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(De)Bonding with embryos: The emotional choreographies of Portuguese IVF patients

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ABSTRACT

In this article we develop the new concept of *emotional choreography* to describe how patients bond, debond and/or rebond with their embryos created *in vitro* using assisted reproductive technologies (ART). Using this concept, we explore how the patients' management of their own emotions intertwines with political, scientific, and religious factors. Our analysis relies on and further advances Thompson's concepts of ethical and ontological "choreography". It is through these forms of choreography that complex contemporary biomedical issues with high political, ethical, and scientific stakes are negotiated, and through which different actors, entities, practices, roles, and norms undergo mutual constitution, reinforcement and (re)definition. Our article draws on the analysis of 69 in-depth interviews and the results of an online survey with 85 respondents.

1. Introduction

Assisted Reproductive Technology (ART) is defined by the World Health Organisation as "all treatments or procedures that include the *in vitro* handling of both human oocytes and sperm, or embryos, for the purpose of establishing a pregnancy" (Zegers-Hochschild et al., 2009: 2685). The psychological impact of ART treatments and procedures on beneficiaries has been addressed extensively in the literature, particularly in the field of psychology following the birth of the first baby conceived by extracorporeal fertilisation – commonly known as *In vitro fertiliz*ation (IVF) – in 1978, in England. In the late eighties, there was a growing interest in the emotional aspects of ART treatments, with an increased focus on difficult emotions and relationship problems, as well as psychological evaluation and support for couples who resort to IVF and embryo transfer (Callan and Hennessey, 1988; Freeman et al., 1985; Mahlstedt et al., 1987; Shaw and Johnston, 1988). Back then, feelings of anxiety, distress, frustration, depression, helplessness, guilt or sorrow were already associated with the emotional strain on IVF patients at different stages of the process (Seibel and Levin, 1987). This academic trend was followed by other studies in the early nineties that turned the focus on maternal-foetal attachment and patients' attitudes toward the fate of their supernumerary cryopreserved embryos (Stanton and Golombok, 1993; Berstein et al., 1994; Laruelle and Englert, 1995). Such studies continued in the 2000s (Bankowski et al., 2005; Fisher et al., 2008; Provoost et al., 2012).

Emotion, affect, bond, and attachment are different but correlated concepts. According to some authors, people form bonds to prosocial values, institutions and other people, and one type of bond is attachment – that is, a bond at the level of psychological affection (Hirschi, 2001 [1969]; Pratt et al., 2011). Other authors, by contrast, distinguish bonding and attachment based on the processes they represent, even though both play a role in the forming of human connections. While bonding refers to the sense of being connected with someone that occurs without any conscious effort, intent, knowledge, or learned skill, attachment instead relates to the learned ability to make psychologically rooted ties with others that give these others significant meaning (Watson, 1997).

Furthermore, while the relationship between the terms "emotion" and "affect" is widely debated (Wetherell, 2012), affect is commonly understood as a more comprehensive concept. According to a culturalist approach, emotions are not subject-centred: they circulate in the world but they also stick to bodies (Ahmed, 2004a, 2004b; Schmitz and Ahmed, 2014) – and this certainly holds for the would-be parent bodies featured in our case material. Emotions do shape the "surfaces" of bodies

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and become their attributes, involving orientations towards and away from others (Ahmed, 2004a). Within an affective economy (Ahmed, 2004b), emotions circulate between bodies, signs and objects, mediating the relationship between the psychic (individuals), the material (bodies and objects) and the social (communities), and binding subjects together (thus intensifying affect). There is a relation between emotions, bodily sensations (as corporeal responses) and judgements about things (ideas and values).

When analysing and discussing what beneficiaries do and how they relate to embryos created *in vitro* (i.e., in a laboratory setting), the concept of emotion work (Hochschild, 1983) is heuristically useful. In this paper, we adopt the term emotion work in the sense given by Exley and Letherby (2001) in their analysis of how life course disruptions associated with infertility, involuntary childlessness, and terminal illness are managed by those individuals who experience them. By emotion work, the authors mean "the skill and effort required to deal with one's own feelings, and those of others within the private sphere" (Exley and Letherby, 2001: 115). However, an account of the complex, dynamic and embedded nature of ART beneficiaries' personal relationships with embryos created in the laboratory is missing in Exley and Letherby's analysis.

In this paper, we therefore aim to describe how IVF patients in Portugal build a relationship with their embryos created *in vitro* using ART. We discuss the processes through which patients bond, debond and/or rebond with these embryos. We also explore how these patients' management of their own emotions intertwines with political, scientific, and religious factors, among others. We argue that this *emotion work* carried out by the prospective parents who resort to *in vitro* fertilization is a dynamic, ongoing process that is intersubjective, relational, and context-dependent, bringing out the significance of people's positionalities and interpolations within broader regulatory, medical, institutional and ethical frameworks. This conceptual proposition stems from previous findings that as ART users' personal and therapeutic trajectories progress, the *in vitro* embryo is reconfigured. Embryos oscillate/shift from being a "living entity" to a "human being" as their physical and emotional "closeness" and "distance" to prospective parents changes (Delaunay and Santos, 2020). Emotions are therefore crucial within IVF, and feelings such as "affection", "detachment", "loss", "grief", "abandonment" and "liberation" explain beneficiaries' attitudes towards their embryos (*ibidem*).

These shifts are linked to the contingency of embryos as material entities. Instead of being polarised as either human or non-human, IVF embryos require a more fluid ontological approach (Casper, 1994) – a post-human perspective. Organisms and biological materials are now frequently perceived and reconfigured as biomedical instruments or objects (Franklin, 2013; Mol, 2002). This novelty introduces the challenge of how to think about the embryo, which is created through biomedical technologies outside the female body (Strathern, 1992). The metaphor of the cyborg is useful here, as the embryo embodies the union between science and nature, between reproductive failure and reproductive hope (Franklin, 1999, 2006), and gives rise to a liminal life at the border of humanness (Squier, 2004). If we are to understand the emotion work involved in ART therapies, we must therefore relate it to the liminal, hybrid nature of the IVF embryo, which is a coupling between machine and organism, and a "condensed image of both imagination and material reality" (Haraway, 1991: 150).

It is important to recognise the hybridity and liminality of the surplus frozen embryo – which is seen as an ambivalent moral object (i.e. it is conceptualized in contingent and conflictual ways) – when discussing IVF users' disposition decisions and unmet needs for communication and emotional support (Raz et al., 2021). Studies have revealed a need to explore users' struggle to express the unique, complex and contingent feelings of relationality with their stored IVF embryos given "the limited language choices, culturally loaded meanings and closed frames of reference" normally available to them (Millbank, 2017: 114). Moreover, the "sequestration" and imperfect "scientisation" of early miscarriage (it tends to be hidden from public view, and there is little medical explanation of its cause) have silenced women's individual experiences of connection and grief (Frost et al., 2007).

Drawing on Pickering's approach to scientific practice in general and his concepts of the *dance of agency* and the *mangle of practice* (Pickering, 1995), we propose a performative and interactive understanding of human embryos created *in vitro*, in the sense that human and material agency are reciprocally intertwined and emerge in ART practice. As in the production of scientific knowledge, where Pickering's "performative approach" – which builds on actor-network theory (Latour, 2005; Law and Hassard, 1999) – points to the evolutionary, unforeseeable and open-ended interplay between various factors (biological, technological, social, and conceptual), we see meaning-making about embryos as also involving permanently-shifting relationships between instruments, moral standards, statistical data, biological matter, regulated practices, and human beings. All these agents are "mangled" together in unpredictable ways that are shaped by the contingencies of place (*in vitro*, *in utero*, and *in cryo* embryos), time (stage of treatment), and cultural frameworks (both lay and expert values and beliefs).

As Pickering (1995) stresses, this performative back and forth dance of agency between people and things, between the human and the non-human, involves dialectics of resistance and accommodation, which can include revisions to goals and intentions in the light of unpredictable events and the failure to achieve those goals. The concept of this goal-oriented and goal-revising dialectic – which is driven by how biomedicine confounds the expectations of both ART beneficiaries and professionals and how they take these reversals into account – is also useful for discussing ART beneficiaries' different and changeable attitudes toward their embryos *in vitro*.

We draw and expand on the theoretical contributions of Charis Thompson (previously Charis Cussins) to the study of both ART and stem cell research (Thompson, 2005, 2013). According to Thompson, complex issues in contemporary biomedicine are negotiated through *choreographies* that involve political, ethical and scientific stakes, whereby different actors, entities, practices, roles, and norms go through a process of coordination, co-constitution, reinforcement and (re)definition. Assisted reproduction is about *making parents* and children at once: ART redefines parenthood and how it is embodied (e.g. through the fusion of partners' gametes/genetic material), disembodied (e.g. through the creation of embryos outside the female body) and re-embodied (e.g.by being transferred to the woman's uterus), because it makes parenthood inextricable from the normatively-loaded processes that cut across different institutional settings, from ethics committees to legislative bodies and ART clinics (Thompson, 2005). Through an *ontological choreography* – defined as a set of coordinated and intertwined dynamics of reproduction at the technical, scientific, personal, emotional, legal, political, and financial levels – these reproductive technologies help to (re) interpret, normalize, and naturalize kinship as well as gender roles (even if the parents provide neither gametes nor womb), thus giving rise to new relations between science and society *(ibidem*).

As Cussins (1998) points out, the various ways in which the infertile female patient is objectified during ART processes – which are not antithetical to personhood – involve her active participation, as well as her relation to practitioners, procedures, instruments, material settings and her own body parts. It is through these forms of objectification that the body is rendered compatible with instruments, and gametes – understood as body parts – become more real and relevant as functional stages within a treatment cycle. Therefore, "patients can manifest agency (and so enact their subjectivity) through their objectification" (Thompson, 2005: 179). Nevertheless, the patient undergoes multiple and significant ontological variations during the course of her treatment, according to different clinical settings and their techniques, embodying new possibilities for her long-term (changing) self: a generic patient in the waiting room; ovaries and follicles on an ultrasound screen; anaesthetised on a surgical table; someone with blocked tubes in the consultation room (Cussins, 1998). Thus it is important for patients to retaining

the consistency of the person through ongoing work to maintain a coherent identity, throughout multiple interactions with the surrounding environment during their changing lives (Thévenot, 2009, 2014).

Drawing on Thompson/Cussins's aforementioned concept of *choreography*, we thus use the new concept of *emotional choreography* to describe how IVF patients connect to their embryos created in the laboratory by third parties – that is, the embryologists – and the role of emotions in this highly entangled process. Although emotions also take part in Thompson's ontological choreography, its focus is on the shifts in ontological status between object and subject (i.e. on ART's production of both parents and children and their recognition as such), instead of emotion work. The term *emotional choreography* has already been used to conceptualize the emergence, materialization and entanglement of emotions, and their changes and effects in fertility clinics (Adrian, 2015). But here the specific focus is on just one part of the therapeutic trajectory – when there is a need for a psychological adaptation to an expected IVF failure – and the ensuing reconfiguration of kinship or treatment options (Adrian, 2015).

We extend this approach to the whole of the therapeutic trajectory, focusing not just on the emotions surrounding an expected IVF failure, but rather on the emotions implicated in beneficiaries' bonding and attachment with their embryos throughout the IVF process. We conceptualize *emotional choreography* as the actions that emotionally-charged actors – in this case, patients themselves – take to coordinate with a set of heterogeneous (human and non-human) elements, throughout their treatment cycles and life stages, in order to give consistency to their self over the long term. The concept of selfhood is relevant when conceptualising emotional choreographies in this scientific, medical and cultural context, since the individual self is put to the test when embarking on this new way of having children, especially when it faces challenging decisions and emotionally burdensome situations related to their *in vitro* embryos. The heterogeneous elements with which patients coordinate their action may include national legislation, regulations, ethical opinions, science, the success or failure of treatments, pro-life issues (that cut across both abortion and stem cell research debates), etc. We see this process as a type of choreography since it is both creative and highly staged, involving the well-coordinated performance of a variety of human and non-human agencies in order to make meaning about and create bonds with embryos. It is emotional because it involves the constant, disputed, and sometimes conflicting management of feelings and affections in a biotechnological environment.

This concept is intended as a heuristic tool for analysing the different emotional gradations and variations that arise in the process of forging (or not forging) bonds with the embryos created *in vitro*. These gradations and variations emerge with shifts in prospective parents' beliefs and expectations, and with the reconfiguration of each embryo's status. Diverse bonding, debonding and rebonding dynamics occur for different patients and even within the same patient, according to their contingent and locally-situated trajectories, and informed by personal and clinical experiences. These may lead to an embryo being treated variously as a potential child or a source of life, as viable reproductive material or simply waste. In our study, this diversity of dynamics both produced and was reinforced by the different emotional responses and narrative strategies of our participants, representing a complex negotiation and intermingling of intimacy, agency, body, biomedicine, personhood and kinship.

In sum, by developing this new concept we aim to advance our theoretical understanding of how very different features come together – within ART processes – to trigger dynamic bonds and emotional attachments between prospective parents and their embryos. These features – which will be explored throughout this paper – range from genetic connectedness, time frames and spatiality, to trust in biomedical science, religious faith, and legal and regulatory norms. Ultimately, we aim to highlight the affirmative and productive role – and choreographic nature – of emotions in biomedical practices and parenting imageries. Other features emerged as relevant but demanded a dedicated analysis elsewhere, most notably the role of gender norms in the performance of emotional work.

2. Background section

It was only in 2006, twenty years after the birth of the first IVF baby, that ART procedures were given a legal framework in Portugal, with the publication of Law nº 32/2006, of 26 June, along with other regulatory mechanisms governing the respective biomedical practices, such as ethical opinions issued by the Portuguese Ethical Council for ART. At that time, ART beneficiaries could only be heterosexual couples who were married or had been in a non-marital partnership for more than 2 years, with a diagnosis of infertility or where there was a risk of transmitting a serious and/or hereditary disease to the child. However, after ten years, the ART law was revised, extending the beneficiary status to single women and female homosexual couples, making eligibility independent of marital status, sexual orientation, or clinical diagnosis of infertility (Law No. 25/2016, of 22 August).

During any given IVF cycle, more embryos may be obtained than can be transferred into the uterus (a maximum of two embryos, according to Portuguese technical guidelines). Surplus embryos can be cryopreserved, but must be used by ART beneficiaries for a new embryo transfer within a period of three years, which in some duly justified cases may be extended to six years. After this period, the embryos can be donated to other patients and/or to scientific research or can be thawed/discarded. This decision is left up to patients, who must give their informed consent prior to the start of fertility treatments.

According to the ART law, although the creation of embryos with the deliberate aim of using them in scientific research is prohibited, research may be conducted on surplus embryos, those that carry a serious genetic anomaly, or those whose condition does not allow their transfer or cryopreservation. Research objectives include the diagnosis of and development of therapies for embryos, the improvement of ART techniques, and the constitution of stem cell banks for transplantation programs or for any other therapeutic purposes. Moreover, in 2016, the National Council for Medically Assisted Procreation (CNPMA) approved the first research project in Portugal using embryos, as it presented "a potential benefit for humanity". This project focuses on the process of embryonic implantation, which is the least successful step during fertility treatments.

3. Methods

This paper reports on a mixed-methods research project into expert and lay meaning-making about human embryos *in vitro*, during both ART and scientific research processes. We draw from an analysis of 69 semi-structured in-depth interviews and from the results of an online survey with 85 respondents. Both interviews and the survey were conducted with a diverse sample of *in vitro* fertilization (IVF) and/or intracytoplasmic sperm injection (ICSI) beneficiaries (including those of both sexes, both single and in relationships, heterosexual and lesbian, with and without previous medical diagnoses of infertility). IVF and ICSI are the two ART techniques for creating embryos outside the woman's body. IVF involves placing an oocyte in a culture dish surrounded by sperm. ICSI consists of directly injecting a live sperm into the egg by puncturing it using a pipette.

All study participants provided written or oral informed consent before data collection. Ethical approval was granted by the host institution of the research project before data collection began. All data were anonymized, including the names of any people or institutions mentioned. Descriptive statistical analysis of relevant variables from the survey was conducted using SPSS (version 26), and qualitative data from interviews were subject to thematic content analysis using MaxQDA (version 2018). Not only were the two modalities of inquiry – survey and interviews – carried out independently; these modalities were also based

on two distinct convenience and snowball sampling processes. Thus, no interviewee was invited to fill out the questionnaire or *vice-versa*.

The online survey comprised a total of 5 dimensions: a) socio-demographic characterization (including respondents' religious beliefs); (b) formation of the parental project and resort to reproductive medicine (e.g., beginning of pregnancy attempts, the moment of resorting to medical support and motivation, etc.); (c) clinical protocol and feelings experienced (the time when treatments were initiated, the current status of the treatment, number of treatment cycles, children born using ART, type of ARTtechniques used, meanings attributed to the parental project, etc.); (d) relationship with the medical team (evaluation of professionals' capacity to provide technical explanations, care, etc.); (e) conceptions of the embryo and IVF (moral statuses attributed, moments of change in these meanings during the therapeutic trajectory, beginning of the construction of an emotional bond, concerns throughout the clinical path, decisions about the fate of existing surplus embryos and respective moral grounds, etc.).

The interview script encompassed several themes and sought to cover the different stages of the therapeutic trajectory both before and after the treatments' completion: the formation of the parental project; infertility diagnosis (if applicable) and decision to resort to specialized medical help; knowledge about ART; description of the therapeutic protocol and lived experience; decision about surplus embryos (if applicable); general conceptions of, and forms of connection with, the created embryos (moral status attributed, moments of change in these understandings, beginning of the construction of an emotional bond, etc.).

Thematic analysis of the interviews was conducted collectively by the members of the project's core team – namely, the principal investigator and the researchers recruited to carry out the fieldwork and analysis of the empirical material. To this end, we periodically held meetings to discuss and gradually refine the categories (themes and codings) employed.

This thematic analysis followed a set of procedures to build categories inductively (Bradley et al., 2007). Firstly, we assembled a preliminary list of themes through an open coding procedure. Here categories emerged based on patterns derived from the raw data rather than preconceived theories. A code tree reflecting the key ideas expressed by the participants was developed in MaxQDA. The themes and coding were then discussed in order to develop a richer and more nuanced reading of the data, rather than necessarily to reach a consensus (Braun and Clarke, 2019). Next, the initial list of themes was progressively shortened and fine-tuned as the interviews were analysed. The code tree was continuously adapted until theoretical saturation was reached, i.e. when no additional codes were found in the interviews. Finally, the themes emerging from the interviewees' discourse – specifically concerning the meanings and emotion work produced around embryos – were reduced to the core topics presented in the findings section of this article: (a) The value of genetic connectedness; (b) The spatial and temporal embeddedness of the embryo; (c) The interplay between religious faith and trust in scientific institutions; (d) The diversity and contingency of the embryo.

Interviews were conducted with couples or individuals between September 5th, 2019 and January 20th, 2021. At the beginning of this research, the authors were aware that addressing such a sensitive topic with a potentially vulnerable population might be ethically and methodologically challenging, and may even compromise the success of the research (Aldridge, 2014). As such, the qualitative component of the project, which involved semi-structured interviews, was carried out by a member of the team who is particularly experienced in addressing sensitive reproductive health topics using qualitative approaches. As we have argued elsewhere, "researching sensitive topics requires a sensitive researcher" (Delaunay et al., 2020); the "emotional competence" of the researcher should therefore be considered important for the success of a study with such features. Emotional competence consists in having emotional reflexivity; the ability to build rapport with interviewee participants; empathy; and the ability to include information resulting from the expression of emotions (of both researcher and interviewee participants) in the analysis.

We issued a call for participation online through social media platforms – and in particular groups dedicated to ART users – disclosing the aim of the project, the scope of the interviews, and the identity of the researcher. The first interviews were carried out with people who had some degree of proximity with the researcher – who either knew the researcher directly or who had common friends. This led to an effect similar to a snowball sampling strategy, through which the researcher was indirectly marked as a safe contact, leading more people to approach him willing to share their personal story with ART.

Before each interview, the researcher clarified the implications of participating in the study. Interviews were carried out at the place, date, and time suggested by the participants, who were able to choose a location where they would feel safe and comfortable sharing their stories and, eventually, expressing feelings. Despite being semi-structured, most interviews were guided by the participant's narrative, with the researcher acting more as an active listener instead of an active inquirer. Participants expressed emotions frequently and, if doing so spontaneously evoked an emotional response in the researcher, this response was not hidden, but became part of the research relationship established.

After each interview, all participants had the opportunity to continue to contact the researcher to share more about their experience, and many did so, adding details or factual information to their narratives. Leaving this communication channel open also allowed for the research relationship not to suddenly end, but to last as long as the participant wished.

Interviewees' ages ranged from 25 to 47 years old (with an average of 38), with all of them cisgender and the vast majority female (slightly above 90%). All but five interviewees were Portuguese. Approximately 95% were living together with a partner, whether married or in a non-marital partnership. Only four interviewees were part of homosexual parenting projects. The vast majority had higher education (81.8%), among which a significant percentage had a postgraduate degree – a Master's and/or PhD (35%). All interviewees were employed.

The survey was available online between October 28th, 2019 and January 31st, 2020, having been disseminated through a patient organisation (Portuguese Fertility Association), LGBT associations (ILGA and Rainbow Families) and a social network platform (Facebook). The 85 respondents were aged between 27 and 55 (mean age of 38 years); 83 were women and two were men (all cisgender); and all were Portuguese nationals except for one Brazilian respondent. There were 79 heterosexuals, three homosexuals, and three bisexuals, 98% (83) of whom live as a couple (in either married or non-marital partnerships). Furthermore, 2/3 had higher education, 92% were in work, 6% were unemployed, and 2.4% were full-time students. 61% of the respondents said they belonged to a religion; of these, 98% were Catholic, and the degree of attachment to religion varied, but the most frequent level of attachment was moderate (60%). At the time of data collection, 27.1% had the IVF in progress or already planned, 14.1% were at the stage of pregnancy, 28.2% had completed the process without pregnancy and 30.6% had undergone processes resulting in a birth.

To clarify the clinical context of each interviewee, each interview excerpt presented in this article is accompanied by a matrix of acronyms to describe the participants' therapeutic trajectory (at the date of the interview). The acronyms refer to five variables and their respective values: (i) type of treatment (IVF or ICSI) and the number of concluded treatment cycles; (ii) number of obtained embryos (OE); (iii) number of successful treatments (ST), i.e. full-term pregnancies obtained during ART treatment; (iv) number of cryopreserved embryos (CE); and (v) number of surplus embryos discarded (DE). For example, '2IVF; 4OE; 1ST; 0CE' means a clinical course consisting of two completed IVF cycles, with a total of four embryos generated, one pregnancy obtained and zero existing cryopreserved embryos at the date of the interview.

4. Results

4.1. The differential statuses of IVF embryos: a choreography of emotions

Patients who resort to conventional IVF or ICSI have a wide diversity of views on and positioning towards their embryos, and their discourses expose the complexity and ambivalence they experience. This is largely because patients' relation to their embryos shapes and is shaped by these embryos' statuses and attributes. Not only do the statuses and attributes of the different embryos vary, but the same embryo can also change its social and moral status, thus affecting the emotional ties that beneficiaries build with them individually (Delaunay and Santos, 2020; Delaunay et al., 2021). It is thus essential to examine the reasons behind the variations in the way embryos are perceived by IVF users to better understand the role of emotions within ART.

Many of our interviewees had never previously been asked their views on the social and moral status of IVF embryos in general, and their embryos in particular, nor about whether they thought the embryo was biological matter, a human being, a potential child or a living entity. Some of them said that they had never reflected on these issues before; others declared they had never discussed them with anyone else; but some had talked them over in discussion forums or chat groups.

In our online survey into respondents' different representations of the embryo, the fact that very different ways of conceiving of the embryo all gained substantial average assent (see Fig. 1) illustrates the complexity that participants' meaning-making processes involve, and this is reinforced by our analysis of the interviews (Delaunay and Santos, 2020; Delaunay et al., 2021). Our survey employed multiple closed-ended questions, asking "What does an embryo represent to you at the moment of *in vitro* fertilization?" and allowing respondents to register their agreement with eight predefined statements along a six-point Likert scale. Each statement – and thus each variable examined – corresponded to a distinct mode of conceiving of the embryo, a distinct "status" within a taxonomy developed based on the existing literature. This design enabled us to better understand respondents' conceptualisations; a single closed-ended question allowing respondents to choose one or more statuses would not have provided such a nuanced picture (see Fig. 1).

Across the 85 survey respondents, the statement with the highest level of agreement (5.0 on average) was "the embryo is the beginning of life", followed by "the embryo is a group of cells" (4.0 on average). The embryo is seen less as "almost a real baby" (3.3 on average) or as "just one step of the ART procedure" (3.1 on average), yet both of these statements still have an average level of agreement above 3.

According to our data analysis, there is little consensus about the social and moral status of the embryo created *in vitro*; participants' views on this are influenced by various factors, including culturally-embedded beliefs and values. ART and, in particular, IVF or ICSI techniques are processes mostly experienced in the private sphere, punctuated by interaction with health professionals. The resulting general absence of feelings towards IVF embryos in public or semi-public discussions prevents the consolidation of a wider social understanding, preserving highly subjective narrative productions of definitions and meanings about embryos. Consequently, the logics that underlie decisions do not always appear to be coherent and reveal this empirical complexity and variability of understandings. The most commonly available discourse is a biomedical one, which tends to reduce life to its functional aspects; professionals use distinctive language, such as "to develop", "to select", "to transfer", "to freeze", drawn from a mechanical and utilitarian approach instead of an emotional one (Delaunay et al., 2021). However, the extent to which there is lay appropriation of this medical discourse also varies.

4.2. Dance in pairs: the value of genetic connectedness

In situations of heterosexual conjugality, different embryos are attributed different statuses depending on whether the genetic material comes from both members of the couple or, on the contrary, gametes (oocytes and/or sperm) have been donated by a third party.

In the first case, the transferred embryo (even when implantation in the uterus is unsuccessful) does not just signify a first attempt at – and therefore a hope of – the woman becoming pregnant; it symbolizes the relationship and very *union* between the two partners. Even when the treatment does not work, and even before the implantation stage, an emotional connection is established with the embryo; there is a feeling that the couple have had a common child, even if only for one moment. The embryo is perceived as *their* embryo that could have become their child, revealing an overlap between the two entities, embryo and baby.

In the second scenario, embryos – not only those already transferred, but also those cryo-stored – are not seen as just a group of cells, nor are they already seen as children; they are perceived instead as another means to an end. So there can sometimes be an absence of emotions when one of these embryos does not develop as expected and does not result in pregnancy.

As Denise's interview (2ICSI; 6OE; 1ST; 3CE) illustrates, participants seem to combine two distinct ways of understanding embryos generated at two separate moments of the therapeutic trajectory: a first treatment cycle, where one embryo is generated from the gametes of both members of the couple; and a second cycle, where multiple embryos are created using donor eggs. On the one hand, she demonstrates her

Fig. 1. Subjective representations of IVF embryos, average level of agreement.

emotional involvement with, and singularisation of, the unique genetically-related embryo that did not fully develop ("it was that magical matching", "the golden child"; "it leaves me with a full heart"). On the other hand, there is a functional understanding of the multiple embryos created from donor oocytes as being interchangeable. This replaceability is manifested, for example, when Denise downplays the loss of one embryo when several are generated ("the idea was for us to have four [embryos], but fine …").

Moreover, there is an overlap between an instrumental approach to the embryo originating from the third-party genetic material ("[the loss of embryos] was just frustrating […], there is no emotional connection") and the emotion work to deal with a feeling of loss associated with the unsuccessful embryo produced in the first IVF cycle with both spouses' gametes ("it was a loss of a child", "mourning was harder"). The former has worth because of its effectiveness and functionality within ART, i.e. because of its reproductive potential to help generate a child, under medical conditions. The latter involves ongoing emotion work to manage feelings and attachments at the most intimate level.

In sum, not only previous negative experiences with treatment failures, but also the geneticisation and biologisation of parenting seem to influence the embryo's status and the emotional connections established with it during an IVF cycle. The emotional choreographies of IVF patients thus consist of the dynamic coordination of the technical, scientific, affective, personal, genetic and kinship aspects of their embryos *in vitro*.

Within the context of this affective engagement favored by a genetic connection, there is also sometimes a feeling of having abandoned a potential child, given its capacity to be implanted and develop in another woman's uterus and thus become a real child in a different family context. Participants can therefore develop an uneasiness towards donating embryos to other beneficiaries because it is seen as equivalent to giving a child up for adoption:

> Gabriel: "It doesn't bother me that the embryos stayed there [cryopreserved]. It puzzled me more that they could be implanted in another woman and develop … It was almost like abandoning a child and someone adopting that kid." (2IVF; 16OE; 1ST; 0CE)

4.3. Spatial and temporal embeddedness of the embryo

a) Fixed steps and improvisation: stages and cycles of a therapeutic trajectory

As well as different embryos having different statuses, the same embryo's status can also vary depending on the stage of the medical procedure or the participants' personal trajectory. Participants can begin to view the embryo as a precious resource, as biological matter to be used in fertility treatments so as to achieve the final goal of becoming pregnant and having a child. Both the interviews and the survey reveal that after the embryo is transferred to – and particularly after it is implanted in – the uterus, this physical connection adds meaning and gives any eventual miscarriage emotional charge. Losing an embryo means more than just the interruption of embryonic development.

For the survey participants (See Fig. 2), an embryo transfer appears undoubtedly to be comparable to the beginning of pregnancy. Embryo transfer is, for most respondents, comparable mainly to the beginning of pregnancy in terms of emotional changes (85%), but also in terms of rational and psychological changes (75%). About half of respondents (48%) consider that embryo transfer is also comparable to early pregnancy in terms of physical changes.

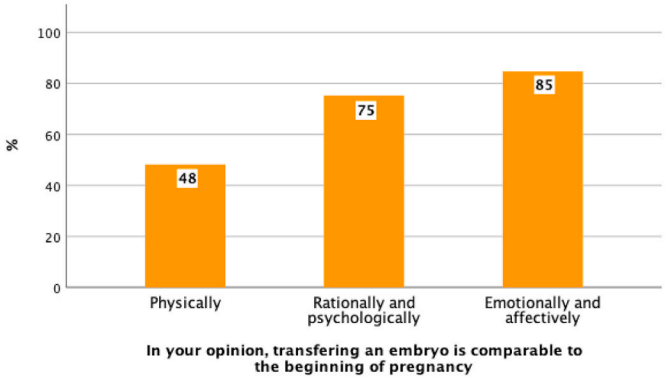

Fig. 2. The subjective beginning of pregnancy at the physical, psychological, and emotional levels, following a transfer.

The birth of a child, viewed as a fundamental temporal milestone in the therapeutic trajectory, can also change ART beneficiaries' perspectives on frozen surplus embryos conceived from the same batch. It does so by conferring potentiality and humanness on embryos *in vitro*, since their future has been materialized in their own living child. As stated below, from being perceived as biological matter and an additional attempt to become pregnant, the spare embryo becomes seen as a genetic sibling of an already-born IVF child (sisterhood/brotherhood), and thus holds the potential to become a child/person (personhood).

> Rita: "To think, hey, it's an embryo, with the same genetics, practically identical to your daughter's. It's a sister. Suddenly, to be able to cross the barrier that I had put on this subject, it's a human being, and to say that … calm down, there will be someone in the world who will have, someone who is, like, Luna's sister, my daughter, because she is a sister, genetically speaking. (…) it is not a biological material, it's an embryo, which has exactly the same, the same configuration as my daughter's … it's a feeling … that's why, it's because of my daughter." (1IVF; 3OE; 1ST; 1CE)

IVF patients' emotional choreographies around their embryos throughout the therapy's trajectory enable them to steer a course between nature and culture when it comes to understanding kinship ties, while leading to new kinds of meaning-making and affectional bonding. This emotion work undertaken by ART patients is linked to the need to care for their embryos *in vitro* for whom they already have feelings (affection, attachment).

> Paula: "It's us, isn't it? It's a little bit of me and my husband that is there, it was mixed. […] [I felt] affection, an enormous desire to have them with me. It was like it was just a … OK, on loan [to the experts] out there, just for them to grow up, isn't it? To give the seed a little water and sun. That idea of the seed that will blossom. […] over the next few years, the date of February 22nd was celebrated as if it was a loss, an abortion, which it wasn't. But it was … Because it's still not considered, is it? By Medicine, it's still not considered to be anything. It's just something that can happen every month without you knowing it. In that case we knew there had been a transfer." (3ICSI; 5OE; 0ST; 0CE)

As mentioned earlier, beneficiaries' experience of ART is embedded in standardized *temporal markers* that delimit different stages of the clinically-assisted procreation process. Beneficiaries therefore monitor each stage, and consequently acknowledge the failure to achieve any of these milestones ("we knew there had been a transfer"). This contrasts

with spontaneous procreation, where couples are not aware of the embryo's development in its early existence (from the moment of fertilisation). The timeline of the therapeutic trajectory therefore shapes – and is shaped by – the emotional choreographies involved in beneficiaries' bonding with the embryo.

b) Dancing in space: *in vitro*, *in utero* and in cryo-embryos

Being inside or outside the woman's body is commonly used as an explanatory factor for the different perspectives on embryos and the associated emotion work patients undertake. Some interviewees felt that it was from the moment of its transfer to the uterus that the embryo became something more than mere biological matter:

> Laura: "That's why I celebrate September 18th. It was around 2:20 p. m. And I have the photograph and I always look at it. September 18th for me is a day that is always marked. Because it was the day I got pregnant, the day my son got into my belly and we started our life together." (1IVF; 5OE; 1ST; 1CE)

However, it is not always at the implantation stage that the embryo created through IVF or ICSI is given its humanness, nor is it always then that an emotional bond develops. To understand the plurality of beneficiaries' bonding dynamics, we need to look not just at the embryo's spatial location, but also at how different ways of visually grasping it are available to beneficiaries depending on its spatial location. As described in the interview excerpts that follow, viewing photographs of the embryo in a Petri dish and/or viewing its transfer to the uterus through ultrasound was insufficient for some ART beneficiaries in our study to truly establish an affective connection with an embryo. Sometimes, it is only after a positive pregnancy test (which can trigger an imagined visual representation of the embryo developing in the womb) or an ultrasound scan between the 4th and the 6th week of gestation, or later, that the pregnancy becomes real to the beneficiaries and is perceived as embodied.

> Flora: "From the moment I got a positive pregnancy test, I tried to actually connect, and then yes, I was talking to the baby. From that time on, for me it was, in fact, a baby. (…) the embryo for me was something alive and a potential baby, but it wasn't a baby yet." (4ICSI; 6OE; 0ST; 0CE)

> Nora: "It was when I heard the heartbeat that I thought 'there's a person there who is developing' and I felt like a mother. And that's when everything changed. For me, we went from being in a biological and health process to being in a much more emotional process." (1FIV; 3–5[1]OE; 2ST; 1CE)

Nevertheless, for some of our interviewees, the loss of an IVF embryo, whether *in utero* or *in vitro*, also emphasises its materiality. Imagining the "tube" where the spare embryos were preserved being thawed may be significant and emotionally impactful. And after an embryo transfer, an early miscarriage may well confront prospective parents with the materiality of the implanted embryo. For example, seeing the gestational sac expelled spontaneously at home, together with the perceived need to say goodbye to the lost embryo, can be difficult to cope with:

> Aurora: "[The expulsion of the gestational sac] prolonged both the physical pain and the emotional pain […] Because it is a mourning no one understands … […] The few people who already knew about my pregnancy were very supportive and came. […] They say […] «You're going to have more children … » […] or « I'm glad it happened [the abortion] right at the beginning» […] But in our heads we are saying « No, no, no, it's not like that. OK, I'm going to have more children, but having this one and the other one will not replace this one» …" (1ICSI; 13OE; 0ST; 3CE)

Some other prospective parents we interviewed mourned an unsuccessful embryo transfer by doing the same emotion work as for a miscarriage. Yet others feel the need to honour and confer dignity on the spare embryos to be discarded by trying to engage in a transfer outside their fertile period, when there is only a small chance of implantation and viable development:

Sandra: "I had read somewhere that sometimes they transfer the embryos to the woman's body at a time when she is no longer fertile. I thought I wanted to do this." (1ICSI; 9OE; 1ST; 7CE).

This emotion work can also occur when beneficiaries bid farewell to their embryos by performing ritual ceremonies (e.g. keeping pictures of the plastic straws, writing goodbye letters to or drawing pictures of the embryos). These decisions that beneficiaries take according to the shifting meanings and statuses attributed to the embryo allow them to maintain the consistency of the self (i.e. the consistency of their identity over the long term). To throw away an embryo with which there were emotional attachments, for example, could disrupt this consistency.

> Sandra: "There was an emotional connection, otherwise I wouldn't have written them a letter, I wouldn't have painted the seven embryos [to be discarded] … I painted the seven embryos as if they were inside my womb, all at the same time."

> Flora: "Because it was confusing for me to throw it in the toilet or in the trash can. And then I put it in a vase, on a plant on our porch. OK, D_ [husband's name] didn't want to see it, nor did he want to watch the ritual […]. But I thought it was the way to stay with us a little bit."

The materiality of the embryo seems key to establishing meaningful emotional ties with it, either *in vitro* or *in utero*, while the processes through which embryos become materialized vary according to their spatial location. How beneficiaries subjectively experience these different forms of materiality also differs. There is a strong link between the emotion work patients perform within their ART trajectories (balancing their costs and benefits) on the one hand, and their processes of meaning-making about, and bonding with, their embryos on the other – processes that are triggered by forms of sensory apprehension that differ depending on these embryos' spatial location.

4.4. A back-and-forth motion: Between religious faith and trust in scientific institutions

Religion emerged, in the survey, as an important dimension of ART users' experience, influencing their views on embryos. For instance, religious respondents are less likely to see the embryo as just one step of the ART procedure ($M = 2.81$; $SD = 1.65$) than are non-religious ones ($M = 3.67$; $SD = 2.04$) ($t(83) = -2.134$; $p = 0.036$). In turn, religious respondents are more likely to see the embryo as the beginning of life ($M = 5.31$; $SD = 1.08$) compared to those who do not have a religion ($M = 4.35$; $SD = 1.87$) ($t(83) = 2.669$; $p = 0{,}009$).

Overall, the survey reveals high levels of agreement about the usefulness and benefits of science. 61.2% of the respondents considered IVF an example of the achievements of medicine and scientific knowledge. Yet for 36.5% the experience of IVF had reinforced our inability to control nature. There was a high level of agreement regarding the benefits of performing pre-implantation genetic testing, and regarding the statement that IVF procedures respect the rights of the child.

As far as we can glean from the interviews, trust in scientific institutions and/or attachment to a faith or religion can also affect the status assigned to the embryo at an early stage, before implantation. There seems to be a balance – instead of an opposition – between religious faith and scientific belief in the way the patients interviewed deal emotionally with both the embryos and medical procedures.

As the statements of Carla and Sandra show, religion/spiritual beliefs

[1] The interviewee was unable to provide the exact total number of generated embryos.

have an impact on beneficiaries' relationship with the *in vitro* embryo because they affect its perceived moral status. They do so via more existential beliefs about the beginning of life and the existence of a prenatal soul, but also through an attitude of resignation when helplessly facing one's fate. Contact with alternative understandings of the embryo – those that diverge from the dominant biomedical or technoscientific discourse – may shape a different gaze on the embryo and the reproductive process, and lead beneficiaries to question the ethical-moral boundaries delimiting its use and manipulation:

> Carla: "The embryo I transferred along with this baby, I still think about it … But that has to do with my beliefs. For me there is life from the moment there is an embryo … and I still think about it, but of course one thing is what we do not control and when we have to resign ourselves to …" (1ICSI; 7OE; 1ST; 5CE)

> Sandra: "The big difference, I think, was after the doulas' training course and beginning to look at the conception differently. The concept of the soul. When does the soul come? Do those embryos already have a soul? Have no soul? I don't know, but those are things I wondered about." (1ICSI; 9OE; 1ST; 7CE)

Furthermore, personhood and counter-gift seem to be reconciled in the interviewees' language. As in Paula's case, conceiving of the spare embryos as human potentialities that can become children in someone else's belly if donated to other couples ("After all, they [the spare embryos] are also allowing other couples to be happy, right?"), is in no way incompatible with deciding to donate embryos for research – a gift given to science out of a sense of gratitude for the opportunity to have had a child ("Given our awareness of how difficult it is, this whole process (…) Yes, please help someone, I don't know, who has a disease, find the cure for all these sorrows").

4.5. Diversity and contingency: the moving character of the embryo

One interesting recurring theme in the interviews was that embryos' meaning and status varies for the very same person, according to the point they have reached in their trajectory and the conditions correlated with this point. There is not an emotional attachment to all embryos, just because they are *their* embryos. The relationship beneficiaries establish with them varies depending on their goals for a specific stage of the life cycle or treatment process.

> Clara: "I have three frozen [embryos]. I am using two. And the third one I ended up not using. There will always be that doubt … "What would that one be like?" […] When I found out that I was pregnant, I thought a little … 'Can I go ahead with this or not?' … And then it was that issue, right? To think that I could have opted for an abortion and … and now I look at her and life does not make any sense without her. Because, maybe, if a fourth child came, this would be the most certain scenario …" (1IVF; 3OE; 1ST; 0CE; 1DE)

Once again, the new-born emerges as a means of reconfiguring the spare frozen embryo, along with a feeling of restlessness about its fate. A "doubt" remains about the decision taken – a disquiet that expresses the possibility of changing the meaning attributed to that surplus embryo, of giving it a status closer to that of a potential child (and, hence, further away from that of a means to an end or biological waste).

The meanings that a beneficiary attributes to human embryos thus depend not only on their personal path and health care trajectory, but above all on the expectations they place on these embryos, i.e., whether they already see them as a potential future child/baby or as a composition of genetic material. If there is no (other) parental project, it seems easier to perceive them as something that is not yet an object of emotional attachment, as a liminal entity in a suspended state, such as spare frozen embryos. But even this dimension is complex and nuanced.

Our interviewees engage in a great deal of emotion work in an attempt to manage their reproductive self, the uncertainty of ART treatments, and the need to deal with their embryos created *in vitro*, whether they become their children or not. Much of this embodied emotional work is performed by women, which can be partially explained by the centrality of biological processes (pregnancy and childbirth) to reproduction, and the fact that ART technologies always involve the medicalization of the female body.

5. Discussion

Throughout this article, we have shown how the human embryo's spatial and temporal symbolic (re)configurations and movements within ART trajectories are both intertwined and complex. These (re)configurations and movements are similar to the choreographies of "aggregation, circulation, and oscillation" which, in Vermeulen's view (Vermeulen, 2018), helped create systems biology as a research field. In our conceptual proposal, a new process of making meaning about these emergent living entities – together with the emotion work associated with this process – integrates/aggregates patients, practitioners, medical settings, kinship, and biotechnologies, in a performative choreography that also involves circulation and oscillation. The circulation of meanings attached to the embryo between experts (health professionals) and laypeople (IVF patients) cuts across different material settings (clinical centres, households, research labs) and underpins beneficiaries' emotional bonding, debonding and rebonding with the embryos. These emotional choreographies overlap with additional oscillating movements between opposing conceptualisations of embryos as care receivers (ART) and caregivers (embryo research), along with attempts to reconcile them. The complexity of these combinations of movements explicitly takes us beyond an essentialist view of embryos either as fixed biological entities or as human beings, leading us to focus on the interactions, as well as the multiplicity and (re)combination of meanings, that help to socially and emotionally construct human IVF embryos.

Our results confirm those of a previous literature review that revealed a wide diversity of social constructions of the IVF embryo, which is variously understood as a collection of cells or a seeding material, as a human life or a baby, as the sibling of an already-born child, as an individual or as public property, as a precious resource or an interim category (Goedeke et al., 2017). The interpretation of the meaning of embryos can be influenced by the changing lives of patients (Cussins, 1998).

There may be struggles between conflicting views and values, and the dominance of one view over another can shift during the treatment process. Thus the emotional nature of IVF shapes and reshapes understandings of embryos (Haimes et al., 2008). Embryos are not fixed, universal biological entities but instead are defined by their specific spatio-temporal and socio-cultural context: the specific stage in the treatment process and/or parenting project; their embodiment as fresh embryos (in the clinic), frozen embryos (in the freezer), implanted embryos (in a woman's uterus) or research embryos (in the laboratory); present legislation; past, current and projected future developments in science in general and assisted conception in particular (*ibidem*).

Moreover, both engendering and embryos' successive statuses during this process are relational (Giraud, 2014). These statuses do not just depend on internal or biological characteristics (cell morphology and size, etc.), but on how embryos are placed within a world of meanings and a set of social relationships between different actors (parents and their babies and/or health professionals and beneficiaries).

Studies have shown that women who conceive with ART report more antenatal emotional attachment: they demonstrate greater tenderness, affection and protectiveness towards the foetus compared to those who have become pregnant spontaneously. This may be explained by the fact that these pregnancies were actively sought and highly desired, and by the difficulty of conceiving (Fisher et al., 2008). When patients understand IVF embryos as living entities, they sometimes assign them the capacity to experience discomfort and even suffering (Nachtigall et al., 2005), thus triggering deep feelings.

Individuals who have experienced a disruptive event in their daily lives or life courses – such as an infertility diagnosis or a pregnancy loss that impacts everyday life and future expectations – engage in emotion work to manage both their sense of self, reaffirming self-identity, and their self in relation to others, maintaining social relationships (Exley and Letherby, 2001). From our results, we can see how unexpected life events or complex situations – such as the loss of an embryo *in utero* (or even *in vitro*) or the anguish of having to decide about the fate of surplus ones – force individuals to engage in emotion work in an attempt to face and manage their feelings – such as loss, distress, anxiety and grief – that arise in connection to reproductive technologies, as well as their actors (health professionals) and products (gametes and embryos). This entangled emotion work also preserves the consistency of the self over the long term.

Other studies also point to how women who have become pregnant through IVF balance faith in a mystic higher power (usually God), and confidence in science and in their personal power and action (Toscano and Montgomery, 2009). Well-informed patients are particularly knowledgeable about medical technology and aware of the odds of their treatment's success, and they sometimes view health and laboratory professionals as holding the greatest amount of power. In the end, however, even these patients seem not to view the advance of technology or science as the major contributor to their treatments' success. Nevertheless, IVF remains a "hope technology" (Franklin, 1997).

It is worth noting the intertwining of religion and modern medical science in our interviewees' therapeutic narratives. Religious belief plays a productive role in ART trajectories (Thompson, 2006), especially when it comes to beneficiaries' relationship with and emotions towards the embryos. Varying degrees of religious belief and practice are incorporated into treatment: there may be an appeal to the religious-political question of embryos' personhood when discussing and deciding on manipulation procedures and their fate or rescue; to spiritual beliefs as a ground for giving up treatment, for explaining successful or unsuccessful technical procedures (God's helping hand or God's decision), and thus for making sense of inconsistencies and failures as well as dealing with anxiety and suffering; or to a theodicy for justifying the decision to use medical technology and accepting how it can reconstitute kinship (*ibidem*).

Through different religious traditions, ART may be tentatively naturalized (e.g. by being seen as a way of achieving the "natural" family), divinized (e.g. by redescribing reproduction in terms of divine creation), and/or rejected (e.g. by condemning the production and destruction of unused embryos) by religious laypeople (Traina et al., 2008). Still other studies describe this intertwining between religion and new reproductive technologies in terms of disjunction (Roberts, 2012) or religious intervention – i.e. permissions and restrictions – and their different outcomes (Inhorn et al., 2017).

Medical visualization technologies, such as ultrasound, allow embryos and foetuses to be seen by families and professionals, even early in the pregnancy, detaching them from the maternal body and offering a special bonding opportunity long before the physical birth (Lupton, 2013). This has helped change how these entities are perceived by both experts and laypeople, blurring the boundaries between embryos, foetuses and infants, by individualizing, singularising and infantilizing the unborn (Boltanski, 2004; Lupton, 2013; Morgan, 2009; Petchesky, 1987; Rapp, 2000).

Studies show that women often experience fear, uncertainty and cautious joy at each stage of the IVF process, in which certain milestones (getting pregnant, seeing the baby on an ultrasound) have more impact than others (Toscano and Montgomery, 2009). While undergoing IVF, the existence of surplus frozen embryos and the visualization of *in utero* and *in vitro* embryos provide some sense of security. Given beneficiaries' uncertainty about treatment outcomes and how many attempts will be needed, spare embryos are reassuring since they are equated to a bonus (additional chances), representing security and the hope of achieving a successful pregnancy (Nachtigall et al., 2005; Svanberg et al., 2001; Toscano and Montgomery, 2009). The materialization of embryos through their visualization serves as a proof and a token of the possibility, even if ephemeral, of becoming a parent.

From the moment beneficiaries give birth to a child, the symbolism and status of the surplus embryo may change; it may no longer represent the chance to become pregnant but be seen as a "virtual" child/person in cryo-storage (forming an embryo-foetus-infant conceptual continuum) (De Lacey, 2005). The birth of an IVF-conceived child – especially if she comes from the same batch – leads some patients to consider the supernumerary embryo as their child (Laruelle and Englert, 1995), as a potential or virtual child, or as the sibling of an already-born child (Blyth et al., 2011; De Lacey, 2005, 2007; McMahon et al., 2003; Nachtigall et al., 2005; Paul et al., 2010; Parry, 2006; Provoost et al., 2009; Söderström-Antilla et al., 2001).

Consistent with our results, empirical evidence from previous studies suggests that patients who understand family as being based on genetic bonds tend to view their embryos as being a genetic replica of an existing child (de Lacey, 2005, 2007, 2017; Laruelle and Englert, 1995; McMahon et al., 2003; Nachtigall et al., 2005; Söderström-Antilla et al., 2001).

According to our study, the type of emotional bonds that beneficiaries create with IVF embryos outside the woman's womb changes depending on whether the genetic material comes from both members of the couple (part of "us") or only one, and on whether there are already children born from an *in vitro* embryo (siblings). The use of reproductive technologies seems to increase the value of genetic relatedness (Sparrow, 2014) – not only between the prospective parents and their potential children (genetic parenthood) but also between IVF siblings (genetic sisterhood/brotherhood) – as beneficiaries realise that their frozen embryos could develop into a being like the children they have already given birth to (Kato, 2014). Nevertheless, the embryo is a symbol not just of the gamete providers' pure genetic connection, but their relationship in a broader sense (Provoost et al., 2012).

The complexity, dilemmas and emotional stress (discomfort, anxiety, uncertainty, grief, regret) associated with the embryo disposition decision are widely recognized (McMahon et al., 2003; Provoost et al., 2012; Söderström-Antilla et al., 2001; Svanberg et al., 2001). These depend not only on how embryos are conceptualized, but also gradually evolve over time as a result of beneficiaries' moral reasoning (de Lacey, 2005, 2007; Nachtigall et al., 2005).

The literature on the rhetorical construction of cryo-stored embryos as virtual persons shows how both embryo donation (especially to other infertile couples) and cryopreservation may sometimes be experienced as child relinquishment. This is because beneficiaries feel responsible for protecting these embryos' interests and well-being, as they see them within the framework of a family underpinned by genetic relatedness (de Lacey, 2005; Nachtigall et al., 2005; Roberts, 2011). In these cases, the embryo's status is defined through "discourses of family relationships" (de Lacey, 2005: 1667) or of "kinship" (Goedeke et al., 2017), insofar as it is "cognitively incorporated into family structure" (Nachtigall et al., 2005: 433).

Since embryo disposal can give rise to grief and be regarded as early pregnancy loss, studies have stressed that ART beneficiaries express the desire for more personalized disposal options associated with greater proximity, respect and comfort –such as taking the embryos home, giving them a farewell ceremony or being discarded through compassionate transfer, i.e. transferred at the wrong time in a menstrual cycle (Fuscaldo et al., 2007, de Lacey, 2017).

The experiences of women and couples using new reproductive technologies, namely IVF, throw light on both *reproductive dilemmas* and *kinship dilemmas* (Franklin, 1997). Technological innovation and scientific progress make possible new forms of choice. But they thereby create uncertainty and introduce relativism into the definition of kinship, as they inaugurate new complex relationships with science and technology. These relationships may be temporary, but they can also be overwhelming and very often confusing. Beneficiaries thus have to do a significant amount of emotion work to cope with the demands of the IVF

procedure, particularly when facing serial failure.

Beneficiaries' conceptions of embryos can also encompass a perception that they are part of a gift transaction, leading to the decision to donate frozen embryos for research (Kato, 2014). In Portugal, the majority of couples are willing to donate their surplus embryos for research purposes (Silvestre, 2015). Here couples report "feelings of reciprocity towards science and medicine, positive views of research and high levels of trust in the medical system" (Samorinha et al., 2014: 652). As explained elsewhere, our respondents describe this either as a transfer of property ownership over which they have dispositional control and unilaterally renounce (i.e. of *utilities*, abstract and replaceable entities to which donors have no emotional connection), or as an emotionally-invested offering ritual (a *countergift* to repay reproductive medicine for making parenthood possible) (Delaunay et al., 2021) that involved a chain of giving-receiving-and-reciprocating (Shaw, 2008).

In sum, we have shown how ART beneficiaries, and specifically women, choreograph many different entities and agencies that are sometimes viewed as opposites – their body parts, such as gametes and wombs; nonhuman objects, such as petri-dishes, test-tubes, ultrasound scans, photographs and pregnancy tests; supra-individual stances such as laws, ethics, religion, biopolitics, and science; and other human beings, such as medical practitioners, partners, and live-born children – in their continuous emotion work around their embryos.

The major heuristic contribution of this paper to the existing and emerging literature in/beyond ART is to demonstrate the interplay between, on the one hand, technology-society relations as they are enacted in biomedical practice and, on the other, the emotional life of IVF (i.e. the affective role of emotion in IVF). To this end, we have discussed how the technological procedures that make up IVF and the emotional work undertaken by its human participants co-constitute the social bond of parenthood, along with kinship and attachment. We also propose that a "more-than-human" perspective on achieving parenthood is needed, challenging the received view of parenthood where human exceptionalism rules. According to this view, parenthood is broadly understood as a valuable human goal and technology is conceived as a backdrop or as a means to that greater human end. However, as our case material illustrates, ontological categories such as the human subject and technical objects are not separate or stand-alone; they exchange properties, they shift position, and they intra-act (Barad, 2007), and this must be acknowledged in future research.

Mapping beneficiaries' emotional oscillations, which are connected to the meanings they produce about the embryo, generates valuable knowledge that can be integrated into procedures and practices in ART clinics/units. Doing so allows us to assess these organisations' capacity to accommodate beneficiaries' different understandings and modes of connecting with the embryos – which can differ from the meanings embedded in the technical and legal norms that regulate their functioning. The resulting knowledge can also improve ART professionals' ability to address patients' vulnerabilities, enabling them to understand the full spectrum of patients' emotions around their embryos, which may affect their decision-making capacity precisely due to their potential emotional charge.

Our analysis of beneficiaries' meaning-making about and emotional attachments to embryos is limited by the specific characteristics of our sampling process (a non-probabilistic, intentional, snowball method). In our thematic analysis of the interviews, our main purpose has been to map the full diversity of perspectives, without necessarily identifying correlations with sociodemographic variables. Moreover, as mentioned in the methodology section, the fact that the sample doesn't cover a greater diversity of social profiles hinders inferences about possible differences in perspective (particularly conceptions of the embryo) among those of different genders and sexual orientations.

With respect to gender diversity, the decision to interview couples – rather than just individuals – had the benefit of leading to greater representation of the male population in the sample, as we were only able to obtain a single interview with a male respondent. This modality also allowed us to directly compare outlooks and thus enabled us to highlight convergences and contrasts between members of a couple along the different dimensions covered by the interview guide – in this case, the plural meanings around the embryo.

Along with the individual interviews, interviews with couples have also made it possible to see the impact of the embodied experience on women's processes of (re)configuring meanings. In particular, the perceived centrality of the embryo's transfer to the uterus, as well as women's experiences of the pregnancy's development and gestational loss, both help determine the embryo's ontological oscillation (Boltanski, 2004). Despite these additional insights gained by interviewing a large number of women, the low proportion of male respondents requires us to further explore the specificities of men's experiences of ART in future research.

Credit author statement

Catarina Delaunay: Conceptualization; Data curation; Formal analysis; Funding acquisition; Investigation; Methodology; Project administration; Resources; Software; Supervision; Validation; Visualization; Roles/Writing – original draft; Writing – review & editing. Luís Gouveia: Formal analysis; Investigation; Methodology; Validation; Visualization; Writing – review & editing. Mário JDS Santos: Formal analysis; Investigation; Methodology; Validation; Visualization; Writing – review & editing. Rita Morais: Formal analysis; Investigation; Methodology; Validation; Visualization; Writing – review & editing.

Data availability

Data will be made available on request.

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References

Adrian, S.W., 2015. Psychological IVF: conceptualizing emotional choreography in a fertility clinic. Distinktion Scand. J. Soc. Theory 16 (3), 302–317.
Ahmed, S., 2004a. The Cultural Politics of Emotion. Edinburgh University Press, Edinburgh.
Ahmed, S., 2004b. Affective economies. Soc. Text 22 (2), 117–139.
Aldridge, J., 2014. Working with vulnerable groups in social research: dilemmas by default and design. Qual. Res. 14 (1), 112–130.
Bankowski, B., Lyerly, A., Faden, R., et al., 2005. The social implications of embryo cryopreservation. Fertil. Steril. 84 (4), 823–832.
Barad, K., 2007. Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning. Duke University Press, Durham and London.
Berstein, J., Lewis, J., Seibel, M., 1994. Effect of previous infertility on maternal–fetal attachment, coping styles, and self-concept during pregnancy. J. Wom. Health 3 (2), 125–133.
Blyth, E., Frith, L., Paul, M.S., et al., 2011. Embryo relinquishment for family building: how should it be conceptualised? Int. J. Law Pol. Fam. 25 (2), 260–285.
Boltanski, L., 2004. La Condition Fœtale. Gallimard, Paris.
Bradley, E.H., Leslie, A.C., Kelly, J.D., 2007. Qualitative data analysis for health services research: developing taxonomy, themes, and theory. Health Serv. Res. 42 (4), 1758–1772.
Braun, V., Clarke, V., 2019. Reflecting on reflexive thematic analysis. Qualitative Research in Sport, Exercise and Health 11 (4).
Callan, V.J., Hennessey, J.F., 1988. Emotional aspects and support in in vitro fertilization and embryo transfer programs. J. In Vitro Fert. Embryo Transf. 5 (5), 290–295.
Casper, M.J., 1994. At the margins of humanity: fetal positions in science and medicine. Sci. Technol. Hum. Val. 19 (3), 307–323.
Cussins, C.M., 1998. Ontological Choreography: agency for women patients in an infertility clinic. In: Berg, M., Mol, A. (Eds.), Differences in Medicine: Unraveling Practices, Techniques, and Bodies. Duke University Press, Durham and London, pp. 166–201.
de Lacey, S., 2005. Parent identity and 'virtual' children: why patients discard rather than donate unused embryos. Hum. Reprod. 20 (6), 1661–1669.

de Lacey, S., 2007. Decisions for the fate of frozen embryos: fresh insights into patients' thinking and their rationales for donating or discarding embryos. Hum. Reprod. 22 (6), 1751–1758.
de Lacey, S., 2017. Death in the clinic: women's perceptions and experiences of discarding supernumerary IVF embryos. Sociol. Health Illness 39 (3), 397–411.
Delaunay, C., Augusto, A., Santos, M.J.D.S., 2020. Invisible Vulnerabilities: Ethical, Practical and Methodological Dilemmas in Conducting Qualitative Research on the Interaction with IVF Embryos. Societies 10 (1), 7.
Delaunay, C., Santos, M.J.D.S., 2020. Proximidade e distanciamento aos mundos do embrião in vitro: experiências significantes em tempos de desassossego. Terceiro Milênio: Revista Crítica de Sociologia e Política 14 (1), 14–40.
Delaunay, C., Santos, M.J.D.S., Gouveia, L., 2021. In vitro metaphors: ART beneficiaries' meaning-making about human embryos in the context of IVF in Portugal. Reproductive Biomedicine and Society Online 13, 62–74.
Exley, C., Letherby, G., 2001. Managing a disrupted lifecourse: issues of identity and emotion work. Health 5 (1), 112–132.
Fisher, J.R.W., Hammarberg, K., Baker, G.H.W., 2008. Antenatal mood and fetal attachment after assisted conception. Fertil. Steril. 89 (5), 1103–1112.
Franklin, S., 1997. Embodied Progress: A Cultural Account of Assisted Conception. Routledge, London and New York.
Franklin, S., 1999. Making representations: the parliamentary debate on the human fertilisation and embryology act. In: Edwards, J. (Ed.), Technologies of Procreation: Kinship in the Age of Assisted Conception. Manchester University Press, Manchester, pp. 129–166.
Franklin, S., 2006. The cyborg embryo our path to transbiology. Theor. Cult. Soc. 23 (7–8), 167–187.
Franklin, S., 2013. Biological Relatives: IVF, Stem Cells, and the Future of Kinship. Duke University Press, Durham and London.
Freeman, E.W., Boxer, A.S., Rickels, K., et al., 1985. Psychological evaluation and support in a program of in vitro fertilization and embryo transfer. Fertil. Steril. 43 (1), 48–53.
Frost, J., Bradley, H., Levitas, R., et al., 2007. The loss of possibility: scientisation of death and the special case of early miscarriage. Sociol. Health Illness 29 (7), 1003–1022.
Fuscaldo, G., Russell, S., Gillam, L., 2007. How to facilitate decisions about surplus embryos: patients' views. Hum. Reprod. 22 (12), 3129–3138.
Giraud, A.-S., 2014. Le corps embryonnaire et foetal dans une approche relationnelle. Recherches familiales 11 (1), 9–17.
Goedeke, S., Daniels, K., Thorpe, M., et al., 2017. The fate of unused embryos: discourses, action possibilities, and subject positions. Qual. Health Res. 27 (10), 1529–1540.
Haimes, E., Porz, R., Scully, J., et al., 2008. 'So, what is an embryo?' A comparative study of the views of those asked to donate embryos for hESC research in the UK and Switzerland. New Genet. Soc. 27 (2), 113–126.
Haraway, D., 1991. Simians, Cyborgs and Women: the Reinvention of Nature. Free Association Books, London.
Hirschi, T., 2001. Causes of Delinquency. Routledge, New York, 1969.
Hochschild, A., 1983. The Managed Heart: Commercialisation of Human Feelings. University of California Press, London.
Inhorn, M.C., Birenbaum-Carmeli, D., Tremayne, S., et al., 2017. Assisted reproduction and Middle East kinship: a regional and religious comparison. Reproductive Biomedicine and Society Online 8 (4), 41–51.
Kato, M., 2014. Giving a gift to the gift: women's experiences of embryo donation in Japan. Anthropol. Forum 24 (4), 351–363.
Laruelle, C., Englert, Y., 1995. Psychological study of in vitro fertilization-embryo transfer participants' attitudes toward the destiny of their supernumerary embryos. Fertil. Steril. 63 (5), 1047–1050.
Latour, B., 2005. Reassembling the Social: an Introduction to Actor-Network-Theory. Oxford University Press, Oxford.
Special issue: sociological review monograph series. In: Law, J., Hassard, J. (Eds.), Actor Network Theory and after 47 (S1), 1–251.
Lupton, D., 2013. The Social Worlds of the Unborn. Palgrave Macmillan, Basingstoke.
Mahlstedt, P.P., Macduff, S., Bernstein, J., 1987. Emotional factors and the in vitro fertilization and embryo transfer process. J. In Vitro Fert. Embryo Transf. 4 (4), 232–236.
McMahon, C.A., Gibson, F.L., Leslie, G.I., et al., 2003. Embryo donation for medical research: attitudes and concerns of potential donors. Hum. Reprod. 18 (4), 871–877.
Millbank, J., 2017. Exploring the ineffable in women's experiences of relationality with their stored IVF embryos. Body Soc. 23 (4), 95–120.
Mol, A., 2002. The Body Multiple: Ontology in Medical Practice. Duke University Press, Durham, NC.
Morgan, L.M., 2009. Icons of Life: A Cultural History of Human Embryos. University of California Press, Berkley and Los Angeles.
Nachtigall, R., Becker, G., Friese, C., et al., 2005. Parents' conceptualization of their frozen embryos complicates the disposition decision. Fertil. Steril. 84 (2), 431–434.
Parry, S., 2006. Re)constructing embryos in stem cell research: exploring the meaning of embryos for people involved in fertility treatments. Soc. Sci. Med. 62 (10), 2349–2359.
Paul, M.S., Berger, R., Blyth, E., et al., 2010. Relinquishing frozen embryos for conception by infertile couples. Fam. Syst. Health 28 (3), 258–273.
Petchesky, R.P., 1987. Foetal images: the power of visual culture in the politics of reproduction. Fem. Stud. 13 (2), 263–292.
Pickering, A., 1995. The Mangle of Practice: Time, Agency, and Science. The University of Chicago Press, Chicago and London.
Pratt, T., Franklin, T., Gau, J., 2011. Key idea: hirschi's social bond/social control theory. In: Key Ideas in Criminology and Criminal Justice. SAGE, Los Angeles, Calif, pp. 55–69.
Provoost, V., Pennings, G., De Sutter, P., et al., 2009. Infertility patients' beliefs about their embryos and their disposition preferences. Hum. Reprod. 24 (4), 896–905.
Provoost, V., Pennings, G., De Sutter, P., et al., 2012. 'Something of the two of us'. The emotionally loaded embryo disposition decision making of patients who view their embryo as a symbol of their relationship. J. Psychosom. Obstet. Gynecol. 33 (2), 45–52.
Rapp, R., 2000. Testing Women, Testing the Fetus: the Social Impact of Amniocentesis in America. Routledge, New York and London.
Raz, A., Vardi, J., Reisner Vain, S., et al., 2021. Unmet communication needs and moral work in the disposition decision concerning surplus frozen embryos: the perspectives of IVF users. Soc. Sci. Med. 274, 113804.
Roberts, E., 2011. Abandonment and accumulation: embryonic futures in the United States and Ecuador. MAQ (Med. Anthropol. Q.) 25 (2), 232–253.
Roberts, E., 2012. God's Laboratory: Assisted Reproduction in the Andes. University of California Press, Berkeley.
Samorinha, C., Pereira, M., Machado, H., et al., 2014. Factors associated with the donation and non-donation of embryos for research: a systematic review. Hum. Reprod. Update 20 (5), 641–655.
Schmitz, S., Ahmed, S., 2014. Affect/emotion: orientation matters. A conversation between sigrid Schmitz and sara ahmed. Freiburger Zeitschrift Für GeschlechterStudien 22 (2), 97–108.
Seibel, M.M., Levin, S., 1987. A new era in reproductive technologies: the emotional stages of in vitro fertilization. J. In Vitro Fert. Embryo Transf. 4 (3), 135–140.
Shaw, R., 2008. The notion of the gift in the donation of body tissues. Socio. Res. Online 13 (6), 41–50.
Shaw, P., Johnston, M., 1988. Counselling needs, emotional and relationship problems in couples awaiting IVF. J. Psychosom. Obstet. Gynecol. 9 (3), 171–180.
Silvestre, M., 2015. Embriões excedentários - entre a técnica, a lei e a ética. Coimbra Editora, Coimbra.
Söderström-Anttila, V., Foudila, T., Ripatti, U., et al., 2001. Embryo donation: outcome and attitudes among embryo donors and recipients. Hum. Reprod. 16 (6), 1120–1128.
Sparrow, R., 2014. Reproductive technologies, risk, enhancement and the value of genetic relatedness. J. Med. Ethics 40 (1), 741–743.
Squier, S., 2004. Liminal Lives: Imagining the Human at the Frontiers of Biomedicine. Duke University Press, Durham, NC.
Stanton, F., Golombok, S., 1993. Maternal-fetal attachment during pregnancy following in vitro fertilization. J. Psychosom. Obstet. Gynecol. 14 (2), 153–158.
Strathern, M., 1992. Reproducing the Future: Essays on Anthropology, Kinship and the New Reproductive Technologies. Manchester University Press, Manchester.
Svanberg, A., Boivin, J., Bergh, T., 2001. Factors influencing the decision to use or discard cryopreserved embryos. Acta Obstet. Gynecol. Scand. 80 (9), 849–855.
Thévenot, L., 2009. Biens et réalités de la vie en société. Disposition et composition d'engagements pluriels. In: Breviglieri, M., Lafaye, C., Trom, D. (Eds.), Compétences critique et sens de la justice. Economica, Paris, pp. 37–55, 2009.
Thévenot, L., 2014. Une Vie Éprouvée: entre migration postcoloniale, discrimination à l'embauche, maternité affectée et adoption salvatrice: quelle 'identité forgée. In: dir, Vrancken D ((Ed.), Penser L'incertain. Presses de l'Université de Laval, Laval, pp. 139–160.
Thompson, C., 2005. Making Parents: the Ontological Choreography of Human Reproductive Technologies. MIT Press, Cambridge and London.
Thompson, C., 2006. God is in the details: comparative perspectives on the intertwining of religion and assisted reproductive technologies. Cult. Med. Psychiatr. 30 (4), 557–561.
Thompson, C., 2013. Good Science: the Ethical Choreography of Stem Cell Research. The MIT Press, Massachusetts.
Toscano, S.E., Montgomery, R.M., 2009. The lived experience of women pregnant (including preconception) post in vitro fertilization through the lens of virtual communities. Health Care Women Int. 30 (11), 1014–1036.
Traina, C., Georges, E., Inhorn, M., et al., 2008. Compatible contradictions: religion and the naturalization of assisted reproduction. In: Lustig, B.A., Brody, B.A., McKenny, G. P. (Eds.), Altering Nature. Philosophy and Medicine. Springer, Dordrecht, pp. 15–85.
Vermeulen, N., 2018. The choreography of a new research field: aggregation, circulation and oscillation. Environ. Plann. 50 (8), 1764–1784.
Watson, K.W., 1997. Bonding and attachment in adoption. Marriage Fam. Rev. 25 (3–4), 159–173.
Wetherell, M., 2012. Affect and Emotion: A New Social Science Understanding. SAGE, Los Angeles, Calif.
Zegers-Hochschild, F., Adamson, G.D., Mouzon, J de, et al., 2009. The ICMART and the WHO revised glossary on ART terminology? Hum. Reprod. 24 (11), 2683–2687.