Available online at www.sciencedirect.com

ScienceDirect

Current Opinion in Psychology

Grounding of rank: embodiment, space, and magnitude

Thomas W Schubert[1,2]

Humans build hierarchical relations, in which they coordinate according to rankings. Rankings need to be mentally represented in order to be communicated and constituted. These mental representations are grounded: They depend on the body and its interactions with the physical and social environment. The review reports evidence from four fields on the nature of this grounding. Work on nonverbal behavior shows that rank is inferred from various magnitudes related to bodily size and strength. Conversely, rank is envisioned using the same magnitudes. Schematized versions of these and other magnitude and dimensional cues influence cognition about ranks. Finally, cognition about ranks shows characteristics of magnitude. These lines of work converge in the conclusion that humans have developed a general representation of rank as a magnitude grounded in bodily size and strength.

Addresses
[1] University of Oslo, Department of Psychology, Forskningsveien 3A, 0373 Oslo, Norway
[2] Instituto Universitário de Lisboa (ISCTE-IUL), Av. das Forças Armadas, 1649-026, Lisboa, Portugal

Corresponding author: Schubert, Thomas W (thomas.schubert@psykologi.uio.no)

Current Opinion in Psychology 2020, **33**:222–226

This review comes from a themed issue on **Power, status and hierarchy**

Edited by **Gerben van Kleef** and **Joey Cheng**

https://doi.org/10.1016/j.copsyc.2019.09.012

2352-250X/© 2019 The Author(s). Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Humans relate to others in various distinct ways in order to coordinate and collaborate. One of these basic ways to relate to others is to rank persons or groups in a linear order according to some criterion [1]. Such ranks can determine access to benefits, resources, or exposure to costs. When creating, entering, navigating, confirming, and changing such rankings, humans need to create and manipulate mental representations of the rank order. In particular, they need to mentally represent and remember their own and others' ranks, and understand others' willingness and potential to climb the hierarchy. They also need to be able to communicate rankings that they claim or accord to each other and understand constitutive acts that establish rank. Often multiple cues are available and need to be integrated.

The body's interactions with the environment play a role in these tasks in various ways. Static and dynamic bodily features provide cues that are used to establish the ranking; this is commonly referred to as nonverbal communication of power, social status, or dominance. Next, beyond the mere use of perceived cues, thinking about, communicating, and constituting rank are influenced by, or grounded in, the body, modality-specific systems in the mind, and the physical environment [2]. We think about rank by thinking about abstracted representations of bodily and spatial cues. Finally, it has been proposed that bodily and spatial cues also feedback to a person's cognition and feeling about herself. I refer to these strands of work as investigating the *grounding* of rank [3••].

There is no single theory of grounding or embodiment, nor is it likely there will be one [3••]. Rather, we have a host of related theories and hypotheses. The goal of the present paper is to give an overview over these strands connected to rank with a focus on the most recent developments, and then to propose how they can fruitfully inform each other in a framework that identifies magnitude representations as the core cognitive module for the representation and communication of rank orders. Note that synthesizing this work can be cumbersome because so many closely related terms are used: authority, power, status, dominance, hierarchy, rank, and so on. Their definitions vary. I will use the generic term rank whenever possible in this review, and more specific terms when necessary. Similarly, I will mainly use the term magnitude, although the term dimension may be more appropriate in some cases.

Inferring rank from bodily magnitudes

A range of bodily cues are used to infer rank and its various correlates [4]. A subset of them actually does correlate with rank [5,6]. In the last few years, we have learned a lot about these cues, partly due to new methods such as reverse correlation approaches and computer-generated renderings of human faces. Data-driven, bottom-up empirical approaches have established that dominance is one of the primary dimensions when judging others' faces [7]. Dominant faces modeled in this manner resemble those of mature men. The gaze of individuals with such faces is involuntarily followed more strongly [8]. Dynamic cues — that is, facial expressions of anger — can mimic such static features. The typical anger expression enhances inferences of bodily strength [9].

Regarding the body as a whole, height [10], expansiveness of posture, and smaller interpersonal distances to others seem to be valid and known cues to high rank [5,6]. Their use impacts inferences of rank, but can have ironic consequences: Displaying expansive postures can be costly when asking for aid, at least for men [11]. However, many more bodily cues contribute to judgments of rank, and their relevance varies across individuals and across cultures [12].

Rank is not a homogenous construct, and different dimensions can be dissociated. In the face, representations of physical strength and representations of social dominance look similar, but can be distinguished. Physical strength inferred from the face is used as a cue to judge social dominance more than vice versa [13].

Rank orders can be ascribed or achieved through various means. One is through threat and forced deference — often referred to as *dominance*. Another is based either on attributes such as age, gender, or ethnicity, or through accruing reputation based on contests, expertise and value to others — typically called *prestige* or social status [14]. Facial features of masculinity and height-to-width ratio may be more important for hierarchies based on dominance, while facial features indicating trustworthiness and competence may more important in prestige-based rankings [15]. In the body, prestige and dominance also seem to be communicated somewhat differently. Both go along with physical expansiveness in posture, but prestige displays rely more on expanded chests, while dominance displays rely more on space-consuming movements. In addition, prestige displays go along with smiles and heads tilted upwards, while dominance displays lack the smiles and go along with heads tilted down and direct gazes [16••]. Fittingly, that particular posture appears to enhance anger impressions [17].

One line of work has attempted to show that expansive postures not only inform others' judgments, but also feedback to one's own feelings of power and bring about behavioral hormonal changes. While the initial evidence on the effects of expansive postures on behavior and hormones [5] has failed to replicate [18–20], there is solid meta-analytic evidence that expansive (versus restrictive) poses increase feelings of power with effects of moderate size [20,21•].

Schematized magnitude cues influence thinking about rank

Inferences of rank from the bodily features of dominance just reviewed are likely to be based on evolved mechanisms that associate them with potential threat and coercive power [9,10]. However, humans also use a variety of non-bodily cues to communicate and infer rank. These non-bodily cues vary in how abstract or schematic they can become, ranging from adornments (hats and crowns) and extensions of the body (thrones and daises, desks and offices, cars), to dwelling size and location and beyond [22,23]. For instance, in accordance with gender stereotypes, photos of men are placed higher on the page in American magazines than photos of women [24••].

Indeed, magnitude cues can be schematized considerably and still influence rank inferences. When reading labels of social groups and roles, their relative and absolute vertical spatial location can interfere with judgments of their social ranks, as has been shown for both German [25] and Chinese participants [26]. In addition, spatial codes derived from motor imagery (up/down key presses) similarly interfere [25,27]. This happens for well-known, newly learned, and even inferred ranks [28]. The cognitive conflict occurring during this interference has been document with EEG [26] and pupillometry methods [29].

This interference occurs because judging rank activates spatial codes. Notably, spatial codes are activated by seeing labels of roles or groups of high or low rank (e.g. king) even without explicit instructions to judge their rank; however, minimal semantic processing is necessary [30,31]. Chinese children show the effect already at 11 years of age with written material, but only when the power judgment is explicitly prompted [27]. When powerful versus powerless group labels are presented auditorily and they have to respond with up versus down button presses, Chinese children show the effect already at six years of age [32]. While spatial codes are activated spontaneously in such paradigms, they can be overwritten by additional verbal cues, showing that language can supersede the processing of perceived magnitudes [30].

Such rather schematic spatial cues can have downstream cognitive effects. Presumably because men are expected to have higher status, they are expected to be elevated in space [29]. Probably for the same reason, faces seen lower in space are perceived as more feminine [33]. Elevated placement of photos on magazine pages increases viewers' attributions of power, status, and dominance to the depicted individuals, and repeated exposure to female spatial elevation on magazine pages decreased endorsements of the stereotype that men are powerful and dominant [24••]. Vertical position on a page is integrated with horizontal cues, which convey agency, to inform leadership judgments [34]. In the standard cyberball paradigm, the socially excluded participant is depicted in a lower position on the screen, while one of the other players is depicted above. When the participants are instead depicted at the top, typical adverse effects of ostracism are diminished [35].

Two caveats are in order. First, interactions of cognition about ranks with spatial magnitudes derived from visual perception or motor imagery are mostly investigated on screens. Not enough work has been done in real (or virtual) space. Second, one relevant study [36] did not

replicate in the Many Labs 2 replication project [37]. This particular paradigm manipulated vertical distance in an organigram. Our own preregistered follow-up studies confirmed the failure, and found that at least in that paradigm, participants infer rank only from ordinal information derived from spatial displays, but ignore interval scale-level information. In contrast, when creating rather than reading an organigram, vertical distance is treated as an interval scale and used to depict power [38]. This contradiction is unresolved.

Rank influences thinking about magnitudes

Just as spatial magnitudes can influence thinking about rank, thinking about rank apparently can also change thinking about spatial magnitudes. Nonverbal status cues affect not only judgments of rank, but also judgments of body size [39]. Information about foes' tactical victories or defeats, even if largely symbolic, can affect estimates of their physical size and bodily formidability [40,41]. The presence of allies and possession of weapons both change judged size and formidability, and threatening outgroup members are judged as smaller and less formidable if the ingroup is seen as able to thwart the threat [42•]. The exact cognitive processes at work in these effects are still to be determined.

This line of work suggests that the representation of another person's formidability acts as a summary representation of a person's rank, or is at least biased by rank. The distinction between prestige and dominance is relevant again: Size/strength representations may be used for both dominance and prestige rankings [43], and may come into conflict [44]. Recent work has traced such influences to judgments of the size of strength and size of racial groups by US participants [45]. Although judgments of size and strength largely reflect actual individuating information, they can be biased by culturally transmitted beliefs [46], which may be due to representing threat as physical size [44].

Rank as magnitude representation

In early work on the embodiment of power, theoretical rationales were largely based on undifferentiated notions mixing conceptual metaphor theory, hypotheses from evolutionary psychology, and empiricist (learning) accounts [25]. However, strong evidence for activation of primary perceptual representations during conceptual thought is largely missing, and seems increasingly unlikely [47]. Building theories of concepts solely around sensory-motor representations, without acknowledging some level of abstraction, is probably futile [2]. Instead, modern grounded theories of knowledge assume abstraction that compresses and distils multimodal information into abstract (but not a modal) representations. In the case of rank, this is a) likely supported by neural reuse in the brain, in particular of the analog magnitude system [48], and b) guided by evolved structures that associate size with rank [49]. Distributed linguistic representations can interact with these abstract representations, and can even provide heuristic information on their own [2].

Both neuropsychological and behavioral evidence suggests that rank is processed as a magnitude similar to number, volume, or brightness [50,51]. Decisions about who is of higher rank take longer the closer in rank the two compared targets are [28,52•,53]. This distance effect is a signature of magnitude processing. Assuming that rank is mentally represented as a magnitude promises an elegant integration of the various findings on interference by spatial cues and the observation of distance effects. However, some inconsistencies remain to be solved. The size effect, another signature of the magnitude system, does not directly replicate for rank: When distance is constant, comparisons are fast both at the lower and the upper end of a hierarchy, instead of slowing down in a linear manner [52•]. It is also unclear how social rank, which is ordinal by nature, is actually handled by a system that evolved for continuous quantities.

Magnitude representation of rank is likely evolutionarily prepared for at least some cues (e.g. bodily size and numerosity [49,54]), enables and guides learning of further associations, and ultimately supports culture-specific associations of specific magnitude cues with rank [22]. Indeed, the ubiquity of magnitude-based and dimension-based cultural practices and artifacts for constituting rank likely results from cultural evolution based on psychological selection for practices and artifacts that resonate with innate representations of rank [22].

Conclusion and outlook

Multiple lines of work have come to overlapping conclusions about how we think about rank: Based on a phylogenetically old system that derives predictions about outcomes of physical conflict from perceptions of size, maturity, muscularity, number of allies in coalitions, and possibly other cues, humans have developed a general representation of rank as a magnitude [16••,44]. Cognizing rank as magnitude allows communicating (and biasing) cognition about rank through physical presentations of other magnitudes, such as size, elevation, loudness, and so on. We can experimentally test such effects with various cognitive paradigms, but also observe their outcome in the anthropological record. Conversely, mental representations of the human body's size and strength may act as a mental shortcut and summary of a person's rank. This account modifies earlier, often sketchy, conceptualizations of the embodiment of power by eschewing purely empiricist unprepared learning notions, while integrating modal sensory as well as abstract or schematized representations [2]. Cognizing rank is related to sensory modalities through representations of magnitudes. Instantiations of magnitudes in the environment and in the body can influence cognition of rank. This

system developed to facilitate the coordination of humans in hierarchical relations.

These conclusions should not be misread as suggesting that humans inevitably submit to stronger, larger, and more masculine others, or even that this should be rightly so. On the contrary, the use of schematized magnitude cues arguably allowed humans to culturally evolve ways to establish rank orders that transcended the givens of the body. Furthermore, rank is typically announced and asserted by culturally informed formal cues — those that are based on dimensions and magnitudes and those that are not. Understanding how both function and interact is important because they determine how we can create and maintain hierarchical relations where they serve the common good, and stay clear of and upend them where they do not.

Conflict of interest statement

Nothing declared.

Acknowledgements

I thank Lei Zhu and Steffen Giessner for suggesting work to be included here, and Alan P. Fiske and Beate Seibt for feedback on the manuscript.

References

1. Fiske AP: **The four elementary forms of sociality: framework for a unified theory of social relations**. *Psychol Rev* 1992, **99**:689-723.

2. Barsalou LW: **On staying grounded and avoiding Quixotic dead ends**. *Psychon Bull Rev* 2016, **23**:1122-1142.

3. •• Matheson HE, Barsalou LW: **Embodiment and grounding in cognitive neuroscience**. In *Stevens' Handbook of Experimental Psychology and Cognitive Neuroscience.* Edited by Wixted JT. John Wiley & Sons, Inc.; 2018:1-27
This is a recent, thorough, and yet accessible review of the cognitive neuroscience of embodiment and grounding. It focuses on theory and provides a structured overview of major theories, hypothesis, methods, and recent trends.

4. Reh S, Van Quaquebeke N, Giessner SR: **The aura of charisma: a review on the embodiment perspective as signaling**. *Leadersh Q* 2017, **28**:486-507.

5. Carney D: **The nonverbal expression of power, status, and dominance**. *Curr Opin Psychol* in press.

6. Hall JA, Coats EJ, LeBeau LS: **Nonverbal behavior and the vertical dimension of social relations: a meta-analysis**. *Psychol Bull* 2005, **131**:898-924.

7. Todorov A, Olivola CY, Dotsch R, Mende-Siedlecki P: **Social attributions from faces: determinants, consequences, accuracy, and functional significance**. *Annu Rev Psychol* 2015, **66**:519-545.

8. Jones BC, DeBruine LM, Main JC, Little AC, Welling LLM, Feinberg DR, Tiddeman BP: **Facial cues of dominance modulate the short-term gaze-cuing effect in human observers**. *Proc R Soc B Biol Sci* 2010, **277**:617-624.

9. Sell A, Cosmides L, Tooby J: **The human anger face evolved to enhance cues of strength**. *Evol Hum Behav* 2014, **35**:425-429.

10. Stulp G, Buunk AP, Verhulst S, Pollet TV: **Human height is positively related to interpersonal dominance in dyadic interactions**. *PLoS One* 2015, **10**:e0117860.

11. Tracy JL, Steckler CM, Randles D, Mercadante E: **The financial cost of status signaling: expansive postural displays are associated with a reduction in the receipt of altruistic donations**. *Evol Hum Behav* 2018, **39**:520-528.

12. Tracy JL, Shariff AF, Zhao W, Henrich J: **Cross-cultural evidence that the nonverbal expression of pride is an automatic status signal**. *J Exp Psychol Gen* 2013, **142**:163-180.

13. Toscano H, Schubert TW, Dotsch R, Falvello V, Todorov A: **Physical strength as a cue to dominance: a data-driven approach**. *Pers Soc Psychol Bull* 2016, **42**:1603-1616.

14. Maner JK: **Dominance and prestige: a tale of two hierarchies**. *Curr Dir Psychol Sci* 2017, **26**:526-531.

15. Van Vugt M, Grabo AE: **The many faces of leadership: an evolutionary-psychology approach**. *Curr Dir Psychol Sci* 2015, **24**:484-489.

16. •• Witkower Z, Tracy JL, Cheng JT, Henrich J: **Two signals of social rank: prestige and dominance are associated with distinct nonverbal displays**. *J Pers Soc Psychol* 2019 http://dx.doi.org/10.1037/pspi0000181
This paper shows how nonverbal signals communicating prestige differ from those communicating dominance. The studies include controlled experiments, observation of group interaction in the lab, and an analysis of real-world political debates. It advances our understanding of the difference between rank and prestige, provides a thorough review of the relevant literature, and also showcases the various methodological approaches such studies can use.

17. Toscano H, Schubert TW, Giessner SR: **Eye gaze and head posture jointly influence judgments of dominance, physical strength, and anger**. *J Nonverbal Behav* 2018, **42**:285-309.

18. Ranehill E, Dreber A, Johannesson M, Leiberg S, Sul S, Weber RA: **Assessing the robustness of power posing: no effect on hormones and risk tolerance in a large sample of men and women**. *Psychol Sci* 2015, **26**:653-656.

19. Metzler H, Grèzes J: **Repeatedly adopting power postures does not affect hormonal correlates of dominance and affiliative behavior**. *PeerJ* 2019, **7**:e6726.

20. Simmons JP, Simonsohn U: **Power posing: *P*-curving the evidence**. *Psychol Sci* 2017, **28**:687-693.

21. • Gronau QF, Van Erp S, Heck DW, Cesario J, Jonas KJ, Wagenmakers E-J: **A Bayesian model-averaged meta-analysis of the power pose effect with informed and default priors: the case of felt power**. *Compr Results Soc Psychol* 2017, **2**:123-138
This paper summarizes the results of several pre-registered studies in the special issue of Comprehensive Results in Social Psychology on power poses. It reports several crucial lessons: First, there is actually evidence for bodily feedback effects from (power) poses on feelings (subjective experiences of power). Second, the meta-analysis finds that evidence although most of the individual (pre-registered) studies did not– effect sizes are small. Third, public dissemination of psychological findings may itself feedback into our studies: Participants who were familiar with the studied effect inflated the effect size.

22. Fiske AP: **Four modes of constituting relationships: consubstantial assimilation; Space, magnitude, time and force; concrete procedures; abstract symbolism**. In *Relational Models Theory: A Contemporary Overview.* Edited by Haslam N. Erlbaum; 2004:61-146.

23. Dorfman A, Heller D, Ben-Shahar D: **Power and high floors: a socioecological perspective**. *Acad Manag Proc* 2018, **2018**:17575.

24. •• Lamer SA, Weisbuch M: **Men over women: the social transmission of gender stereotypes through spatial elevation**. *J Exp Soc Psychol* 2019, **84**:103828
This comprehensive series of studies show that exposure to male spatial elevation increases endorsement of gender stereotypes of dominance. It provides a thorough test of the process, combining content analysis with experimental studies. The study also demonstrates how to cope with small sample sizes due to subject pool limitations: It includes a meta-analysis of seven studies that were run over several years.

25. Schubert TW: **Your highness: vertical positions as perceptual symbols of power**. *J Pers Soc Psychol* 2005, **89**:1-21.

26. Wu X, Jia H, Wang E, Du C, Wu X, Dang C: **Vertical position of Chinese power words influences power judgments: evidence**

from spatial compatibility task and event-related potentials. *Int J Psychophysiol* 2016, **102**:55-61.

27. Lu L, Schubert TW, Zhu L: **The spatial representation of power in children**. *Cogn Process* 2017, **18**:375-385.

28. von Hecker U, Klauer KC, Sankaran S: **Embodiment of social status: verticality effects in multilevel rank-orders**. *Soc Cogn* 2013, **31**:374-389.

29. Zarzeczna N, von Hecker U, Proulx T, Haddock G: **Powerful men on top: Stereotypes interact with metaphors in social categorizations**. *J Exp Psychol Hum Percept Perform* https://doi.org/10.1037/xhp0000699.

30. Dai Q, Zhu L: **Verbal-spatial and visuospatial coding of power–space interactions**. *Conscious Cogn* 2018, **63**:151-160.

31. Jiang T, Sun L, Zhu L: **The influence of vertical motor responses on explicit and incidental processing of power words**. *Conscious Cogn* 2015, **34**:33-42.

32. Tang F, Zhou H, Zhang H, Zhu L: **Development of spatial representation of power in children**. *J Exp Child Psychol* 2018, **173**:239-249.

33. Lamer SA, Weisbuch M, Sweeny TD: **Spatial cues influence the visual perception of gender**. *J Exp Psychol Gen* 2017, **146**:1366-1371.

34. Paladino MP, Mazzurega M, Bonfiglioli C: **Up-and-left as a spatial cue of leadership**. *Br J Soc Psychol* 2017, **56**:599-608.

35. Schoel C, Eck J, Greifeneder R: **A matter of vertical position: consequences of ostracism differ for those above versus below its perpetrators**. *Soc Psychol Personal Sci* 2014, **5**:149-157.

36. Giessner SR, Schubert TW: **High in the hierarchy: how vertical location and judgments of leaders' power are interrelated**. *Organ Behav Hum Decis Process* 2007, **104**:30-44.

37. Klein RA, Vianello M, Hasselman F, Adams BG, Adams RB, Alper S, Aveyard M, Axt JR *et al.*: **Many Labs 2: investigating variation in replicability across samples and settings**. *Adv Methods Pract Psychol Sci* 2018, **1**:443-490.

38. Giessner SR, Schubert TW: **Power and vertical positions in an organization chart: A pre-registered replication report of Study 3a and a modification of Study 1a, Giessner & Schubert (2007)**. *Collabra Psychol* 2019, **5**:25.

39. Marsh AA, Yu HH, Schechter JC, Blair RJR: **Larger than life: humans' nonverbal status cues alter perceived size**. *PLoS One* 2009, **4**:e5707.

40. Holbrook C, Fessler DMT: **Sizing up the threat: the envisioned physical formidability of terrorists tracks their leaders' failures and successes**. *Cognition* 2013, **127**:46-56.

41. Yu W, Sun Z, Zhou J, Xu C, Shen M: **Humans conceptualize victory and defeat in body size**. *Sci Rep* 2017, **7**:44136.

42. • Holbrook C, López-Rodríguez L, Fessler DMT, Vázquez A, Gómez Á: **Gulliver's politics: conservatives envision potential enemies as readily vanquished and physically small**. *Soc Psychol Personal Sci* 2017, **8**:670-678

The article investigates the formidability representation hypothesis in an intergroup setting, contributing to this rapidly evolving literature. It reports two studies conducted in the United States and in Spain that use the standard measures of envisioned formidability. Correlational data are analyzed using mediation analysis. The paper concludes that participants with conservative attitudes envision (potentially threatening) Syrian refugees as less formidable because they are confident in interventions that can thwart the threat.

43. Knapen JEP, Pollet TV, van Vugt M: **When better seems bigger: perceived performance of adult professional football players is positively associated with perceptions of their body size**. *Evol Psychol* 2019, **17**:147470491984191.

44. Holbrook C, Fessler DMT, Navarrete CD: **Looming large in others' eyes: racial stereotypes illuminate dual adaptations for representing threat versus prestige as physical size**. *Evol Hum Behav* 2016, **37**:67-78.

45. Wilson JP, Hugenberg K, Rule NO: **Racial bias in judgments of physical size and formidability: from size to threat**. *J Pers Soc Psychol* 2017, **113**:59-80.

46. Johnson DJ, Wilson JP: **Racial bias in perceptions of size and strength: the impact of stereotypes and group differences**. *Psychol Sci* 2019, **30**:553-562.

47. Casasanto D, Gijssels T: **What makes a metaphor an embodied metaphor?** *Linguist Vanguard* 2015, **1**.

48. Anderson ML: **Neural reuse: a fundamental organizational principle of the brain**. *Behav Brain Sci* 2010, **33**:245-266.

49. Sheehy-Skeffington J, Thomsen L: **Egalitarianism: psychological and socio-ecological foundations**. *Curr Opin Psychol* 2019 http://dx.doi.org/10.1016/j.copsyc.2019.08.014.

50. Chiao JY: **Neural basis of social status hierarchy across species**. *Curr Opin Neurobiol* 2010, **20**:803-809.

51. Pornpattananangkul N, Zink CF, Chiao JY: **Neural basis of social status hierarchy**. In *The Psychology of Social Status.* Edited by Cheng JT, Tracy JL, Anderson C. New York: Springer; 2014:303-323.

52. • Holmgren J, Isager PM, Schubert TW: **Evidence for magnitude representations of social hierarchies: size and distance effects**. *PLoS One* 2018, **13**:e0203263

It is considered to be a signature of magnitude processing that comparisons of objects become easier with increasing distance between them. This recent test of the distance effect for rank judgments provides a more detailed and comprehensive view than previous studies. A clear distance effect is found for both well-known and newly learned hierarchies. However, the observed size effect, which has never been tested before for social ranks, has a quadratic instead of a linear shape, contradicting previous work on magnitude judgments.

53. Jiang T, Zhu L: **Is power–space a continuum? Distance effect during power judgments**. *Conscious Cogn* 2015, **37**:8-15.

54. Lourenco SF, Bonny JW, Schwartz BL: **Children and adults use physical size and numerical alliances in third-party judgments of dominance**. *Front Psychol* 2016, **6**.