10.1016/j.paid.2010.06.015

Gelkopf, M. (2011). The use of humor in serious mental illness: A review. *Evidence-Based Complementary and Alternative Medicine*, *2011*, 342837. https://doi.org/10.1093/ecam/nep106

Genç, H., & Saritas, S. (2020). The effects of watching comedy videos on anxiety and vital signs in surgical oncology patients. *Explore*, *16*(6), 401–406. https://doi.org/10.1016/j.explore.2020.02.009

Gervais, M., & Wilson, D. S. (2005). The evolution and functions of laughter and humor: A synthetic approach. *The Quarterly Review of Biology*, *80*(4), 395–430. https://doi.org/10.1086/498281

Giger, J.-C., Piçarra, N., Alves-Oliveira, P., Oliveira, R., & Arriaga, P. (2019). Humanization of robots: Is it really such a good idea? *Human Behavior and Emerging Technologies*, *1*(2), 111–123. https://doi.org/10.1002/hbe2.147

Gockley, R., Bruce, A., Forlizzi, J., Michalowski, M., Mundell, A., Rosenthal, S., ... Wang, J. (2005). Designing robots for long-term social interaction. In M. Meng & H. Zhang (Eds.), *2005 ieee/rsj international conference on intelligent robots and systems* (pp. 1338–1343). https://doi.org/10.1109/IROS.2005.1545303

Gonot-Schoupinsky, F. N., & Garip, G. (2018). Laughter and humour interventions for well-being in older adults: A systematic review and intervention classification. *Complementary Therapies in Medicine*, *38*, 85–91. https://doi.org/10.1016/j.ctim.2018.04.009

Gonzalez-Pacheco, V., Ramey, A., Alonso-Martín, F., Castro-Gonzalez, A., & Salichs, M. A. (2011). Maggie: A social robot as a gaming platform. *International Journal of Social Robotics*, *3*, 371–381. https://doi.org/10.1007/s12369-011-0109-8

Gosling, S. D., Rentfrow, P. J., & Swann Jr, W. B. (2003). A very brief measure of the big-five personality domains. *Journal of Research in Personality*, *37*(6), 504–528. https://doi.org/10.1016/S0092-6566(03)00046-1

Greengross, G. (2013). Humor and aging: A mini-review. *Gerontology*, *59*(5), 448–453. https://doi.org/10.1159/000351005

Gutierrez, F. J., Ochoa, S. F., Cornejo, R., & Vassileva, J. (2019). Designing computer-supported technology to mediate intergenerational social interaction: A cultural perspective. In S. Sayago (Ed.), *Perspectives on human-computer interaction research with older people* (pp. 199–214). Springer. https://doi.org/10.1007/978-3-030-06076-3_13

Hair, J. F. (2009). *Multivariate data analysis.* Retrieved from `https://inimoose.tumblr.com/post/725532861668655104/this-morning-nasa-abandoned-their-mars-rover/amp`

Hall, J. A. (2017). Humor in romantic relationships: A meta-analysis. *Personal Relationships*, *24*(2), 306–322. https://doi.org/10.1111/pere.12183

Hamner, M. (2009). Expanding the technology acceptance model to examine personal computing technology utilization in government agencies in developing countries. *Government Information Quarterly*, *26*(1), 128–136. https://doi.org/10.1016/j.giq.2007.12.003

Hampes, W. P. (2001). Relation between humor and empathic concern. *Psychological*

Reports, *88*(1), 241–244. https://doi.org/10.2466/pr0.2001.88.1.241

Hancock, P. A., Pepe, A. A., & Murphy, L. L. (2005). Hedonomics: The power of positive and pleasurable ergonomics. *Ergonomics in Design*, *13*(1), 8–14. https://doi.org/10.1177/106480460501300104

Harrison, L. K., Carroll, D., Burns, V. E., Corkill, A. R., Harrison, C. M., Ring, C., & Drayson, M. (2000). Cardiovascular and secretory immunoglobulin a reactions to humorous, exciting, and didactic film presentations. *Biological Psychology*, *52*(2), 113–126. https://doi.org/10.1016/s0301-0511(99)00033-2

Hasan, M. K., Lee, S., Rahman, W., Zadeh, A., Mihalcea, R., Morency, L.-P., & Hoque, E. (2021). Humor knowledge enriched transformer for understanding multimodal humor. In *Proceedings of the aaai conference on artificial intelligence* (Vol. 35, pp. 12972–12980). https://doi.org/10.1609/aaai.v35i14.17534

Hashemian, M., Paiva, A., Mascarenhas, S., Santos, P. A., & Prada, R. (2019). Social power in human-robot interaction: Towards more persuasive robots. In J. Cabibihan, F. Mastrogiovanni, A. Pandey, S. Rossi, & M. Staffa (Eds.), *2019 28th ieee international conference on robot and human interactive communication (ro-man)* (pp. 2015–2017). https://doi.org/10.1109/RO-MAN46459.2019.8956298

Hayashi, K., Kawachi, I., Ohira, T., Kondo, K., Shirai, K., & Kondo, N. (2016). Laughter is the best medicine? a cross-sectional study of cardiovascular disease among older japanese adults. *Journal of Epidemiology*, *26*(10), 546–552. https://doi.org/10.2188/jea.JE20150196

Heerink, M., Kröse, B., Evers, V., & Wielinga, B. (2009). Influence of social presence on acceptance of an assistive social robot and screen agent by elderly users. *Advanced Robotics*, *23*(14), 1909–1923. https://doi.org/10.1163/016918609X12518783330289

Heerink, M., Kröse, B., Evers, V., & Wielinga, B. (2010). Assessing acceptance of assistive social agent technology by older adults: The almere model. *International Journal of Social Robotics*, *2*(4), 361–375. https://doi.org/10.1007/s12369-010-0068-5

Heijden, H. (2004). User acceptance of hedonic information systems. *MIS Quarterly*, *28*(4), 695–704. https://doi.org/10.2307/25148660

Heintz, S. (2017). Putting a spotlight on daily humor behaviors: Dimensionality and relationships with personality, subjective well-being, and humor styles. *Personality and Individual Differences*, *104*, 407–412. https://doi.org/10.1016/j.paid.2016.08.042

Heintz, S., & Ruch, W. (2015). An examination of the convergence between the conceptualization and the measurement of humor styles: A study of the construct validity of the humor styles questionnaire. *HUMOR: International Journal of Humor Research*, *28*(4), 611–633. https://doi.org/10.1515/humor-2015-0095

Henkin, B., & Fish, J. M. (1986). Gender and personality differences in the appreciation of cartoon humor. *The Journal of Psychology*, *120*(2), 157–175. https://doi.org/10.1080/00223980.1986.9712625

Hills, P., & Argyle, M. (2002). The oxford happiness questionnaire: A compact scale for the measurement of psychological well-being. *Personality and Individual Differences*, *33*(7), 1073–1082. https://doi.org/10.1016/S0191-8869(01)00213-6

Ho, C.-C., & MacDorman, K. F. (2010). Revisiting the uncanny valley theory: Developing and validating an alternative to the godspeed indices. *Computers in Human Behavior*, *26*(6), 1508–1518. https://doi.org/10.1016/j.chb.2010.05.015

Hoemann, K., Khan, Z., Feldman, M. J., Nielson, C., Devlin, M., Dy, J., ... Quigley, K. S. (2020). Context-aware experience sampling reveals the scale of variation in affective experience. *Scientific Reports*, *10*(1), 1–16. https://doi.org/10.1038/s41598-020-69180-y

Hoffmann, L., Krämer, N. C., Lam-Chi, A., & Kopp, S. (2009). Media equation revisited: Do users show polite reactions towards an embodied agent? In Z. Ruttkay, M. Kipp, A. Nijholt, & H. Vihljálmsson (Eds.), *Intelligent virtual agents: 9th international conference* (pp. 159–165). https://doi.org/10.1007/978-3-642-04380-2_19

Höflich, J. R., & El Bayed, A. (2015). Perception, acceptance, and the social construction of robots—exploratory studies. In J. Vincent, S. Taipale, B. Sapio, G. Lugano, & L. Fortunati (Eds.), *Social robots from a human perspective* (pp. 39–51). Springer. https://doi.org/10.1007/978-3-319-15672-9_4

Hornbæk, K., & Hertzum, M. (2017). Technology acceptance and user experience: A review of the experiential component in hci. *ACM Transactions on Computer-Human Interaction*, *24*(5), 1–30. https://doi.org/10.2307/25148660

Howell, R. T., Kern, M. L., & Lyubomirsky, S. (2007). Health benefits: Meta-analytically determining the impact of well-being on objective health outcomes. *Health Psychology Review*, *1*(1), 83–136. https://doi.org/10.1080/17437190701492486

Hu, L.-t., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, *6*(1), 1–55. https://doi.org/10.1080/10705519909540118

Iivari, N., Kinnula, M., Kuure, L., & Keisanen, T. (2020). "arseing around was fun!"–humor as a resource in design and making. In R. Bernhaupt, F. Mueller, D. Verweij, & J. Andres (Eds.), *Proceedings of the 2020 chi conference on human factors in computing systems* (pp. 1–13). https://doi.org/10.1145/3313831.3376169

Ikeda, S., Ikeda, A., Yamagishi, K., Hori, M., Kubo, S., Sata, M., ... others (2021). Longitudinal trends in blood pressure associated with the frequency of laughter: The circulatory risk in communities study (circs), a longitudinal study of the japanese general population. *Journal of Epidemiology*, *31*(2), 125–131. https://doi.org/10.2188/jea.JE20190140

Imlawi, J., & Gregg, D. (2014). Engagement in online social networks: The impact of self-disclosure and humor. *International Journal of Human-Computer Interaction*, *30*(2), 106–125. https://doi.org/10.1080/10447318.2013.839901

Isen, A. M. (2008). Some ways in which positive affect influences decision making and problem solving. In M. Lewis, J. M. Haviland-Jones, & L. F. Barret (Eds.), *Handbook of emotions* (Vol. 3, pp. 548–573). The Guilford Press.

Jalali, S., Kheirkhah, F., Ahmadi, H., Seifi Zarei, B., et al. (2008). Effect of laughter therapy on blood pressure patients with essential hypertension. *Journal of Babol University of Medical Sciences*, *10*(5), 35–40.

Jemmi Priya, J. (2016). *Effectiveness of laughter therapy on blood pressure among patients with hypertension at a selected hospital in kancheepuram district.* (Unpublished doctoral dissertation). Karpaga Vinayaga College of Nursing, Maduranthagam.

Jiang, F., Lu, S., Jiang, T., & Jia, H. (2020). Does the relation between humor styles and subjective well-being vary across culture and age? a meta-analysis. *Frontiers in Psychology*, *11*, 2213. https://doi.org/10.3389/fpsyg.2020.02213

Jones, J. M. (1970). Cognitive factors in the appreciation of humor: A theoretical and experimental analysis. *Dissertation Abstracts International Section A: Humanities and Social Sciencesy*, *31*(6A), 3038.

Jorgensen, T. D., Pornprasertmanit, S., Schoemann, A. M., & Rosseel, Y. (2021). semtools: Useful tools for structural equation modeling [Computer software manual]. Retrieved from `https://cran.r-project.org/package=semTools` (R package version 0.5-4)

Jovanovic, V. (2011). Do humor styles matter in the relationship between personality and subjective well-being? *Scandinavian Journal of Psychology*, *52*(5), 502–507. https://doi.org/10.1111/j.1467-9450.2011.00898.x

Kahneman, D. (2003). A perspective on judgment and choice: mapping bounded rationality. *American psychologist*, *58*(9), 697. https://doi.org/10.1037/0003-066X.58.9.697

Kanji, N., White, A., & Ernst, E. (2006). Autogenic training to reduce anxiety in nursing students: randomized controlled trial. *Journal of Advanced nursing*, *53*(6), 729–735. https://doi.org/10.1111/j.1365-2648.2006.03779.x

Katagiri, Y., Nass, C., & Takeuchi, Y. (2001). Cross-cultural studies of the computers are social actors paradigm: The case of reciprocity. In M. J. Smith, G. Salvendy, D. Harris, & R. Koubek (Eds.), *Usability evaluation and interface design: Cognitive engineering, intelligent agents, and virtual reality* (pp. 1558–1562). Lawrence Erlbaum Mahwah, NJ.

Katz, J. E. (2002). *Machines that become us: The social context of personal communication technology.* Transaction Publishers.

Ke, C., Lou, V. W.-q., Tan, K. C.-k., Wai, M. Y., & Chan, L. L. (2020). Changes in technology acceptance among older people with dementia: The role of social robot engagement. *International Journal of Medical Informatics*, *141*. https://doi.org/10.1016/j.ijmedinf.2020.104241

Keith-Spiegel, P. (1972). Early conceptions of humor: Varieties and issues. In J. Goldstein (Ed.), *The psychology of humor: Theoretical perspectives and empirical issues* (pp. 4–39). Academic Press New York. https://doi.org/10.1016/B978-0-12-288950-9.50007-9

Kelley, K. (2019). Mbess: The mbess r package [Computer software manual]. Retrieved from `https://cran.r-project.org/package=MBESS` (R package version 4.6.0)

Kemp, A., Palmer, E., & Strelan, P. (2019). A taxonomy of factors affecting attitudes towards educational technologies for use with technology acceptance models. *British Journal of Educational Technology*, *50*(5), 2394–2413. https://doi.org/10.1111/bjet.12833

Kerkkänen, P., Kuiper, N. A., & Martin, R. A. (2004). Sense of humor, physical health, and well-being at work: A three-year longitudinal study of finnish police officers. *HUMOR: International Journal of Humor Research*, *17*(1-2), 21–35. https://doi.org/10.1515/humr.2004.006

Keyes, C. L. (2007). Promoting and protecting mental health as flourishing: a complementary strategy for improving national mental health. *American Psychologist*, *62*(2), 95–108. https://doi.org/10.1037/0003-066X.62.2.95

Khalid, H. M., & Helander, M. G. (2006). Customer emotional needs in product design. *Concurrent Engineering*, *14*(3), 197–206. https://doi.org/10.1177/1063293X06068387

Kiefer, R. A. (2008). An integrative review of the concept of well-being. *Holistic Nursing Practice*, *22*(5), 244–252. https://doi.org/10.1097/01.HNP.0000334915.16186.b2

Kim, J., Godfrey, M., & Eys, M. (2022). A double-edged sword: The nature of team comedians in sport teams. *Journal of Applied Sport Psychology*, *34*(1), 204–227. https://doi.org/10.1080/10413200.2020.1759158

King, W. R., & He, J. (2006). A meta-analysis of the technology acceptance model. *Information & Management*, *43*(6), 740–755. https://doi.org/10.1016/j.im.2006.05.003

Koch, S. D. A. (2008). Propiedades psicométricas del cuestionario de estilos de humor (cuestihu): Validación venezolana. *Avances en Medición*, *6*, 71-84. Retrieved from `https://www.humanas.unal.edu.co/lab_psicometria/application/files/6616/0463/3548/VOL_6._Articulo7_Validacin_CUESTIHU_71-84.pdf`

Koestler, A. (1964). *The act of creation: A study of the conscious and unconscious processes of humor, scientific discovery and art.* Mass Market Paperback.

Kok, B. E., Coffey, K. A., Cohn, M. A., Catalino, L. I., Vacharkulksemsuk, T., Algoe, S. B., ... Fredrickson, B. L. (2013). How positive emotions build physical health: Perceived positive social connections account for the upward spiral between positive emotions and vagal tone. *Psychological Science*, *24*(7), 1123–1132. https://doi.org/10.1177/0956797612470827

Kool, V., & Agrawal, R. (2016). Technology and hedonism. In V. Kool & R. Agrawal (Eds.), *Psychology of technology* (pp. 253–304). Springer.

https://doi.org/10.1007/978-3-319-45333-0_6

Kraft, T. L., & Pressman, S. D. (2012). Grin and bear it: The influence of manipulated facial expression on the stress response. *Psychological Science*, *23*(11), 1372–1378. https://doi.org/10.1177/0956797612445312

Kreibig, S. D. (2010). Autonomic nervous system activity in emotion: A review. *Biological Psychology*, *84*(3), 394–421. https://doi.org/10.1016/j.biopsycho.2010.03.010

Kret, M. E., Venneker, D., Evans, B., Samara, I., & Sauter, D. (2021). The ontogeny of human laughter. *Biology Letters*, *17*(9), 20210319. https://doi.org/10.1098/rsbl.2021.0319

Kuiper, N. A., & McHale, N. (2009). Humor styles as mediators between self-evaluative standards and psychological well-being. *The Journal of Psychology*, *143*(4), 359–376. https://doi.org/10.3200/JRLP.143.4.359-376

Kulic, D., & Croft, A., E. (2007). Affective state estimation for human–robot interaction. *IEEE transactions on robotics*, *23*(5), 991–1000. https://doi.org/10.1109/TRO.2007.904899

Kurtz, L. E., & Algoe, S. B. (2017). When sharing a laugh means sharing more: Testing the role of shared laughter on short-term interpersonal consequences. *Journal of Nonverbal Behavior*, *41*, 45–65. https://doi.org/10.1007/s10919-016-0245-9

Lacey, C., & Caudwell, C. (2019). Cuteness as a 'dark pattern'in home robots. In J. Kim, D. Sirkin, A. Tapus, M. Jung, & S. Kwak (Eds.), *2019 14th acm/ieee international conference on human-robot interaction (hri)* (pp. 374–381). https://doi.org/10.1109/HRI.2019.8673274

Lackner, H. K., Weiss, E. M., Hinghofer-Szalkay, H., & Papousek, I. (2014). Cardiovascular effects of acute positive emotional arousal. *Applied Psychophysiology and Biofeedback*, *39*(1), 9–18. https://doi.org/10.1007/s10484-013-9235-4

La Fave, L. (1961). *Humor judgments as a function of reference groups* (Unpublished doctoral dissertation). The University of Oklahoma.

LaFave, L. (1972). Humor judgments as a function of reference groups and identification classes. In J. Goldstein (Ed.), *The psychology of humor: Theoretical perspectives and empirical issues* (pp. 195–210). Academic Press New York, NY.

LaFrance, M. (1983). Felt versus feigned funniness: Issues in coding smiling and laughing. In P. McGhee & J. Goldstein (Eds.), *Handbook of humor research: Volume 1: Basic issues* (pp. 1–12). Springer. https://doi.org/10.1007/978-1-4612-5572-7_1

LaFrance, M., & Woodzicka, J. A. (1998). No laughing matter: Women's verbal and nonverbal reactions to sexist humor. In J. K. Swim & C. Stangor (Eds.), *Prejudice: The target's perspective* (pp. 61–80). Academic Press. https://doi.org/10.1016/B978-012679130-3/50038-7

Lang, H., Klepsch, M., Nothdurft, F., Seufert, T., & Minker, W. (2013). Are computers still social actors? In W. Mackay, S. Brewster, & S. Bodker (Eds.), *Chi ea '13: Chi '13 extended abstracts on human factors in computing systems* (pp. 859–864).

https://doi.org/10.1145/2468356.2468510

Lapierre, S. S., Baker, B. D., & Tanaka, H. (2019). Effects of mirthful laughter on pain tolerance: A randomized controlled investigation. *Journal of Bodywork and Movement Therapies*, *23*(4), 733–738. https://doi.org/10.1016/j.jbmt.2019.04.005

Law, M. M., Broadbent, E. A., & Sollers, J. J. (2018). A comparison of the cardiovascular effects of simulated and spontaneous laughter. *Complementary Therapies in Medicine*, *37*, 103–109. https://doi.org/10.1016/j.ctim.2018.02.005

Lee, J.-E. R., & Nass, C. I. (2010). Trust in computers: The computers-are-social-actors (casa) paradigm and trustworthiness perception in human-computer communication. In D. Latusek & A. Gerbasi (Eds.), *Trust and technology in a ubiquitous modern environment: Theoretical and methodological perspectives* (pp. 1–15). IGI Global. https://doi.org/10.4018/978-1-61520-901-9.ch001

Lee, K.-M., & Nass, C. (2009). Social-psychological origins of feelings of presence: Creating social presence with machine-generated voices. *Media Psychology*, *7*(1), 31–45. https://doi.org/10.1207/S1532785XMEP0701_2

Lee, K. M., Peng, W., Jin, S.-A., & Yan, C. (2006). Can robots manifest personality?: An empirical test of personality recognition, social responses, and social presence in human–robot interaction. *Journal of Communication*, *56*(4), 754–772. https://doi.org/10.1111/j.1460-2466.2006.00318.x

Lee, L. C., & Hao, K. C. (2015). Designing and evaluating digital game-based learning with the arcs motivation model, humor, and animation. *International Journal of Technology and Human Interaction (IJTHI)*, *11*(2), 80–95. https://doi.org/10.4018/ijthi.2015040105

Lee, Y., Kozar, K. A., & Larsen, K. R. (2003). The technology acceptance model: Past, present, and future. *Communications of the Association for Information Systems*, *12*(1), 50.

Lefcourt, H. M., Davidson-Katz, K., & Kueneman, K. (1990). Humor and immune-system functioning. *HUMOR: International Journal of Humor Research*, *3*(3), 305–321. https://doi.org/10.1515/humr.1990.3.3.305

Legris, P., Ingham, J., & Collerette, P. (2003). Why do people use information technology? a critical review of the technology acceptance model. *Information & Management*, *40*(3), 191–204. https://doi.org/10.1016/S0378-7206(01)00143-4

Lehmann-Willenbrock, N., & Allen, J. A. (2014). How fun are your meetings? investigating the relationship between humor patterns in team interactions and team performance. *Journal of Applied Psychology*, *99*(6), 1278–1287. https://doi.org/10.1037/a0038083

Leite, I., Martinho, C., & Paiva, A. (2013). Social robots for long-term interaction: a survey. *International Journal of Social Robotics*, *5*, 291–308. https://doi.org/10.1007/s12369-013-0178-y

Lemon, J. (2006). Plotrix: A package in the red light district of r. *R-News*, *6*(4), 8–12. Retrieved from `https://www.r-project.org/doc/Rnews/Rnews%7B/_%7D2006-4.pdf`

L. Fredrickson, B., & Levenson, R. W. (1998). Positive emotions speed recovery from the cardiovascular sequelae of negative emotions. *Cognition & Emotion*, *12*(2), 191–220. https://doi.org/10.1080/026999398379718

Lipponen, A., J, & Tarvainen, P., M. (2019). A robust algorithm for heart rate variability time series artefact correction using novel beat classification. *Journal of Medical Engineering & Technology*, *43*(3), 173–181. https://doi.org/10.1080/03091902.2019.1640306

Low, C. A., Salomon, K., & Matthews, K. A. (2009). Chronic life stress, cardiovascular reactivity, and subclinical cardiovascular disease in adolescents. *Psychosomatic Medicine*, *71*(9), 927–931. https://doi.org/10.1097/PSY.0b013e3181ba18ed

Luevano, V. X., Pablo, J. N., Velazquez, M. L., Chance, B., & Ramirez, B. (2021). Attachment as a predictor of attraction to humor styles. *Personality and Individual Differences*, *173*, 110634. https://doi.org/10.1016/j.paid.2021.110634

Lüdecke, D. (2019). sjstats: Statistical functions for regression models [Computer software manual]. Retrieved from `https://doi.org/10.5281/zenodo.1284472` (R package version 0.17.3) 10.5281/zenodo.1284472

Madden, T. J., Ellen, P. S., & Ajzen, I. (1992). A comparison of the theory of planned behavior and the theory of reasoned action. *Personality and Social Psychology Bulletin*, *18*(1), 3–9. https://doi.org/10.1002/nur.4770180205

Maki, S. M., Booth-Butterfield, M., & McMullen, A. (2012). Does our humor affect us?: An examination of a dyad's humor orientation. *Communication Quarterly*, *60*(5), 649–664. https://doi.org/10.1080/01463373.2012.723670

Marangunić, N., & Granić, A. (2015). Technology acceptance model: A literature review from 1986 to 2013. *Universal Access in the Information Society*, *14*(1), 81–95. https://doi.org/10.1007/s10209-014-0348-1

Martin, G. N., & Sullivan, E. (2013). Sense of humor across cultures: A comparison of british, australian and american respondents. *North American Journal of Psychology*, *15*(2), 375–384. https://doi.org/10.3389/fpsyg.2016.01495

Martin, L. R., Friedman, H. S., Tucker, J. S., Tomlinson-Keasey, C., Criqui, M. H., & Schwartz, J. E. (2002). A life course perspective on childhood cheerfulness and its relation to mortality risk. *Personality and Social Psychology Bulletin*, *28*(9), 1155–1165. 10.1177/014616720228120

Martin, R. A. (1998). Approaches to the sense of humor: A historical review. In W. Ruch (Ed.), *The sense of humor: Explorations of a personality characteristic* (p. 15-60). Walter de Gruyter & Co. https://doi.org/10.1515/9783110804607.15

Martin, R. A., & Ford, T. (2018). *The psychology of humor: An integrative approach.* Academic press.

Martin, R. A., Kuiper, N. A., Olinger, L. J., & Dance, K. A. (1993). Humor, coping with stress, self-concept, and psychological well-being. *HUMOR: International Journal of Humor Research*, *6*(1), 89–104. https://doi.org/10.1515/humr.1993.6.1.89

Martin, R. A., & Lefcourt, H. M. (1984). Situational humor response questionnaire: Quantitative measure of sense of humor. *Journal of Personality and Social Psychology*, *47*(1), 145–155. https://doi.org/10.1037/0022-3514.47.1.145

Martin, R. A., Puhlik-Doris, P., Larsen, G., Gray, J., & Weir, K. (2003). Individual differences in uses of humor and their relation to psychological well-being: Development of the humor styles questionnaire. *Journal of Research in Personality*, *37*(1), 48–75. https://doi.org/10.1016/S0092-6566(02)00534-2

Marziali, E., McDonald, L., & Donahue, P. (2008). The role of coping humor in the physical and mental health of older adults. *Aging and Mental Health*, *12*(6), 713–718. https://doi.org/10.1080/13607860802154374

Mathieson, K. (1991). Predicting user intentions: comparing the technology acceptance model with the theory of planned behavior. *Information Systems Research*, *2*(3), 173–191. https://doi.org/10.1287/isre.2.3.173

McCartney Matthews, M. L. (2011). *A funny thing happened on the way to the hippocampus: The effects of humor on student achievement and memory retention* (Unpublished doctoral dissertation). Arizona State University.

McDowell, I. (2006). *Measuring health: A guide to rating scales and questionnaires*. Oxford University Press, USA.

McGee, E., & Shevlin, M. (2009). Effect of humor on interpersonal attraction and mate selection. *The Journal of Psychology*, *143*(1), 67–77. https://doi.org/10.3200/JRLP.143.1.67-77

McGhee, P. E., & Frank, M. (2014). *Humor and children's development: A guide to practical applications*. Routledge.

McGuinness, L. A., & Higgins, J. P. (2021). Risk-of-bias visualization (robvis): An r package and shiny web app for visualizing risk-of-bias assessments. *Research synthesis methods*, *12*(1), 55–61. https://doi.org/10.1002/jrsm.1411

Mendiburo-Seguel, A., Páez, D., & Martínez-Sánchez, F. (2015). Humor styles and personality: A meta-analysis of the relation between humor styles and the big five personality traits. *Scandinavian Journal of Psychology*, *56*(3), 335–340. https://doi.org/10.1111/sjop.12209

Menne, I. M., Lange, B. P., & Unz, D. C. (2018). My humorous robot: Effects of a robot telling jokes on perceived intelligence and liking. In J. Kim, D. Sirkin, A. Tapus, M. Jung, & S. Kwak (Eds.), *Hri '18: Companion of the 2018 acm/ieee international conference on human-robot interaction* (pp. 193–194). https://doi.org/10.1145/3173386.3177015

Mesmer-Magnus, J., Glew, D. J., & Viswesvaran, C. (2012). A meta-analysis of positive humor in the workplace. *Journal of Managerial Psychology*, *27*(2), 155–190.

https://doi.org/10.1108/02683941211199554

Meyer, J. C. (2000). Humor as a double-edged sword: Four functions of humor in communication. *Communication Theory*, *10*(3), 310–331. https://doi.org/10.1111/j.1468-2885.2000.tb00194.x

Mihalcea, R., & Strapparava, C. (2005, October). Making computers laugh: Investigations in automatic humor recognition. In *Proceedings of human language technology conference and conference on empirical methods in natural language processing* (pp. 531–538).

Miller, M., & Fry, W. F. (2009). The effect of mirthful laughter on the human cardiovascular system. *Medical Hypotheses*, *73*(5), 636–639. https://doi.org/10.1016/j.mehy.2009.02.0445

Minsky, M. (2007). *The emotion machine: Commonsense thinking, artificial intelligence, and the future of the human mind*. Simon and Schuster.

Mirnig, N., Stadler, S., Stollnberger, G., Giuliani, M., & Tscheligi, M. (2016). Robot humor: How self-irony and schadenfreude influence people's rating of robot likability. In S. Okita, B. Mutlu, & T. Shibata (Eds.), *2016 25th ieee international symposium on robot and human interactive communication (ro-man)* (pp. 166–171). https://doi.org/10.1109/ROMAN.2016.7745106

Mirnig, N., Stollnberger, G., Giuliani, M., & Tscheligi, M. (2017). Elements of humor: How humans perceive verbal and non-verbal aspects of humorous robot behavior. In B. Mutlu, M. Tscheligi, A. Weiss, & J. Young (Eds.), *Proceedings of the companion of the 2017 acm/ieee international conference on human-robot interaction* (pp. 211–212). https://doi.org/10.1145/3029798.3038337

Moher, D., Shamseer, L., Clarke, M., Ghersi, D., Liberati, A., Petticrew, M., ... Stewart, L. A. (2015). Preferred reporting items for systematic review and meta-analysis protocols (prisma-p) 2015 statement. *Systematic Reviews*, *4*(1), 1–9. https://doi.org/10.1186/2046-4053-4-1

Moore, T. E., Griffiths, K., & Payne, B. (1987). Gender, attitudes towards women, and the appreciation of sexist humor. *Sex Roles*, *16*(9), 521–531. https://doi.org/10.1007/BF00292486

Mora-Ripoll, R. (2011). Potential health benefits of simulated laughter: A narrative review of the literature and recommendations for future research. *Complementary Therapies in Medicine*, *19*(3), 170–177. https://doi.org/10.1016/j.ctim.2011.05.003

Morreall, J. (2012). Philosophy of humor. In E. Zalta & U. Nodelman (Eds.), *Stanford encyclopedia of philosophy*. Stanford University.

Mulder, M. P., & Nijholt, A. (2002). *Humour research: State of the art*. Citeseer.

Murstein, B. I., & Brust, R. G. (1985). Humor and interpersonal attraction. *Journal of Personality Assessment*, *49*(6), 637–640. https://doi.org/10.3200/JRLP.143.1.67-77

Muthén, B. O. (1983). Latent variable structural equation modeling with categorical data. *Journal of Econometrics*, *22*(1-2), 43–65. https://doi.org/10.1016/0304-4076(83)90093-3

Myers, J. (2003). Exercise and cardiovascular health. *Circulation*, *107*(1), e2–e5. https://doi.org/10.1161/01.CIR.0000048890.59383.8

Müller, L., & Ruch, W. (2011). Humor and strengths of character. *The Journal of Positive Psychology*, *6*(5), 368–376. https://doi.org/10.1080/17439760.2011.594079

Nadal, C., Sas, C., & Doherty, G. (2020). Technology acceptance in mobile health: scoping review of definitions, models, and measurement. *Journal of Medical Internet Research*, *22*(7), e17256. https://doi.org/10.2196/17256

Nagoor, K., & Dudekula, R. (2015). Effect of laughter therapy on blood pressure and pulse rate in south indian population. *International Journal of Health Sciences & Research*, *5*(6), 269–274.

Nasir, U. M., Iwanaga, S., Nabi, A., Urayama, O., Hayashi, K., Hayashi, T., . . . Suzuki, F. (2005). Laughter therapy modulates the parameters of renin-angiotensin system in patients with type 2 diabetes. *International Journal of Molecular Medicine*, *16*(6), 1077–1081.

Nass, C., Fogg, B., & Moon, Y. (1996). Can computers be teammates? *International Journal of Human-Computer Studies*, *45*(6), 669–678. https://doi.org/10.1006/ijhc.1996.0073

Nass, C., & Moon, Y. (2002). Machines and mindlessness: Social responses to computers. *Psychology and Aging*, *56*(1), 81–103. https://doi.org/10.1111/0022-4537.00153

Nass, C., Steuer, J., & Tauber, E. R. (1994). Computers are social actors. In B. Adelson, S. Dumais, & J. Olson (Eds.), *Chi '94: Proceedings of the sigchi conference on human factors in computing systems* (pp. 72–78). https://doi.org/10.1145/191666.191703

Nass, C., Takayama, L., & Brave, S. (2015). Socializing consistency: From technical homogeneity to human epitome. In P. Zhang & D. Galleta (Eds.), *Human-computer interaction and management information systems: Foundations* (pp. 387–406). Routledge. https://doi.org/10.4324/9781315703619

Nemeslaki, A., Aranyossy, M., & Sasvári, P. (2016). Could on-line voting boost desire to vote?–technology acceptance perceptions of young hungarian citizens. *Government Information Quarterly*, *33*(4), 705-714. https://doi.org/10.1016/j.giq.2016.11.003

Nezlek, J. B., & Derks, P. (2001). Use of humor as a coping mechanism, psychological adjustment, and social interaction. *HUMOR: International Journal of Humor Research*, *14*(4), 395–413. https://doi.org/10.1515/humr.2001.011

Niculescu, A., van Dijk, B., Nijholt, A., Li, H., & See, S. L. (2013). Making social robots more attractive: The effects of voice pitch, humor and empathy. *International Journal of Social Robotics*, *5*(2), 171–191. https://doi.org/10.1007/s12369-012-0171-x

Niculescu, A. I., & Banchs, R. E. (2019). Humor intelligence for virtual agents. In L. D'Haro, R. Banchs, & H. Li (Eds.), *9th international workshop on spoken dialogue system technology* (pp. 285–297). https://doi.org/10.1007/978-981-13-9443-0_25

Nijholt, A. (2016). Humor engineering in smart environments. In S. Fukuda (Ed.), *Emotional engineering* (pp. 37–57). Springer.

Nijholt, A. (2018a). From word play to world play: Introducing humor in human-computer interaction. In 1-8 (Ed.), *Ecce '18: Proceedings of the 36th european conference on cognitive ergonomics* (pp. 1–8). https://doi.org/10.1145/3232078.3232239

Nijholt, A. (2018b). Robotic stand-up comedy: State-of-the-art. In *Distributed, ambient and pervasive interactions: Understanding humans: 6th international conference, dapi 2018* (pp. 391–410).

Nijholt, A., Niculescu, A. I., Valitutti, A., & Banchs, R. E. (2017). Humor in human-computer interaction: A short survey. In P. Palanque, J. Gulliksen, & A. Joshi (Eds.), (pp. 527–530). Indian Institute of Technology.

Nikitina, E. A. (2007). Techno-socialization of a human being. In C. Baillie (Ed.), *Abstracts of the workshop on philosophy & engineering* (p. 75). Citeseer.

Noguchi, Y., Kamide, H., & Tanaka, F. (2018). Effects on the self-disclosure of elderly people by using a robot which intermediates remote communication. In J. Cabibihan, F. Mastrogiovanni, A. Pandey, S. Rossi, & M. Staffa (Eds.), *2018 27th ieee international symposium on robot and human interactive communication (ro-man)* (pp. 612–617). https://doi.org/10.1109/ROMAN.2018.852556

Nolan, J., & Plageman, G. (2011–2016). *Person of interest.*

Nomura, T., Suzuki, T., Kanda, T., & Kato, K. (2006). Altered attitudes of people toward robots: Investigation through the negative attitudes toward robots scale. In *Proc. aaai-06 workshop on human implications of human-robot interaction* (Vol. 2006, pp. 29–35).

Norman, D. (2014). *Things that make us smart: Defending human attributes in the age of the machine*. Diversion Books.

Norrick, N. R. (2004). Non-verbal humor and joke performance. *HUMOR: International Journal of Humor Research*, *17*(4), 401–409. https://doi.org/10.1515/humr.2004.17.4.401

Nunes, A., Limpo, T., Lima, C. F., & Castro, S. L. (2018). Short scales for the assessment of personality traits: Development and validation of the portuguese ten-item personality inventory (tipi). *Frontiers in Psychology*, *9*, 461. https://doi.org/10.3389/fpsyg.2018.00461

O'Connell, W. E. (1960). The adaptive functions of wit and humor. *The Journal of Abnormal and Social Psychology*, *61*(2), 263–270. https://doi.org/10.1037/h0047766

O'connell, W. E. (1969). The social aspects of wit and humor. *The Journal of Social Psychology*, *79*(2), 183–187. https://doi.org/10.1080/00224545.1969.9922406

Oliveira, R., & Arriaga, P. (2022). A systematic review of the effects of laughter on blood pressure and heart rate variability. *HUMOR: International Journal of Humor Research*, *35*(2), 135–167. https://doi.org/10.1515/humor-2021-0111

Oliveira, R., Arriaga, P., Axelsson, M., & Paiva, A. (2021). Humor–robot interaction: a scoping review of the literature and future directions. *International Journal of Social Robotics*, *13*(6), 1369–1383. https://doi.org/10.1007/s12369-020-00727-9

Oliveira, R., Arriaga, P., & Barreiros, J. (2023). The role of humor in social, psychological, and physical well-being. *International Journal of Humor Research*(0). https://doi.org/10.1515/humor-2022-0072

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., ... others (2021). The prisma 2020 statement: an updated guideline for reporting systematic reviews. *International Journal of Surgery*, *88*, 105906. https://doi.org/10.1016/j.ijsu.2021.105906

Pan, M. K. X. J., Croft, E. A., & Niemeyer, G. (2018). Evaluating social perception of human-to-robot handovers using the robot social attributes scale (rosas). In T. Kanda, S. Sabanovic, G. Hoffman, & A. Tapus (Eds.), *Hri '18: Proceedings of the 2018 acm/ieee international conference on human-robot interaction* (pp. 443–451). https://doi.org/10.1145/3171221.3171257

Panksepp, J. (2007). Neuroevolutionary sources of laughter and social joy: Modeling primal human laughter in laboratory rats. *Behavioural Brain Research*, *182*(2), 231–244. https://doi.org/10.1016/j.bbr.2007.02.015

Park, E., & Kwon, S. J. (2016). The adoption of teaching assistant robots: A technology acceptance model approach. *Program: Electronic Library and Information Systems*, *50*(4), 354–366. https://doi.org/10.1108/PROG-02-2016-0017

Park, N., Peterson, C., & Seligman, M. E. (2004). Strengths of character and well-being. *Journal of Social and Clinical Psychology*, *23*(5), 603–619. https://doi.org/10.1521/jscp.23.5.603.50748

Park, N., Peterson, C., & Seligman, M. E. (2006). Character strengths in fifty-four nations and the fifty us states. *The journal of positive psychology*, *1*(3), 118–129. https://doi.org/10.1080/17439760600619567

Pee, L. G., Woon, I. M., & Kankanhalli, A. (2008). Explaining non-work-related computing in the workplace: A comparison of alternative models. *Information & Management*, *45*(2), 120–130. https://doi.org/10.1016/j.im.2008.01.004

Pessoa, L. (2008). On the relationship between emotion and cognition. *Nature reviews neuroscience*, *9*(2), 148–158. https://doi.org/10.1038/nrn2317

Peterson, B. G., & Carl, P. (2020). Performanceanalytics: Econometric tools for performance and risk analysis [Computer software manual]. Retrieved from `https://cran.r-project.org/package=PerformanceAnalytics` (R package version 2.0.4)

Peterson, C., Ruch, W., Beermann, U., Park, N., & Seligman, M. E. (2007). Strengths of character, orientations to happiness, and life satisfaction. *The Journal of Positive Psychology*, *2*(3), 149–156. https://doi.org/10.1080/17439760701228938

Phillips, E., Zhao, X., Ullman, D., & Malle, B. F. (2018). What is human-like? decomposing robots' human-like appearance using the anthropomorphic robot (abot) database. In T. Kanda, S. Ŝabanović, G. Hoffman, & A. Tapus (Eds.), *Proceedings of the 2018 acm/ieee international conference on human-robot interaction* (pp. 105–113). https://doi.org/10.1145/3171221.3171268

Piçarra, N., Giger, J.-C., Pochwatko, G., & Gonçalves, G. (2015). Validation of the portuguese version of the negative attitudes towards robots scale. *European Review of Applied Psychology*, *65*(2), 93–104. https://doi.org/10.1016/j.erap.2014.11.002

Pickering, T. G., Hall, J. E., Appel, L. J., Falkner, B. E., Graves, J., Hill, M. N., ... Roccella, E. J. (2005). Recommendations for blood pressure measurement in humans. *Circulation*, *115*(5), 697–716. https://doi.org/10.1161/01.CIR.0000154900.76284.F6.

Plato, Hamilton, E., Cairns, H., & Jowett, B. (1997). *The collected dialogues of plato.* JSTOR.

Polimeni, J., & Reiss, J. P. (2006). The first joke: Exploring the evolutionary origins of humor. *Evolutionary Psychology*, *4*(1). https://doi.org/10.1177/147470490600400129

Poncet, P. (2019). modeest: Mode estimation [Computer software manual]. Retrieved from `https://cran.r-project.org/package=modeest` (R package version 2.4.0)

Provine, R. R. (1992). Contagious laughter: Laughter is a sufficient stimulus for laughs and smiles. *Bulletin of the Psychonomic Society*, *30*(1), 1–4. https://doi.org/10.3758/BF03330380

Provine, R. R. (2004). Laughing, tickling, and the evolution of speech and self. *Current Directions in Psychological Science*, *13*(6), 215–218. https://doi.org/10.1111/j.0963-7214.2004.00311.x

Provine, R. R., & Emmorey, K. (2006). Laughter among deaf signers. *Journal of Deaf Studies and Deaf Education*, *11*(4), 403–409. https://doi.org/10.1093/deafed/enl008

Rampalliwar, S., Rajak, C., & Singh, P. (2016). Can 6-week practice of hasya yoga reduce the cardiovascular hyper-reactivity and other cardiac parameters? *Journal of Pharmaceutical and Biomedical Sciences*, *6*(9).

Ramírez-Correa, P., Grandón, E., & Órdenes, L. (2020). Explaining the use of social network sites as seen by older adults: The enjoyment component of a hedonic information system. *International Journal of Environmental Research and Public Health*, *16*(10), 1673. https://doi.org/10.3390/ijerph16101673

Raskin, V. (2008). *The primer of humor research* (Vol. 8). Walter de Gruyter.

Rato, D., Correia, F., Pereira, A., & Prada, R. (2023). Robots in games. *International Journal of Social Robotics*, *15*(1), 37–57. https://doi.org/10.1007/s12369-022-00944-4

Reyes, A., Rosso, P., & Buscaldi, D. (2009). Evaluating humorous features: Towards a humour taxonomy. In B. Prasad, P. Lingras, & R. Nevatia (Eds.), *Indian international conference on artificial intelligence* (pp. 1373–1390).

Ribeiro, J. P., & Cummins, R. (2008). O bem-estar pessoal: estudo de validação da versão portuguesa da escala. In *Actas do 7º congresso nacional de psicologia da saúde. lisboa: Ispa* (pp. 505–8).

Rizzolo, D., Zipp, G. P., Stiskal, D., Simpkins, S., et al. (2009). Stress management strategies for students: The immediate effects of yoga, humor, and reading on stress. *Journal of College Teaching & Learning*, *6*(8). https://doi.org/10.19030/tlc.v6i8.1117

Robinson, D. T., & Smith-Lovin, L. (2001). Getting a laugh: Gender, status, and humor in task discussions. *Social Forces*, *80*(1), 123–158. https://doi.org/10.3758/BF03330380

Roeckelein, J. E. (2002). *The psychology of humor: A reference guide and annotated bibliography.* Greenwood Press/Greenwood Publishing Group.

Rogers, E. M. (2002). Diffusion of preventive innovations. *Addictive Behaviors*, *27*(6), 989–993. https://doi.org/10.1007/978-3-642-79868-9_2

Rogerson-Revell, P. (2007). Humour in business: A double-edged sword: A study of humour and style shifting in intercultural business meetings. *Journal of Pragmatics*, *39*(1), 4–28. https://doi.org/10.1016/j.pragma.2006.09.005

Romero, E., & Pescosolido, A. (2008). Humor and group effectiveness. *Human relations*, *61*(3), 395–418. https://doi.org/10.1177/0018726708088999

Rosseel, Y. (2012). lavaan: An R package for structural equation modeling. *Journal of Statistical Software*, *48*(2), 1–21. https://doi.org/10.18637/jss.v048.i02

Rothbart, M. K. (1973). Laughter in young children. *Psychological Bulletin*, *80*(3), 247–256. https://doi.org/10.1037/h0034846

RStudio Team. (2021). Rstudio: Integrated development for r [Computer software manual]. Retrieved from `http://www.rstudio.com/` (Version 1.4.1106)

Ruch, W., & Heintz, S. (2016). The german version of the humor styles questionnaire: Psychometric properties and overlap with other styles of humor. *Europe's Journal of Psychology*, *12*(3), 434–441. https://doi.org/10.5964/ejop.v12i3.1116

Ruch, W., & Heintz, S. (2017). Experimentally manipulating items informs on the (limited) construct and criterion validity of the humor styles questionnaire. *Frontiers in Psychology*, *8*, 616. https://doi.org/10.3389/fpsyg.2017.00616

Ruch, W., Heintz, S., Platt, T., Wagner, L., & Proyer, R. T. (2018). Broadening humor: Comic styles differentially tap into temperament, character, and ability. *Frontiers in Psychology*, *9*, 6. https://doi.org/10.3389/fpsyg.2018.000066

Ruch, W., & McGhee, P. E. (2014). Humor intervention programs. In A. C. Parks & S. M. Schueller (Eds.), *The wiley blackwell handbook of positive psychological interventions* (pp. 179–193). Wiley Online Library. https://doi.org/10.1002/9781118315927.ch10

Ruch, W., McGhee, P. E., & Hehl, F.-J. (1990). Age differences in the enjoyment of incongruity-resolution and nonsense humor during adulthood. *Psychology and Aging*, *5*(3), 348. https://doi.org/10.1037/0882-7974.5.3.348

Ruch, W., & Raskin, V. (2008). *Psychology of humor* (No. 8). Mouton de Gruyter.

Ruiz-Padial, E., & Ibáñez-Molina, A. J. (2018). Fractal dimension of eeg signals and heart dynamics in discrete emotional states. *Biological Psychology*, *137*, 42–48. https://doi.org/10.1016/j.biopsycho.2018.06.008

Russell, S. V., Young, C. W., Unsworth, K. L., & Robinson, C. (2017). Bringing habits and emotions into food waste behaviour. *Resources, Conservation and Recycling*, *125*, 107–114. https://doi.org/10.1016/j.resconrec.2017.06.007

Ryff, C. D. (1989). Happiness is everything, or is it? explorations on the meaning of psychological well-being. *Journal of Personality and Social Psychology*, *57*(6), 1069–1081. https://doi.org/10.1037/0022-3514.57.6.1069

Ryu, K. H., Shin, H. S., & Yang, E. Y. (2015). Effects of laughter therapy on immune responses in postpartum women. *The Journal of Alternative and Complementary Medicine*, *21*(12), 781–788. https://doi.org/10.1089/acm.2015.0053

Sackett, A. M., Meyvis, T., Nelson, L. D., Converse, B. A., & Sackett, A. L. (2010). You're having fun when time flies: The hedonic consequences of subjective time progression. *Psychological Science*, *21*(1), 111–117. https://doi.org/10.1177/0956797609354832

Sakurada, K., Konta, T., Watanabe, M., Ishizawa, K., Ueno, Y., Yamashita, H., & Kayama, T. (2020). Associations of frequency of laughter with risk of all-cause mortality and cardiovascular disease incidence in a general population: Findings from the yamagata study. *Journal of Epidemiology*, *30*(4), 188–193. https://doi.org/10.2188/jea.JE20180249

Sakuragi, S., Sugiyama, Y., & Takeuchi, K. (2002). Effects of laughing and weeping on mood and heart rate variability. *Journal of Physiological Anthropology and Applied Human Science*, *21*(3), 159–165. https://doi.org/10.2114/jpa.21.159

Salomi, S., Varanasi, V. R., & Balananda, P. (2018). A cross-sectional study on the role of laughter therapy on regulation of blood pressure in visakhapatnam population. *National Journal of Physiology, Pharmacy and Pharmacology*, *8*(11), 1515–1517. https://doi.org/10.5455/njppp.2018.8.0519312082018

Salovaara, A., & Tamminen, S. (2009). Acceptance or appropriation? a design-oriented critique of technology acceptance models. In H. Isomäki & P. Saariluoma (Eds.), *Future interaction design ii.* London: Springer. https://doi.org/10.1007/978-1-84800-385-9_8

Sampietro, M. (2014). *Use and effects of humor in international teams: A cross country comparison.* EGEA spa.

Savage, B. M., Lujan, H. L., Thipparthi, R. R., & DiCarlo, S. E. (2017). Humor, laughter, learning, and health! a brief review. *Advances in Physiology Education*, *41*(3), 341–347. https://doi.org/10.1152/advan.00030.2017

Schaier, A. H., & Cicirelli, V. G. (1976). Age differences in humor comprehension and appreciation in old age. *Journal of Gerontology*, *31*(5), 577–582. https://doi.org/10.1093/geronj/31.5.577

Schermer, J. A., Papazova, E. B., Kwiatkowska, M. M., Rogoza, R., Park, J., Kowalski, C. M., ... others (2021). Predicting self-esteem using humor styles: A cross-cultural study. In E. Vanderheiden & C. H. Mayer (Eds.), *The palgrave handbook of humour research* (pp. 15–39). Springer. https://doi.org/10.1007/978-3-030-78280-1_2

Schermer, J. A., Rogoza, R., Branković, M., Oviedo-Trespalacios, O., Volkodav, T., Ha, T. T. K., ... others (2022). Humor styles are related to loneliness across 15 countries. *Europe's Journal of Psychology*, *18*(4), 422–436. https://doi.org/10.5964/ejop.5407

Schneider, M., Voracek, M., & Tran, U. S. (2018). "a joke a day keeps the doctor away?" meta-analytical evidence of differential associations of habitual humor styles with mental health. *Scandinavian Journal of Psychology*, *59*(3), 289–300. https://doi.org/10.1111/sjop.12432

Schumacker, R. E., & Lomax, R. G. (2010). *A beginner's guide to structural equation modeling*. New York: Routledge.

Scott, S. K., Lavan, N., Chen, S., & McGettigan, C. (2014). The social life of laughter. *Trends in Cognitive Sciences*, *18*(12), 618–620. https://doi.org/10.1016/j.tics.2014.09.002

Seligman, M. E. P., & Csikszentmihalyi, M. (2000). Positive psychology: An introduction. *American Psychologist*, *55*(1), 279–298. https://doi.org/10.1037/0003-066X.55.1.5

Shaffer, F., & Ginsberg, J. P. (2017). An overview of heart rate variability metrics and norms. *Frontiers in Public Health*, *5*, 258. https://doi.org/10.3389/fpubh.2017.00258

Shaftesbury, A. A. C. (1744). *Sensus communis: An essay on the freedom of wit and humour*. Cambridge University Press.

Sheeran, P., & Taylor, S. (1999). Predicting intentions to use condoms: A meta-analysis and comparison of the theories of reasoned action and planned behavior 1. *Journal of applied social psychology*, *29*(8), 1624–1675. https://doi.org/10.1111/j.1559-1816.1999.tb02045.x

Shin, D.-H., & Choo, H. (2011). Modeling the acceptance of socially interactive robotics: Social presence in human–robot interaction. *Interaction Studies*, *12*(3), 430–460. https://doi.org/10.1075/is.12.3.04shi

Shin, H., & Larson, L. R. (2020). The bright and dark sides of humorous response to online customer complaint. *European Journal of Marketing*, *54*(8), 2013–2047. https://doi.org/10.1108/EJM-08-2018-0522

Shoda, V. P., & Yamanaka, T. (2021). A study on instructional humor: How much humor is used in presentations? *Behavioral Sciences*, *12*(1), 7. https://doi.org/10.3390/bs12010007

Shultz, T. R. (1972). The role of incongruity and resolution in children's appreciation of cartoon humor. *Journal of Experimental Child Psychology*, *13*(3), 456–477. https://doi.org/10.1016/0022-0965(72)90074-4

Shurcliff, A. (1968). Judged humor, arousal, and the relief theory. *Journal of Personality and Social Psychology*, *8*(4, Pt. 1), 360–363. https://doi.org/10.1037/h0025493

Silvia, P. J., & Rodriguez, R. M. (2020). Time to renovate the humor styles questionnaire? an item response theory analysis of the hsq. *Behavioral Sciences*, *10*(11), 173. https://doi.org/10.3390/bs10110173

Simon, H. A. (1991). Bounded rationality and organizational learning. *Organization Science*, *2*(1), 125–134. https://doi.org/10.1287/orsc.2.1.125

Sjöbergh, J., & Araki, K. (2008). Robots make things funnier. In H. Hattori, T. Kawamura, T. Idé, M. Yokoo, & Y. Murakami (Eds.), *New frontiers in artificial intelligence. jsai 2008. lecture notes in computer science* (pp. 306–313). https://doi.org/10.1007/978-3-642-00609-8_27

Smith, W. J., Harrington, K. V., & Neck, C. P. (2000). Resolving conflict with humor in a diversity context. *Journal of Managerial Psychology*, *15*(6), 606–625. https://doi.org/10.1108/02683940010346743

Sok, J., Borges, J. R., Schmidt, P., & Ajzen, I. (2021). Farmer behaviour as reasoned action: a critical review of research with the theory of planned behaviour. *Journal of Agricultural Economics*, *72*(2), 388–412. https://doi.org/10.1111/1477-9552.12408

Solomon, S., & Kernis, M. H. (2006). Self-esteem is central to human well-being. In H. Kernis Michael (Ed.), *Self-esteem issues and answers: A sourcebook of current perspectives* (pp. 254–260). Psychology Press.

Sono, S., Meilani, N. L., Prihyugiarto, T., & Karyanti, Y. (2018). Analysis of the technology acceptance model (tam) on survey system based smartphone by the national population and family planning indonesia. In T. Connie & D. Suwawi (Eds.), *2018 6th international conference on information and communication technology (icoict)* (p. 394-401). https://doi.org/10.1109/ICoICT.2018.8354399

Spatola, N., Belletier, C., Normand, A., Chausse, P., Monceau, S., Augustinova, M., ... Ferrand, L. (2018). Not as bad as it seems: When the presence of a threatening humanoid robot improves human performance. *Science Robotics*, *3*(21), eaat5843. https://doi.org/10.1126/scirobotics.aat5843

Srofe, L. A., & Waters, E. (1976). The ontogenesis of smiling and laughter: A perspective on the organization of development in infancy. *Psychological Review*, *83*(3), 173–189. https://doi.org/10.1037/0033-295X.83.3.173

Steptoe, A., O'Donnell, K., Marmot, M., & Wardle, J. (2008). Positive affect, psychological well-being, and good sleep. *Journal of Psychosomatic Research*, *64*(4), 409–415.

https://doi.org/10.1016/j.jpsychores.2007.11.008

Sterne, J. A., Hernán, M. A., Reeves, B. C., Savović, J., Berkman, N. D., Viswanathan, M., … others (2016). Robins-i: A tool for assessing risk of bias in non-randomised studies of interventions. *BMJ*, *355*. https://doi.org/10.1136/bmj.i4919

Sterne, J. A., Savović, J., Page, M. J., Elbers, R. G., Blencowe, N. S., Boutron, I., … others (2019). Rob 2: A revised tool for assessing risk of bias in randomised trials. *BMJ*, *366*. https://doi.org/10.1136/bmj.l4898

Stieger, S., Formann, A. K., & Burger, C. (2011). Humor styles and their relationship to explicit and implicit self-esteem. *Personality and Individual Differences*, *50*(5), 747–750. https://doi.org/10.1016/j.paid.2010.11.025

Stoll, B., Jung, M. F., & Fussell, S. R. (2018). Keeping it light: Perceptions of humor styles in robot-mediated conflict. In J. Kim, D. Sirkin, A. Tapus, M. Jung, & S. Kwak (Eds.), *Hri '18: Companion of the 2018 acm/ieee international conference on human-robot interaction* (pp. 247–248). https://doi.org/10.1145/3173386.3176996

Strohkorb Sebo, S., Traeger, M., Jung, M., & Scassellati, B. (2018). The ripple effects of vulnerability: The effects of a robot's vulnerable behavior on trust in human-robot teams. In T. Kanda, S. Sabanovic, G. Hoffman, & A. Tapus (Eds.), *Hri '18: Proceedings of the 2018 acm/ieee international conference on human-robot interaction* (pp. 178–186). https://doi.org/10.1145/3171221.3171275

Sucala, M. L., Stefan, S., Szentagotai-Tatar, A., & David, D. (2010). Time flies when you expect to have fun. an experimental investigation of the relationship between expectancies and the perception of time progression. *Cognition, Brain, Behavior*, *14*(3), 231. https://doi.org/10.1177/0956797609354832

Sugawara, J., Tarumi, T., & Tanaka, H. (2010). Effect of mirthful laughter on vascular function. *The American Journal of Cardiology*, *106*(6), 856–859. https://doi.org/10.1016/j.amjcard.2010.05.011

Sullivan, P. J., & Dithurbide, L. (2007). The psychometric properties of the humor styles questionnaire with a sample of athletes. *Journal of Sport & Exercise Psychology*, *29*, 207.

Sully, J. (1902). *An essay on laughter: Its forms, its causes, its development and its value*. Longmans, Green, and Company.

Suls, J. (1983). Cognitive processes in humor appreciation. In P. E. McGhee & J. H. Goldstein (Eds.), *Handbook of humor research* (pp. 39–57). Springer. https://doi.org/10.1007/978-1-4612-5572-7_3

Suls, J. M. (1972). A two-stage model for the appreciation of jokes and cartoons: An information-processing analysis. In J. Goldstein (Ed.), *The psychology of humor: Theoretical perspectives and empirical issues* (Vol. 1, pp. 81–100).

Suoqiao, Q. (2007). Translating 'humor'into chinese culture. *HUMOR: International Journal of Humor Research*, *20*(3), 277–295. https://doi.org/10.1515/HUMOR.2007.014

Surendran, P., et al. (2012). Technology acceptance model: A survey of literature. *International Journal of Business and Social Research*, *2*(4), 175–178. https://doi.org/10.1007/s10209-014-0348-1

Sweeney, J. C., & Soutar, G. N. (2001). Consumer perceived value: The development of a multiple item scale. *Journal of Retailing*, *77*(2), 203–220. https://doi.org/10.1016/S0022-4359(01)00041-0

Tae, M., & Lee, J. (2020). The effect of robot's ice-breaking humor on likeability and future contact intentions. In T. Belpaeme, J. Young, H. Gunes, & L. Riek (Eds.), *Hri '20: Companion of the 2020 acm/ieee international conference on human-robot interaction* (pp. 462–464). https://doi.org/10.1145/3371382.3378267

Taherdoost, H. (2018). A review of technology acceptance and adoption models and theories. *Procedia Manufacturing*, *22*, 960–967. https://doi.org/10.1016/j.promfg.2018.03.137

Talbot, L. A., & Lumden, D. B. (2000). On the association between humor and burnout. *HUMOR: International Journal of Humor Research*, *13*(4), 419–428. https://doi.org/10.1515/humr.2000.13.4.419

Tamilmani, K., Rana, N. P., Prakasam, N., & Dwivedi, Y. K. (2019). The battle of brain vs. heart: A literature review and meta-analysis of "hedonic motivation" use in utaut2. *International Journal of Information Management*, *46*, 222–235. https://doi.org/10.1016/j.ijinfomgt.2019.01.008

Tay, B. T., Low, S. C., Ko, K. H., & Park, T. (2016). Types of humor that robots can play. *Computers in Human Behavior*, *60*, 19–28. https://doi.org/10.1016/j.chb.2016.01.042

Thomas, E. F., McGarty, C., Spears, R., Livingstone, A. G., Platow, M. J., Lala, G., & Mavor, K. (2020). 'that's not funny!'standing up against disparaging humor. *Journal of Experimental Social Psychology*, *86*, 103901. https://doi.org/10.1016/j.jesp.2019.103901

Thorson, J. A., & Powell, F. C. (1993). Development and validation of a multidimensional sense of humor scale. *Journal of Clinical Psychology*, *49*(1), 13–23. https://doi.org/10.1002/1097-4679(199301)49:1<13::AID-JCLP2270490103>3.0.CO;2-S

Toda, N., & Nakanishi-Toda, M. (2011). How mental stress affects endothelial function. *Pflügers Archiv - European Journal of Physiology*, *462*(6), 779–794. 10.1007/s00424-011-1022-6

Todt, D., & Vettin, J. (2005). Human laughter, social play, and play vocalizations of non-human primates: An evolutionary approach. *Behaviour*, *142*(2), 217–240. https://doi.org/10.1163/1568539053627640

Tonkin, M., Vitale, J., Herse, S., Williams, M.-A., Judge, W., & Wang, X. (2018). Design methodology for the ux of hri: A field study of a commercial social robot at an airport. In T. Kanda, S. Sabanovic, G. Hoffman, & A. Tapus (Eds.), *Hri '18: Proceedings of the 2018 acm/ieee international conference on human-robot interaction* (pp. 407–415). https://doi.org/10.2307/25148660

Torrent-Sellens, J., Salazar-Concha, C., Ficapal-Cusí, P., & Saigí-Rubío, F. (2021). Using digital platforms to promote blood donation: Motivational and preliminary evidence from latin america and spain. *International Journal of Environmental Research and Public Health*, *18*(8), 4270. https://doi.org/10.3390/ijerph18084270

Tourinho, A., & de Oliveira, B. (2020). Time flies when you are having fun: Cognitive absorption and beliefs about social media usage. *AIS Transactions on Replication Research*, *5*(1), 4. https://doi.org/10.17705/1atrr.00036

Triandis, H. C. (1977). *Interpersonal behavior.* Brooks/Cole Publishing Company.

Triandis, H. C. (1979). Values, attitudes, and interpersonal behavior. In *Nebraska symposium on motivation* (Vol. 27, pp. 195–259). University of Nebraska Press.

Triebel, R., Arras, K., Alami, R., Beyer, L., Breuers, S., Chatila, R., ... others (2016). Spencer: A socially aware service robot for passenger guidance and help in busy airports. In D. Wettergreen & T. Barfoot (Eds.), *Field and service robotics* (pp. 607–622). https://doi.org/10.1007/978-3-319-27702-8_40

Trudel-Fitzgerald, C., Tworoger, S. S., Poole, E. M., Williams, D. R., & Kubzansky, L. D. (2016). Prospective changes in healthy lifestyle among midlife women: When psychological symptoms get in the way. *American Journal of Preventive Medicine*, *51*(3), 327–335. https://doi.org/10.1016/j.amepre.2016.04.021

Tsang, S., Royse, C. F., & Terkawi, A. S. (2017). Guidelines for developing, translating, and validating a questionnaire in perioperative and pain medicine. *Saudi Journal of Anaesthesia*, *11*(Suppl 1), S80. https://doi.org/10.4103/sja.SJA_203_17

United Nations General Assembly. (2015). *Transforming our world: The 2030 agenda for sustainable development.* Retrieved from `https://sustainabledevelopment.un.org/post2015/transformingourworld`

Unknown. (n.d.). *Unknown Title.* `https://inimoose.tumblr.com/post/725532861668655104/this-morning-nasa-abandoned-their-mars-rover/amp`. (Accessed: 28/11/2023)

Vallerand, R. J. (1997). Toward a hierarchical model of intrinsic and extrinsic motivation. In M. Zanna (Ed.), *Advances in experimental social psychology* (Vol. 29, pp. 271–360). Elsevier. https://doi.org/10.1016/S0065-2601(08)60019-2

van der Wal, C. N., & Kok, R. N. (2019). Laughter-inducing therapies: Systematic review and meta-analysis. *Social Science & Medicine*, *232*, 473–488. https://doi.org/10.1016/j.socscimed.2019.02.018

Vásquez, C., & Aslan, E. (2021). "cats be outside, how about meow": Multimodal humor and creativity in an internet meme. *Journal of Pragmatics*, *171*, 101–117. https://doi.org/10.1016/j.pragma.2020.10.006

Venkatesh, V. (2000). Determinants of perceived ease of use: Integrating control, intrinsic motivation, and emotion into the technology acceptance model. *Information Systems Research*, *11*(4), 342–365. https://doi.org/10.1287/isre.11.4.342.11872

Venkatesh, V., & Bala, H. (2008). Technology acceptance model 3 and a research agenda on interventions. *Decision Sciences*, *39*(2), 273–315. https://doi.org/10.1111/j.1540-5915.2008.00192.x

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science*, *46*(2), 186–204. https://doi.org/10.1287/mnsc.46.2.186.11926

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, *27*(3), 425–478. https://doi.org/10.2307/30036540

Venkatesh, V., Thong, J. Y., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly*, *36*(1), 157–178. https://doi.org/10.2307/41410412

Venkatesh, V., Thong, J. Y., & Xu, X. (2016). Unified theory of acceptance and use of technology: A synthesis and the road ahead. *Journal of the Association for Information Systems*, *17*(5), 328–376. https://doi.org/10.17705/1jais.00428

Vettin, J., & Todt, D. (2004). Laughter in conversation: Features of occurrence and acoustic structure. *Journal of Nonverbal Behavior*, *28*(2), 93–115. https://doi.org/10.1023/B:JONB.0000023654.73558.72

Vilaro, M. J., Wilson-Howard, D. S., Zalake, M. S., Tavassoli, F., Lok, B. C., Modave, F. P., … Krieger, J. L. (2021). Key changes to improve social presence of a virtual health assistant promoting colorectal cancer screening informed by a technology acceptance model. *BMC Medical Informatics and Decision Making*, *21*(1), 196. https://doi.org/10.1186/s12911-021-01543-z

Vlachopoulos, C., Xaplanteris, P., Alexopoulos, N., Aznaouridis, K., Vasiliadou, C., Baou, K., … Stefanadis, C. (2009). Divergent effects of laughter and mental stress on arterial stiffness and central hemodynamics. *Psychosomatic Medicine*, *71*(4), 446–453. https://doi.org/10.1097/PSY.0b013e318198dcd4

Vladisavljević, M., & Mentus, V. (2019). The structure of subjective well-being and its relation to objective well-being indicators: evidence from eu-silc for serbia. *Psychological reports*, *122*(1), 36–60. https://doi.org/10.1177/0033294118756335

Walsh, T., Varsaluoma, J., Kujala, S., Nurkka, P., Petrie, H., & Power, C. (2014). Axe ux: Exploring long-term user experience with iscale and attrakdiff. In A. Lugmayr (Ed.), *Academicmindtrek '14: Proceedings of the 18th international academic mindtrek conference: Media business, management, content & services* (pp. 32–39). https://doi.org/10.1145/2676467.2676480

Wang, W. (2017). Smartphones as social actors? social dispositional factors in assessing anthropomorphism. *Computers in Human Behavior*, *68*, 334–344.

https://doi.org/10.1016/j.chb.2016.11.022

Wang, X., & Goh, D. H.-L. (2017). Video game acceptance: A meta-analysis of the extended technology acceptance model. *Cyberpsychology, Behavior, and Social Networking*, *20*(11), 662–671. https://doi.org/10.1089/cyber.2017.0086

Wang, Y. (2020). Humor and camera view on mobile short-form video apps influence user experience and technology-adoption intent, an example of tiktok (douyin). *Computers in Human Behavior*, *110*, 106373. https://doi.org/10.1016/j.chb.2020.106373

Wang, Y.-C., Chiang, S.-T., Chiang, H.-l., Huang, G.-S., Gao, R.-X., & Chang, Y.-W. (2020). The benefits of laughing quigong on the perceived stress and heart rate. *Archives of Clinical and Biomedical Research*, *4*, 130–144.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The panas scales. *Journal of Personality and Social Psychology*, *54*(6), 1063–1070. https://doi.org/10.1037/0022-3514.54.6.1063

Weber, K., Ritschel, H., Aslan, I., Lingenfelser, F., & André, E. (2018). How to shape the humor of a robot-social behavior adaptation based on reinforcement learning. In S. D'Mello, G. Panayotis, S. Scherer, E. Provost, M. Soleymani, & M. Worsley (Eds.), *Icmi '18: Proceedings of the 20th acm international conference on multimodal interaction* (pp. 154–162). https://doi.org/10.1145/3242969.3242976

Weber, M., & Quiring, O. (2019). Is it really that funny? laughter, emotional contagion, and heuristic processing during shared media use. *Media Psychology*, *22*(2), 173–195. https://doi.org/10.1080/15213269.2017.1302342

Weiss, A., & Bartneck, C. (2015). Meta analysis of the usage of the godspeed questionnaire series. In Y. Nakauchi & M. Imai (Eds.), *2015 24th ieee international symposium on robot and human interactive communication (ro-man)* (p. 381-388). https://doi.org/10.1109/ROMAN.2015.7333568

Wellenzohn, S., Proyer, R. T., & Ruch, W. (2018). Who benefits from humor-based positive psychology interventions? the moderating effects of personality traits and sense of humor. *Frontiers in Psychology*, *9*, 821. https://doi.org/10.3389/fpsyg.2018.00821

Wendt, C. S., & Berg, G. (2009). Nonverbal humor as a new dimension of hri. In *Roman 2009 - the 18th ieee international symposium on robot and human interactive communication,* (pp. 183–188). https://doi.org/10.1109/ROMAN.2009.5326230

Wickberg, D. (1998). *The senses of humor: Self and laughter in modern america.* Cornell University Press.

Wilkins, J., & Eisenbraun, A. J. (2009). Humor theories and the physiological benefits of laughter. *Holistic Nursing Practice*, *23*(6), 349–354. https://doi.org/10.1097/HNP.0b013e3181bf37ad

Williams, M., & Emich, K. J. (2014). The experience of failed humor: Implications for interpersonal affect regulation. *Journal of Business and Psychology*, *29*, 651–668.

https://doi.org/10.1007/s10869-014-9370-9

Williams, M. D., Rana, N. P., & Dwivedi, Y. K. (2015). The unified theory of acceptance and use of technology (utaut): A literature review. *Journal of Enterprise Information Management*, *28*(3), 443–488. https://doi.org/10.1108/JEIM-09-2014-0088

Woo, H., LeTendre, G. K., Pham-Shouse, T., & Xiong, Y. (2021). The use of social robots in classrooms: A review of field-based studies. *Educational Research Review*, *33*, 100388. https://doi.org/10.1016/j.edurev.2021.100388

Wood, A., & Niedenthal, P. (2018). Developing a social functional account of laughter. *Social and Personality Psychology Compass*, *12*(4), e12383. https://doi.org/10.1111/spc3.12383

Wrench, J. S., & McCroskey, J. C. (2001). A temperamental understanding of humor communication and exhilaratability. *Communication Quarterly*, *49*(2), 142–159. https://doi.org/10.1080/01463370109385622

Wu, J., & Du, H. (2012). Toward a better understanding of behavioral intention and system usage constructs. *European Journal of Information Systems*, *21*(6), 680–698. https://doi.org/10.1057/ejis.2012.15

Wu, W.-Y., & Ke, C.-C. (2015). An online shopping behavior model integrating personality traits, perceived risk, and technology acceptance. *Social Behavior and Personality: An International Journal*, *43*(1), 85–97. https://doi.org/10.2224/sbp.2015.43.1.85

Yan, T., Conrad, F. G., Tourangeau, R., & Couper, M. P. (2011). Should i stay or should i go: The effects of progress feedback, promised task duration, and length of questionnaire on completing web surveys. *International Journal of Public Opinion Research*, *23*(2), 131-147. https://doi.org/10.1093/ijpor/edq046

Yang, H., Xu, H., Zhang, Y., Liang, Y., & Lyu, T. (2022). Exploring the effect of humor in robot failure. *Annals of Tourism Research*, *95*, 103425. https://doi.org/10.1016/j.annals.2022.10342

Yannakis, N., G, Hallam, J., & Lund, H., H. (2008). Entertainment capture through heart rate activity in physical interactive playgrounds. *User Modeling and User-Adapted Interaction*, *18*(1), 207–243. https://doi.org/10.1007/s11257-007-9036-7

Yim, B. H., & Byon, K. K. (2021). Validation of the sport fan model of goal-directed behavior: Comparison to theory of reasoned action, theory of planned behavior, and model of goal-directed behavior. *Journal of Global Sport Management*, *6*(4), 388–408. https://doi.org/10.1080/24704067.2020.1765699

Yim, J. (2016). Therapeutic benefits of laughter in mental health: a theoretical review. *The Tohoku Journal of Experimental Medicine*, *239*(3), 243–249. https://doi.org/10.1620/tjem.239.243

Yoder, M. A., & Haude, R. H. (1995). Sense of humor and longevity: older adults' self-ratings compared with ratings for deceased siblings. *Psychological Reports*, *76*(3), 945–946. https://doi.org/10.2466/pr0.1995.76.3.945

Yovetich, N. A., Dale, J. A., & Hudak, M. A. (1990). Benefits of humor in reduction of threat-induced anxiety. *Psychological Reports*, *66*(1), 51–58. https://doi.org/10.2466/pr0.1990.66.1.51

Yu, J.-A., & Kim, K.-S. (2009). Effects of laughter therapy on stress response and pain of military personnel with low back pain in hospital. *Journal of Muscle and Joint Health*, *16*(1), 36–45.

Yue, X., Jiang, F., Lu, S., & Hiranandani, N. (2016). To be or not to be humorous? cross cultural perspectives on humor. *Frontiers in Psychology*, *7*, 1495. https://doi.org/10.3389/fpsyg.2016.01495

Yue, X. D., Liu, K. W.-Y., Jiang, F., & Hiranandani, N. A. (2014). Humor styles, self-esteem, and subjective happiness. *Psychological Reports*, *115*(2), 517–525. https://doi.org/10.2466/07.02.PR0.115c18z6

Yuen, K. F., Cai, L., Qi, G., & Wang, X. (2021). Factors influencing autonomous vehicle adoption: An application of the technology acceptance model and innovation diffusion theory. *Technology Analysis & Strategic Management*, *33*(5), 505–519. https://doi.org/10.1080/09537325.2020.1826423

Yun, O. B., Kim, S.-J., & Jung, D. (2015). Effects of a clown–nurse educational intervention on the reduction of postoperative anxiety and pain among preschool children and their accompanying parents in south korea. *Journal of Pediatric Nursing*, *30*(6), e89–e99. https://doi.org/10.1016/j.pedn.2015.03.003

Zhang, M., Gursoy, D., Zhu, Z., & Shi, S. (2021). Impact of anthropomorphic features of artificially intelligent service robots on consumer acceptance: moderating role of sense of humor. *International Journal of Contemporary Hospitality Management*, *33*(12), 3883–3905. https://doi.org/10.1108/IJCHM-11-2020-1256

Zhao, J., Wang, Y., & Kong, F. (2014). Exploring the mediation effect of social support and self-esteem on the relationship between humor style and life satisfaction in chinese college students. *Personality and Individual Differences*, *64*, 126–130. https://doi.org/10.1016/j.paid.2014.02.02

Zillmann, D., & Cantor, J. R. (1972). Directionality of transitory dominance as a communication variable affecting humor appreciation. *Journal of Personality and Social Psychology*, *24*(2), 191–211. https://doi.org/10.1037/h0033384

Ziv, A. (2010). The social function of humor in interpersonal relationships. *Society*, *47*(1), 11–18. https://doi.org/10.1007/s12115-009-9283-9

Zucker, A., & Le Feuvre, C. (2021). *Ancient and medieval greek etymology: Theory and practice i* (Vol. 111). Walter de Gruyter GmbH & Co KG.

APPENDIX A

Appendix

Table A.1. Comparison of blood pressure (S- Systolic; D - Diastolic) levels using repeated measures after a laughter inducing intervention and between intervention groups and control groups.

Study	Laughter	Intervention				Control			
		Pre		Post		Pre		Post	
		S (M ± SD)	D (M ± SD)	S (M ± SD)	D (M ± SD)	S (M ± SD)	D (M ± SD)	S (M ± SD)	D (M ± SD)
Jemmi Priya (2016)	Simulated	144.52 ± 5.37	94.52 ± 2.93	126.8 ± 5.17	82.88 ± 3.13				
Jalali et al. (2008)**	Spontaneous	151.9 ± 6.3	86.7 ± 11	137.2 ± 4.2	79.7 ± 9.5				
Eshg et al. (2017)**	Spontaneous	136 ± 18.6	80.8 ± 7.3	119 ± 18.8	74.3 ± 7.8				
Hasan and Saritas (2020)	Spontaneous	132.25 ± 18.96	83.61 ± 14.04	128.15 ± 15.57	79.77 ± 11.63	128.63 ± 16.07	80.88 ± 9.93	127.47 ± 14.38	78.97 ± 9.24
Nasir et al. (2005)	Spontaneous	129 ± 9	76 ± 6	128 ± 9	73 ± 8				
Salomi et al. (2018)	Simulated	126.37 ± 6.09	79.49 ± 8.29	118.67 ± 5.81	72.96 ± 7.94				
Kasenda and Jael (2016)	Simulated	122.5 ± 9.25	80.75 ± 7.99	114.75 ± 7.69	77.75 ± 7.16	n/a	81.5 ± 7.45	n/a	82.25 ± 7.34
Rampalliwar et al. (2016)	Simulated	124.4 ± 5.25	82.44 ± 2.96	122.9 ± 4.29	76.78 ± 3.57				
Yun et al. (2015) b	Spontaneous	114.00 ± 8.79	75.13 ± 7.74	112.17 ± 6.51	72.83 ± 7.19	115.30 ± 8.97	71.74 ± 8.11	118.37 ± 9.28	75.75 ± 5.83

Nagoor and Dudekula (2015)	Simulated	125.37 ± 6.09	79.49 ± 8.29	119.7 ± 5.62	73.56 ± 8.73				
Berger et al. (2014) b	Spontaneous	126.3 ± 11.7	81.3 ± 8.7	122.7 ± 11.4	80.9 ± 8.7	125.2 ± 18.4	79.3 ± 12.6	122.9 ± 16.2	79.2 ± 10.9
Krebs et al. (2014)	Simulated	133.15 ± 18.94	87.75 ± 12.86	120.65 ± 14.79	81.42 ± 10.9				
Chang et al. (2013)	Simulated	124.34 ± 24.25	78.22 ± 11.1	119.91 ± 14.03	80.22 ± 8.21	112.87 ± 11.97	78.94 ± 8.14	113.19 ± 17.55	76.19 ± 12.29
Sugawara et al. (2010)	Spontaneous	112 ± 2	59 ± 2	110 ± 2	58 ± 2				
Rizzolo et al. (2009)	Spontaneous	113.95 ± 10.03	70.05 ± 7.72	110.45 ± 12.08	65.09 ± 8.83				
Kanji et al. (2006)	Spontaneous	116.5 ± 11.1	75.8 ± 11.6	110.2 ± 12.2	74.4 ± 11.7	110.1 ± 15.5	73.8 ± 12.3	112.6 ± 12.9	73.7 ± 10.2
Boone et al. (2000)	Spontaneous	118 ± 4	78 ± 6	120 ± 6	80 ± 6				
Ellis et al. (2017)	Simulated	137.5 ± 21.4	n/a	133.4 ± 18.1	n/a				
Alcântara et al. (2016)	Spontaneous	112.2 ± 13	71 ± 11.7	116.7 ± 14.9	75 ± 16.7				
Yu and Kim (2009)	Simulated	n/a	n/a	132 ± 17.85	84.71 ± 10.2	n/a	n/a	121.11 ± 11.49	77.37 ± 10.12
Berger et al. (2014) a	Spontaneous	109.6 ± 12.3	63.3 ± 9.1	107.7 ± 9.4	67.6 ± 8.4	115.5 ± 14.7	68.45 ± 11	108.1 ± 12.7	63.3 ± 9.2

Yun et al. (2015) a	Spontaneous	103.78 ± 12.68	64.22 ± 10.99	101.91 ± 10.69	59.62 ± 12.75	107.00 ± 9.54	61.78 ± 12.09	108.52 ± 9.37	60.56 ± 10.09

TABLE A.2. Item loadings for the three sub-dimensions of the RoSAS (warmth, competence and safety) for the original model (including all of the items of the scale) and the final solution.

Original item (translated version)	Initial model			Final model		
	Warmth	Discomfort	Competence	Warmth	Discomfort	Competence
Social (Social)	.75	-.23 -.07		–	–	–
Emotional (Emocional)	.73	-.24 -.41		.90	-.04	.08
Feeling (Sentimental)	.69	-.24 -.45		.86	-.04	-05
Compassionate (Empático)	.68	-.11 -.32		.66	.06	.12
Happy (Feliz)	.68	-.12 -.35		.65	.06	.10
Trustworthy (Merecedor de confiança)	.49	-.45 .06		–	–	–
Knowledgeable (Culto)	.47	.09 .35		–	–	–
Organic (Orgânico)	.40	.13 -.28		–	–	–
Dangerous (Perigoso)	.27	.76 .16		-.01	.85	.03
Scary (Assustador)	.26	.72 .07		.03	.76	-.03
Strange (Estranho)	.11	.70 .18		-.11	.58	.01
Agressive (Agressivo)	.42	.65 .04		.19	.67	.06
Awful (Péssimo)	.35	.57 -.13		–	–	–
Awkward (Constrangedor)	.36	.55 -.09		–	–	–
Capable (Capaz)	.22	-.10 .75		–	–	–
Competent (Competente)	.65	-.26 .70		.17	.05	.98
Responsive (Responsivo)	.39	-.18 .52		.07	.01	.65
Interactive (Interativo)	.37	-.22 .52		.07	.01	.63
KMO = .43; $\chi^2(153) = 2050.60$; p <.001				KMO = .73; χ^2 (55) = 830.14; p <.001		

Notes: These item loadings were calculated through a CFA (Confirmatory Factor Analysis), using Maximum Likelihood extraction and using a Varimax rotation. Loadings superior to .40 are presented in bold. The total variance explained by the original solution is 50.27% (with the factor warmth explaining 18.49%, the factor safety explaining 16.11% and the factor competence explaining 15.34%). The total variance explained by the final solution is 58.17% (with the factor warmth explaining 22.58%, the factor safety explaining 20.77% and the factor competence explaining 18.87%).

TABLE A.3. Item loadings for the three sub-dimensions of the Godspeed scale (perceived likeability, perceived safety and perceived intelligence) for the original model (including all of the items of the scale) and the final solution.

Original item (translated version)	Initial model			Final model		
	Factor 1	Factor 2	Factor 3	Factor 1	Factor 2	Factor 3
Awful (Péssimo)	.79	.29	-.04	.43	.76	.08
Like (Gosto)	.69	.09	.07	.11	.58	.33
Pleasant (Agradável)	.67	.20	.07	.26	.65	.34
Irresponsible (Irresponsável)	.59	.18	.14	.42	.34	.29
Friendly (Amigável)	.56	.27	.29	.22	.30	.65
Nice (Simpático)	.48	.09	.33	.12	.19	.80
Ignorant (Ignorante)	.10	.85	-.14	.66	.25	.002
Incompetent (Incompetente)	.29	.53	.10	.71	.20	.09
Smart (Esperto)	.15	.48	.18	.55	.15	.19
Silly (Pateta)	.06	.41	.28	.67	.09	.09
Passive (Passivo)	.17	.34	.12	–	–	–
Agitated (Agitado)	.14	.14	.69	.48	.14	.29
Anxious (Ansioso)	.16	.09	.61	.49	.18	.15
KMO = .79; χ^2 (78) = 420.07; p <.001				KMO = .85; χ^2 (66) = 806.39; p <.001		

Notes: These item loadings were calculated through a CFA (Confirmatory Factor Analysis), using Maximum Likelihood extraction and using a Varimax rotation. Loadings superior to .40 are presented in bold. The total variance explained by the original solution is 44.61% (with the first factor explaining 29.82%, the second factor explaining 8.20% and the third factor explaining 0.86%). The total variance explained by the final solution is 49.35% (with the first factor explaining 35.84%, the second factor explaining 8.27% and the third factor explaining 5.24%).

TABLE A.5. Bivariate correlations between RoSAs items for women (above the diagonal) and for men (below the diagonal), and the item correlations for pre and post measures over a two-weeks interval (diagonal).

Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

1. Social	.77**	.51**	.49**	.36**	.42**	.001	.24**	.07	.04	.07	.10	.02	.07	.01	.14	.43**	.34**	.27**
2. Emotional	.70**	.75**	.77**	.60**	.50**	.35**	.08	.20*	-.02	-.06	-.13	.06	.04	.15	-.07	.19	.10	.15
3. Feeling	.63**	.80**	.82**	.49**	.47**	.43**	.09	.08	-.04	-.02	-.09	.09	.06	.03	-.10	.22	.18	.08
4. Compassionate	.56**	.57**	.59**	.62**	.45**	.30**	.08	.25*	-.07	.04	-.12	.17	.08	.19	-.03	.17	.04	.14
5. Happy	.64**	.64**	.63**	.59**	.70**	.36*	.05	.07	-.10	-.05	-.31**	.02	.10	.07	-.12	.19	.13	.17
6. Trustworthy	.43**	.40**	.32**	.20	.23*	.58**	.23*	.19	-.20*	-.25*	-.13	-.13	-.01	-.14	.19	.57**	.23*	.17
7. Knowledgable	.31**	.23*	.24**	.36**	.26*	.07	.50**	.06	.12	-.01	.09	.21*	.18	.08	.27**	.64**	.12	.15

8. Organic	.39**	.37**	.44**	.51**	.45**	.16	.19	.59**	.18	.03	.02	-.07	-.02	.17	.001	.08	-.01	.03
9. Dangerous	.08	-.03	-.02	.16	.19	-.15	.23*	.20	.60**	.62**	.31**	.51**	.33**	.31**	.21*	.11	.02	.07
10. Scary	.11	-06	.02	.11	.21	.01	.23*	.25*	.71**	.59**	.37**	.42**	.40**	.30**	-.01	-.08	-.04	.03
11. Strange	-.04	-.06	-.14	-.01	.17	-.18	.13	.15	.59**	.60**	.48**	.33**	.28**	.39**	.04	-.03	-.01	-.11
12. Aggressive	.17	.20	.17	.36**	.35**	-.11	.40**	.34**	.65**	.47**	.56**	.59**	.45**	.25*	.04	.08	.06	.01
13. Awful	.12	.23*	.31**	.19	.33**	.04	.18	.40**	.47**	.38**	.36**	.58**	.63**	.33**	.004	.08	.05	-.02
14. Awkward	.27**	.20	.17	.27*	.33**	-.06	.20	.39**	.48**	.48**	.45**	.38**	.41**	.57**	-.13	.02	.16	.01
15. Capable	.20	-.02	-.11	-.05	-.05	.20	.31**	-.17	.01	.15	.14	.08	-.13	.00	.40**	.57**	.17	.27**

16. Competent	.44**	.24**	.14	.28**	.21	.44**	.57**	.04	.07	.13	.10	.16	-.03	.08	.72**	.37**	.61**	
17. Responsive	.23*	.09	-.01	.08	.10	.12	.14	-.06	.02	.01	.18	-.01	-.06	.06	.41**	.69**	.38**	.62**
18. Interactive	.22*	.06	.02	.24*	.10	.07	.07	.001	.02	-.02	.03	.09	-.09	.02	.40**	.63**	.46**	.46**

Table A.7. Inter-dimensions correlations.

Dimension		RoSAS			Godspeed (1)			Godspeed (2)			NARS	
		Warmth	Discomfort	Competence	Likeability	Safety	Intelligence	Likeability	Safety	Intelligence	NARHT	NATIR
RoSAS	Warmth	–	.04	.21**	-.03	.003	-.17*	-.02	.18*	.19**	-.37**	-.09
	Discomfort		–	.03	-.40**	-.41**	-.33**	-.42**	-.42**	-.29**	.36**	.48**
	Competence			–	.29**	.03	.17*	.30**	.04	.13	-.31**	-.24**
Godspeed (1)	Likeability				–	.45**	.53**	.99**	.42**	.46**	-.54**	-.67**
	Safety					–	.54**	.46**	.84**	.53**	-.18*	-.33**

	Intelligence	–	.60**	.53**	.97**	-.23**	-.35**
Godspeed (2)	Likeability		–	.45**	.50**	-.55**	-.67**
	Safety			–	.50**	-.20**	-.39**
	Intelligence				–	-.16*	-.29 **
NARS	NARHT					–	.63**
	NATIR						–

Table A.4. Bivariate correlations of the items of the RoSAs.

Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 Social	–	.60**	.56**	.46**	.54**	.37**	.27**	.21**	.06	.09	-.11	.10	.09	.14	.17*	.44**	.29**	.25**
2 Emotional		–	.79**	.59**	.58**	.38**	.14	.27**	-.03	-.01	-.11	.13	.13	.17*	-.04	.23**	.11	.11
3 Feeling			–	.54**	.55**	.38**	.15*	.23**	-.04	-.01	-.12	.13	.17*	.09	-.10	.19**	.11	.06
4 Compassionate				–	.52**	.26**	.20**	.36**	.02	.07	-.08	.25**	.12	.22**	-.03	.23**	.08	.19**
5 Happy					–	.30**	.15*	.24**	.04	.08	-.08	.20**	.21**	.20**	-.08	.21**	.13	.15*
6 Trustworthy						–	.15*	.18*	-.19*	-.13	-.16*	-.12*	.01	-.11	.20**	.52**	.20**	.14
7 Knowledgable							–	.11	.17*	.10	.11	.30**	.18*	.14	.29**	.60**	.12	.11
8 Organic								–	.19**	.12	.07	.12	.16*	.26**	-.07	.06	-.04	.01
9 Dangerous									–	.66**	.44**	.57**	.40**	.39**	.11	.07	.04	.03
10 Scary										–	.47**	.44**	.39**	.38**	.07	.01	-.03	.01
11 Strange											–	.44**	.31**	.42**	.08	.01	.05	-.07
12 Aggressive												–	.51**	.32**	.06	.12	.03	.05
13 Awful													–	.37**	-.07	.02	-.01	-.06
14 Awkward														–	-.07	.04	.11	.01
15 Capable															–	.64**	.28**	.33**
16 Competent																–	.66**	.63**
17 Responsive																	–	.38**
18 Interactive																		–

* Correlation is significant at the .05 level.
** Correlation is significant at the .001 level.

TABLE A.6. Internal consistency for each dimension of the initial (1) and final (2) solutions obtained for the scales used according to sex.

Sex	RoSAS (1)			RoSAS (2)		
	Warmth	Discomfort	Competence	Warmth	Discomfort	Competence
Female	.78	.78	.72	.82	.74	.78
Male	.89	.86	.70	.87	.86	.69
Overall	.84	.82	.71	.84	.80	.74
	Godspeed scale (1)			Godspeed (2)		
	Perceived likeability	Perceived safety	Perceived intelligence	Perceived likeability	Perceived safety	Perceived intelligence
Female	.82	.45	.63	.84	.63	.64
Male	.78	.42	.84	.79	.78	.81
Overall	.80	.44	.76	.82	.70	.75
		Godspeed (3)		NARS		
	Factor 1	Factor 2	Factor 3	NARHT	NATIR	
Female	.66	.79	.77	.79	.81	
Male	.88	.81	.75	.86	.75	
Overall	.80	.79	.76	.80	.83	

TABLE A.8. Initial confirmatory analysis.

Original item	***Item translation***	***Original item dimension***	***Factor 1 (17.72%)***	***Factor 2 (11.08%)***	***Factor 3 (8.95%)***	***Factor 4 (5.31%)***
I laugh and joke a lot with my closest friends.	Eu rio-me e digo muitas piadas quando estou com os meus amigos mais próximos.	Affiliative	.74			
I enjoy making people laugh.	Eu gosto de fazer com que as outras pessoas se riam.	Affiliative	.70			
I don't have to work very hard at making other people laugh—I seem to be a naturally humorous person.	Não preciso de me esforçar muito para fazer outras pessoas rir. Sou uma pessoa naturalmente engraçada.	Affiliative	.70			
If I am feeling depressed, I can usually cheer myself up with humor.	Se me sinto deprimido/a, normalmente consigo animar-me com o meu sentido de humor.	Self-enhancing	.64			
It is my experience that thinking about some amusing aspect of a situation is often a very effective way of coping with problems.	Por experiência própria, posso afirmar que pensar num aspeto divertido de uma situação é uma estratégia eficaz para lidar com os problemas.	Self-enhancing	.64			

If I am feeling upset or unhappy I usually try to think of something funny about the situation to make myself feel better.	Quando me sinto infeliz ou chateado/a tento pensar em algo engraçado para me sentir melhor.	Self-enhancing	.58	
My humorous outlook on life keeps me from getting overly upset or depressed about things.	A minha visão bem-humorada da vida faz com que não fique demasiado triste ou deprimido/a com as coisas que me acontecem.	Self-enhancing	.56	
Even when I'm by myself, I'm often amused by the absurdities of life.	Mesmo quando estou sozinho/a, consigo divertir-me com as coisas absurdas da vida.	Self-enhancing	.54	
I usually don't like to tell jokes or amuse people. (R)	Não gosto de contar piadas ou de divertir as pessoas. (R)	Affiliative	.54	.46
If I'm by myself and I'm feeling unhappy, I make an effort to think of something funny to cheer myself up.	Quando estou sozinho/a e me sinto infeliz, faço um esforço para pensar em algo engraçado para me animar.	Self-enhancing	.52	
I usually don't laugh or joke around much with other people. (R)	Não costumo rir-me ou contar piadas quando estou com outras pessoas. (R)	Affiliative	.50	.44

I don't need to be with other people to feel amused – I can usually find things to laugh about even when I'm by myself.	Não preciso de estar com outras pessoas para me divertir. Normalmente consigo encontrar motivos para me rir mesmo quando estou sozinho/a.	Self-enhancing	.47	
If I am having problems or feeling unhappy, I often cover it up by joking around, so that even my closest friends don't know how I really feel.	Quando estou com problemas ou quando me sinto infeliz, normalmente disfarço fazendo piadas, para que nem os meus amigos mais próximos percebam como eu realmente me sinto.	Self-defeating		
Sometimes I think of something that is so funny that I can't stop myself from saying it, even if it is not appropriate for the situation.	Às vezes, quando penso em alguma coisa demasiado engraçada não me consigo impedir de a dizer, mesmo que a ocasião não seja apropriada.	Aggressive		
I often go overboard in putting myself down when I am making jokes or trying to be funny.	Frequentemente rebaixo-me demais quando estou a contar piadas ou a tentar ser engraçado/a.	Self-defeating		.58

Letting others laugh at me is my way of keeping my friends and family in good spirits.	O meu método para manter os meus amigos e a minha família bem-dispostos é deixá-los rirem-se de mim.	Self-defeating	.57
I will often get carried away in putting myself down if it makes my family or friends laugh.	Não me importo de me rebaixar a mim mesmo/a se isso fizer a minha família ou os meus amigos rir.	Self-defeating	.56
I let people laugh at me or make fun at my expense more than I should.	Deixo que as pessoas gozem comigo e se riam à minha custa mais frequentemente do que deveria.	Self-defeating	.55
I often try to make people like or accept me more by saying something funny about my own weaknesses, blunders, or faults.	Procuro muitas vezes que as pessoas gostem mais de mim ou me aceitem melhor por dizer coisas engraçadas sobre as minhas próprias fraquezas, falhas, ou erros.	Self-defeating	.51
If someone makes a mistake, I will often tease them about it.	Se alguém comete um erro, eu gozo com essa pessoa por causa disso.	Aggressive	.51
I don't often say funny things to put myself down. (R)	Não costumo dizer coisas engraçadas para me rebaixar. (R)	Self-defeating	.48

If I don't like someone, I often use humor or teasing to put them down.	Se não gosto de uma pessoa, normalmente uso o humor para a irritar ou rebaixar.	Aggressive	.43	
When I am with friends or family, I often seem to be the one that other people make fun of or joke about.	Quando estou com a minha família ou com os meus amigos, normalmente sou aquela pessoa com que os outros gozam e sobre quem fazem piadas.	Self-defeating	.42	
I usually can't think of witty things to say when I'm with other people. (R)	Geralmente não consigo pensar em coisas engraçadas ou inteligentes para dizer quando estou com outras pessoas. (R)	Affiliative		.52
I rarely make other people laugh by telling funny stories about myself. (R)	Raramente consigo fazer rir as outras pessoas ao contar histórias engraçadas sobre mim. (R)	Affiliative		.51
I do not like it when people use humor as a way of criticizing or putting someone down. (R)	Não gosto quando as pessoas utilizam o humor para criticar ou para rebaixar alguém. (R)	Aggressive		.44
I never participate in laughing at others even if all my friends are doing it. (R)	Eu nunca me rio à custa de alguém, mesmo que todos os meus amigos o façam. (R)	Aggressive		.44

I don't often joke around with my friends. (R)	Não partilho muitos momentos divertidos com os meus amigos. (R)	Affiliative	.43		.44	
People are never offended or hurt by my sense of humor. (R)	Nunca ofendi ou magoei alguém com o meu sentido de humor. (R)	Aggressive				
If I am feeling sad or upset, I usually lose my sense of humor. (R)	Quando me sinto triste ou chateado/a, normalmente perco o meu sentido de humor. (R)	Self-enhancing				
Even if something is really funny to me, I will not laugh or joke about it if someone will be offended. (R)	Mesmo que uma coisa seja extremamente engraçada para mim, se alguém se sentir ofendido com isso não me rio nem faço piadas sobre o assunto. (R)	Aggressive			.40	.41
When telling jokes or saying funny things, I am usually not very concerned about how other people are taking it.	Quando conto piadas ou digo coisas engraçadas, não me costumo preocupar com a forma como as outras pessoas reagem ao que eu digo.	Aggressive				

Table A.9. HSQ (original structure) correlations with personality, affect and well-being.

Scale	***Sub-dimension***	***Affiliative***	***Self-enhancing***	***Aggressive***	***Self-defeating***
TIPI	Extraversion	.42**	.15**	-.04	-.16**
	Oppeness	.32**	.30**	-.10	-.02
	Agreeableness	.25 **	.12*	-.20**	-.01
	Consciousness	.16**	.09	-.28**	-.24**
	Emotional stability	.14*	.33**	.09	-.04
PANAS	Positive affect	.23**	.40**	.03	.03
	Negative affect	-.07	-.28**	-.07	.15**
Well-being	–	.27**	.38**	-.02	-.04

Table A.10. Exploratory factor analysis of the Humor Styles Questionnaire

Original item (Original item dimension)	Factor 1 (17.72%)	Factor 2 (11.08%)	Factor 3 (8.95%)	Factor 4 (5.31%)	Factor 5 (4.36%)	Factor 6 (3.77%)	Factor 7 (3.34%)
KMO = .82; Bartlett's test of sphericity (496) = 3264.88, p <.001 Total variance explained = 54.53%							
I usually don't like to tell jokes or amuse people. (R; AF)	.75						
I usually don't laugh or joke around much with other people. (R; AF)	.68						
I don't have to work very hard at making other people laugh—I seem to be a naturally humorous person. (AF)	.65						
I laugh and joke a lot with my closest friends. (AF)	.65						
I rarely make other people laugh by telling funny stories about myself. (R; AF)	.65						
I enjoy making people laugh. (AF)	.63						
I don't often joke around with my friends. (R; AF)	.59						

I usually can't think of witty things to say when I'm with other people. (R; AF)	.59	
If I am feeling upset or unhappy I usually try to think of something funny about the situation to make myself feel better. (SE)		.74
Even when I'm by myself, I'm often amused by the absurdities of life. (SE)		.73
If I'm by myself and I'm feeling unhappy, I make an effort to think of something funny to cheer myself up. (SE)		.71
I don't need to be with other people to feel amused – I can usually find things to laugh about even when I'm by myself. (SE)		.69
If I am feeling depressed, I can usually cheer myself up with humor. (SE)		.66

It is my experience that thinking about some amusing aspect of a situation is often a very effective way of coping with problems. (SE)	.60	
My humorous outlook on life keeps me from getting overly upset or depressed about things. (SE)	.60	
Letting others laugh at me is my way of keeping my friends and family in good spirits. (SD)		.72
I often go overboard in putting myself down when I am making jokes or trying to be funny. (SD)		.72
I will often get carried away in putting myself down if it makes my family or friends laugh. (SD)		.70

I often try to make people like or accept me more by saying something funny about my own weaknesses, blunders, or faults. (SD)	.66	
I let people laugh at me or make fun at my expense more than I should. (SD)	.53	
When I am with friends or family, I often seem to be the one that other people make fun of or joke about. (SD)	.42	
If I am having problems or feeling unhappy, I often cover it up by joking around, so that even my closest friends don't know how I really feel. (SD)	.42	
Even if something is really funny to me, I will not laugh or joke about it if someone will be offended. (R; AG)		.69

I do not like it when people use humor as a way of criticizing or putting someone down. (R; AG)		.68		
People are never offended or hurt by my sense of humor. (R; AG)		.61		
I never participate in laughing at others even if all my friends are doing it. (R; AG)		..58		
I don't often say funny things to put myself down. (R; SD)	.45	.50		
If I don't like someone, I often use humor or teasing to put them down. (AG)			.65	
If someone makes a mistake, I will often tease them about it. (AG)			.59	
If I am feeling sad or upset, I usually lose my sense of humor. (R; SE)				.69

When telling jokes or saying funny things, I am usually not very concerned about how other people are taking it. (AG)	.72
Sometimes I think of something that is so funny that I can't stop myself from saying it, even if it is not appropriate for the situation. (AG)	

Table A.11. Correlations and internal consistency of the EFA.

	F1	**F2**	**F3**	**F4**	**F5**	**F6**	**F7**
F1	.83	.43**	.12*	.07	.05	.20**	.04
F2		.82	.19**	-.17**	.05	.05	.20**
F3			.74	.18**	.36**	-.08	.11
F4				.67	.32**	.18**	-.006
F5					.49	-.08	.18**
F6						–	-.09
F7							–

Notes: Cronbach's α is presented in the diagonal. Cronbach's α for F6 and F7 are not presented as these dimensions only include 1 item each.
** Correlation is significant at the .01 level (2-tailed).
* Correlation is significant at the .05 level (2-tailed).

Table A.13. Correlations between HSQ dimensions (pre and post).

Sub-dimension	***Affiliative***	***Self-enhancing***	***Aggressive***	***Self-defeating***
Affiliative (post)	.59**	.15	.05	.05
Self-enhancing (post)	.34**	.58**	-.14	-.06
Aggressive (post)	.10	-.12	.51**	..19
Self-defeating (post)	.03	-.06	.26**	.50**

Table A.12. Correlations between the HSQ dimensions according to participants' sex (original structure).

	Self-enhancing	**Self-defeating**	**Affiliative**	**Aggressive**
Self-enhancing	–	.06	.41**	-.01
Self-defeating	.29*	–	.08	.33**
Affiliative	.52**	.19*	–	.10
Aggressive	.01	.34**	.16	–

Notes: Correlations for women are presented above the diagonal; correlations for men are presented below the diagonal.
** Correlation is significant at the .01 level (2-tailed).
* Correlation is significant at the .05 level (2-tailed).

Table A.14. Reliability estimates and model fit indices for each version of the HSQ.

Sample	Indicator	SEN	AFF	AGG	SDE	Model fit
Portuguese	α	0.80	0.87	0.70	0.81	χ^2 (113) = 537.41; p < .001; CFI = 0.80; TLI = 0.76; NFI = 0.87; SRMR = 0.08; RMSEA = 0.11; p $\geq$ 0.05
	ω	0.81	0.85	0.66	0.77	
	AVE	0.40	0.47	0.26	0.36	

Venezuelan	α	0.85	0.83	0.71	0.53	$\chi^2(113) = 2{,}446.15$; $p < .001$; CFI = 0.39; TLI = 0.32; NFI = 0.47; SRMR = 0.14; RMSEA = 0.14; $p \geq 0.05$); 90% CI [0.14, 0.15].
	ω	0.83	0.82	0.67	0.48	
	AVE	0.54	0.47	0.40	0.36	
Brazilian	α	0.50	0.51	0.58	0.34	χ^2 (113) = 371.53; $p < .001$; CFI = 0.80; TLI = 0.75; NFI = 0.89; SRMR = 0.08; RMSEA = 0.11; $p \geq 0.05$; 90% CI [0.10, 0.12].
	ω	0.60	0.51	0.36	0.21	
	AVE	0.26	0.22	0.14	0.10	

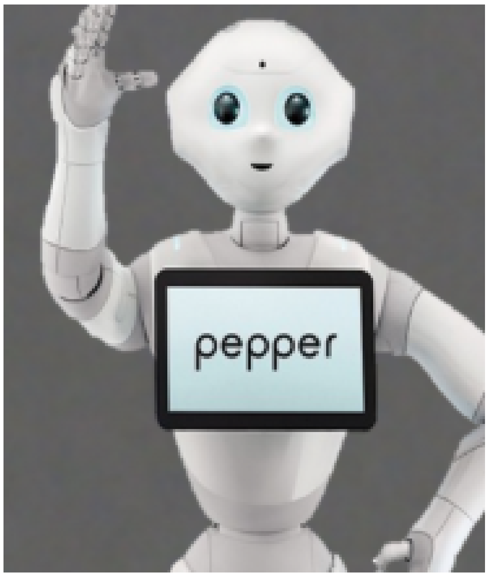
Notes: AFF = Affiliative; SEN = Self-enhancing, AGG = Aggressive; SDE = Self-defeating.

TABLE A.15. Standardized factor loadings for the reduced HSQ.

	SEN	AFF	AGG	SDE
HSQ 2	0.65			
HSQ 10	0.83			
HSQ 18	0.75			
HSQ 5		0.74		
HSQ 13		0.84		
HSQ 21		0.80		
HSQ 3			0.77	
HSQ 15			0.50	
HSQ 27			0.69	
HSQ 8				0.83
HSQ 20				0.61
HSQ 32				0.72

Notes: AFF = Affiliative; SEN = Self-enhancing, AGG = Aggressive; SDE = Self-defeating.

(A) Human.



(B) Pepper.

FIGURE A.1. Photos used in the vignettes.

TABLE A.16. Full list of jokes and translation.

Humor style	Portuguese	English	Included in the study
Affiliative	"As embalagens de Mentos deviam vir com elogios como "És espetacular" e chamarem-se Complimentos."	"Mentos packages should come with small compliments like "You're awesome" and be called Complimentos."	×

	”Todos somos viajantes no tempo a viajar a exatamente 60 minutos por hora.”	“We are all time travelers traveling at exactly 60 minutes per hour.”	
	”Só porque uma pessoa não sabe dançar, não quer dizer que não deva dançar.”	“Just because someone doesn’t know how to dance, doesn’t mean they shouldn’t.”	
	”No outro dia encontrei uma aranha e levei-a para fora de casa em vez de a matar. Fomos beber uns copos. Quer ser advogada. Aranha simpática.”	“The other day I found a spider and took it out instead of killing it. We went out for some drinks. It wants to be lawyer. Nice spider!”	
	”Há algumas pessoas que são como eletricistas. Iluminam sempre o meu dia.”	“Some people are like electricians. Always light up my day.”	
Self-enhancing	”Sou tão bom a dormir, que o consigo fazer até de olhos fechados.”	“I am so good at sleeping, I can do it with my eyes closed.”	
	”Eu levo sempre a vida com um grão de sal... e uma rodela de limão... e um shot de tequila!”	“I always take life with a grain of salt… and a slice of lemon… and a shot of tequila!”	×
	”Eu gosto do meu trabalho. Simplesmente, fascina-me. Consigo ficar sentado a olhar para ele durante horas.”	“I like my work. It simply fascinates me. I can sit and stare at it for hours.”	×

	”Eu sou baixinho, mas não faz mal. Todos sabemos que as melhores coisas, vêm em embalagens pequenas.”	“I am short, but it’s ok. Everyone knows the best things in life come in small packages.”	×
	”Eu tento sempre fazer exercício físico assim que me levanto... antes do meu cérebro descobrir o que está a acontecer.”	“I always try to do physical exercise as soon as I get up... before my brain finds out what is happening.”	
Self-defeating	”Tenho um complexo de inferioridade... mas não é um complexo muito bom.”	“I have an inferiority complex... but it’s not a really good one.”	
	”Chumbei tantas vezes a matemática que já perdi a conta.”	“I failed math so many times, I lost count.”	
	”Se eu tivesse de me descrever numa palavra, seria... ”mau a seguir indicações”.”	“If I had to describe myself in one word, it would be... ‘bad at following directions’.”	
	”Eu costumava pensar que era uma pessoa indecisa... mas agora não tenho tanta certeza.”	“I used to think I was an indecisive person... but now I am not so sure.”	
	”Sei bem como as pilhas se sentem. Eu também nunca sou incluído em nada.”	“I know how batteries feel. I am also never included in anything.”	×
Aggressive	”Adoro o som que tu fazes... quando te calas.”	“I love the sound you make... when you shut up.”	
	”As cebolas choram quando olham para ti.”	“Onions cry when they look at you.”	

	”Pessoas como tu são a razão pela qual as embalagens de shampô vêm com instruções.”	“People like you are the reason shampoo bottles come with instructions.”
	”És como uma atualização de software... Sempre que te vejo, penso ”Agora não”!.”	“You are like a software update... Everytime I see you, I think ‘Not now!’.”
	”Os espelhos não mentem. Felizmente para ti, também não se riem.”	“Mirrors don’t lie. Luckily for you, they also don’t laugh.”

TABLE A.20. Final factorial structure of the HSQ.

Original Label	Self-defeating	Self-enhancing	Affiliative
Total Variance (59.07)	27.23	19.18	12.66

TABLE A.17. Correlations of all jokes to participants’ perceptions of humor styles expressed.

Category	Label	Affiliative	Self-enhancing	Self-defeating	Aggressive
Affiliative	J1_AF	.10 (p = .29)	.15 (p = .12)	.08 (p = .39)	-.11 (p = .25)
	J2_AF	-.12 (p = .22)	-.06 (p = 53)	-.05 (p = .64)	-.07 (p = .49)
	J3_AF	-.02 (p = .86)	.18 (p = .06)	-.06 (p = .53)	-.11 (p = .28)
	J4_AF	.05 (p = .64)	.04 (p = .65)	-.08 (p = .42)	.09 (p = .38)
	J5_AF	-.02 (p = .83)	.05 (p = .60)	.01 (p = .92)	-.07 (p = .48)
Self-enhancing	J1_SE	-.13 (p = .18)	.03 (p = .79)	.00 (p = 99)	-.12 (p = .24)
	J2_SE	.08 (p = .42)	.15 (p = .12)	-.06 (p = .52)	-.03 (p = .73)
	J3_SE	.17 (p = .07)	.11 (p = .27)	-.04 (p = .69)	-.09 (p = .38)
	J4_SE	-.03 (p = .75)	.17 (p = .07)	-.04 (p = .71)	-.10 (p = .31)
	J5_SE	-.01 (p = .93)	.04 (p = .68)	.02 (p = .80)	-.13 (p = .20)
Self-defeating	J1_SD	.11 (p = .27)	.03 (p = .76)	.13 (p = .17)	-.03 (p = .72)
	J2_SD	-.05 (p = .64)	-.01 (p = .95)	.00 (p = .99)	-.09 (p = .38)
	J3_SD	.13 (p = .17)	.01 (p = .90)	.06 (p = .53)	.05 (p = .63)
	J4_SD	.23 (p = .02)	.02 (p = .88)	.03 (p = .77)	-.01 (p = .92)
	J5_SD	.15 (p = .13)	-.01 (p = .94)	.18 (p = .06)	-.06 (p = .53)
Aggressive	J1_AG	.17 (p = .07)	-.05 (p = .64)	.07 (p = .47)	-.01 (p = .91)
	J2_AG	.26 (p = .01)	-.12 (p = .21)	.16 (p = .11)	.08 (p = .42)
	J3_AG	.31 (p = .001)	-.01 (p = .91)	.24 (p = .01)	.09 (p = .36)
	J4_AG	.15 (p = .12)	.07 (p = .50)	-.01 (p = .90)	.04 (p = .68)
	J5_AG	.18 (p = .06)	.15 (p = .13)	.19 (p = .05)	.16 (p = .11)

Self-defeating	HSQ_scale_20	Frequentemente rebaixo-me demais quando estou a contar piadas ou a tentar ser engraçado/a.
Self-defeating	HSQ_scale_28	Quando estou com problemas ou quando me sinto infeliz, normalmente disfarço fazendo piadas, para que nem os meus amigos mais próximos percebam como eu realmente me sinto.
Self-defeating	HSQ_scale_8	Não me importo de me rebaixar a mim mesmo/a se isso fizer a minha família ou os meus amigos rir.
Self-defeating	HSQ_scale_12	Procuro muitas vezes que as pessoas gostem mais de mim ou me aceitem melhor por dizer coisas engraçadas sobre as minhas próprias fraquezas, falhas, ou erros.
Self-defeating	HSQ_scale_16	Não costumo dizer coisas engraçadas para me rebaixar.
Affiliative	HSQ_scale_13	Eu rio-me e digo muitas piadas quando estou com os meus amigos mais próximos.

Self-defeating	HSQ_scale_4	Deixo que as pessoas gozem comigo e se riam à minha custa mais frequentemente do que deveria.	
Self-defeating	HSQ_scale_32	O meu método para manter os meus amigos e a minha família bem-dispostos é deixá-los rirem-se de mim.	
Affiliative	HSQ_scale_21	Eu gosto de fazer com que as outras pessoas se riam.	
Self-enhancing	HSQ_scale_10		Quando me sinto infeliz ou chateado/a tento pensar em algo engraçado para me sentir melhor.
Self-enhancing	HSQ_scale_14		A minha visão bem-humorada da vida faz com que não fique demasiado triste ou deprimido com as coisas que me acontecem.

Self-enhancing	HSQ_scale_18		Quando estou sozinho e me sinto infeliz, faço um esforço para pensar em algo engraçado para me animar.	
Self-enhancing	HSQ_scale_2		Se me sinto deprimido/a, normalmente consigo animar-me com o meu sentido de humor.	
Affiliative	HSQ_scale_1R			Não costumo rir-me ou contar piadas quando estou com outras pessoas.
	KMO	Bartlett	df	Sig.
	.78	411.458	91	.000

TABLE A.18. Correlations between humor styles and the funniness evaluation of the jokes presented to participants.

Category	Label	Self-enhancing	Self-defeating	Affiliative
Self-enhancing	J1_SE	.08 (p = .41)	-.02 (p = .81)	-.07 (p = .48)
	J2_SE	.22 (p = .02)	-.05 (p = .63)	.04 (p = .71)
	J3_SE	.23 (p = .02)	-.03 (p = .78)	.05 (p = .61)
	J4_SE	.21 (p = .03)	-.06 (p = .56)	.03 (p = .79)
	J5_SE	.18 (p = .06)	-.01 (p = .95)	-.05 (p = .62)
Self-defeating	J1_SD	.15 (p = .11)	.13 (p = .19)	.13 (p = .23)
	J2_SDn	.05 (p = .50)	-.02 (p = .88)	-.01 (p = .44)
	J3_SD	.07 (p = .50)	.07 (p = .45)	.08 (p = .44)
	J4_SD	.02 (p = .83)	.06 (p = .53)	.09 (p = .36)
	J5_SD	.02 (p = .84)	.19 (p = .005)	.15 (p = .13)
Affiliative	J1_AF	.16 (p = .11)	.07 (p = .48)	.23 (p = .03)
	J2_AF	.03 (p = .74)	-.07 (p = .48)	-.11 (p = .28)
	J3_AF	.30 (p = .002)	-.10 (p = .32)	-.03 (p = .77)
	J4_AF	.11 (p = .28)	-.05 (p = .58)	.12 (p = .26)
	J5_AF	.12 (p = .23)	-.02 (p = .83)	.17 (p = .11)

TABLE A.19. Sample sociodemographic characteristics.

		M	SD	Mode	Median	Min.	Max.
Age		20.75	5.45	19	19	18	51
		n	%				
Sex	Female	98	90.70				
	Male	10	9.30				
	Prefer not to say	–	–				

TABLE A.21. Correlations among HSQ dimensions for men (n = 10) and for women (n = 98).

	Self-enhancing	Affiliative	Aggressive	Self-defeating
Self-enhancing	–	.30 (p = .41)	-.30 (p = .40)	-.08 (p = .82)
Affiliative	.24 (p = .02)	–	-.50 (p = .14)	.51 (p = .13)
Aggressive	.25 (p = .01)	.02 (p = .85)		.17 (p = .64)
Self-defeating	.05 (p = .64)	.21 (p = .04)	.20 (p = .05)	–

TABLE A.22. Participant distribution per condition (valid n = 381).

Actor	Humor style	n	%
Robot (n = 203, 53.1%)	Affiliative	47	12.3
	Self-enhancing	68	17.8
	Self-defeating	45	11.8
	Control	43	11.3
Human (n = 179, 46.9%)	Affiliative	35	9.2
	Self-enhancing	48	12.6
	Self-defeating	39	10.2
	Control	57	17.2
Total		382	100

Table A.23. Sample sociodemographic characteristics.

		M	SD	Mode	Median	Min.	Max.
Age		24.57	5.91	22	22	18	57
		n	%				
Sex	Female	286	74.9				
	Male	94	24.6				
	Prefer not to say	1	.03				
Occupation	Student	209	54.7				
	Student-worker	56	14.7				
	Unemployed	35	9.2				
	Full-time employed	74	19.4				
	Other	8	2.1				
Previous interaction with social robots	Yes	32	8.4				
	No	349	91.4				
Previous interaction with Pepper	Yes	1	.03				
	No	381	99.7				