

# Do Friendship Influence Space Perception? With Particular Reference to the Curse of the Suspicious Participants

**Nicolas Morgado (nicolas.morgado@upmf-grenoble.fr)**

Laboratoire de Psychologie et Neurocognition (CNRS), Université Pierre-Mendès-France, 38040 Grenoble, France

**Dominique Muller (dominique.muller@upmf-grenoble.fr)**

Laboratoire Interuniversitaire de Psychologie, Institut Universitaire de France et Université Pierre-Mendès-France, 38040 Grenoble, France

**Mathieu Pinelli (mathieu.pinelli@upmf-grenoble.fr)**

Laboratoire de Psychologie et Neurocognition (CNRS), Université Pierre-Mendès-France, 38040 Grenoble, France

**Éric Guinet (eric.guinet@upmf-grenoble.fr)**

Laboratoire de Psychologie et Neurocognition (CNRS), Université Pierre-Mendès-France, 38040 Grenoble, France

**Édouard Gentaz (edouard.gentaz@unige.ch)**

Université de Genève / FAPSE UNI MAIL ; 40, Boulevard du Pont-d'Arve 1211 Genève 4

**Richard Palluel-Germain (richard.palluel@upmf-grenoble.fr)**

Laboratoire de Psychologie et Neurocognition (CNRS), Université Pierre-Mendès-France, 38040 Grenoble, France

## Abstract

In this study, we tested the hypothesis that social relationships affect the perception of distance. When participants imagined passing through a wall and a disliked-person, they perceived shorter aperture widths than when they intended to pass between a wall and a liked-person. This result was observed only for passable apertures suggesting that social constraints may influence visual perception only when people can actually perform this action. We discuss the results according to an embodied approach to visual perception but also with an alternative explanation in terms of possible demand characteristics. We also discuss some methodological points supposed to improve the validity of such experiments.

**Keywords:** Space Perception; Embodiment, Psychosocial Resources; Affective Closeness; Demand Characteristics

## Introduction

According to Proffitt and Linkenauger (2013) the visual perception of space depends on the phenotype of the perceiver. More precisely, the optical information would be scaled on the morphological, physiological, and behavioral properties of the body. For instance, decreasing people's ability to reach an object leads them to perceive it as being farther away (e.g., Lourenco & Longo, 2009; Morgado, Gentaz, Guinet, Osiurak, & Palluel-Germain, in press).

Previous works tried to extend this account to the influence of social factors on visual perception (Chambon, 2009; Harber, Yeung, & Iacovelli, 2011; Morgado, Muller, Gentaz, & Palluel-Germain, 2011). For example, Schnall, Harber, Stefanucci, & Proffitt (2008) observed that people underestimate the slant of a steep hill when they are accompanied by a friend instead of being alone. According

to the authors, this difference in slant estimation reflects that social support, as a social resource, can compensate the potential effort associated with climbing the hill and thus reduces its perceived steepness.

In some cases, however, the social constraints associated with a given action constitute a cost rather than a resource. Previous works suggest that people maintain a personal space around them and that they feel discomfort when someone invades this space (Hayduk, 1983). Moreover, this discomfort seems to increase as the physical interpersonal distance decrease (Hayduk, 1981). Interestingly, the discomfort associated with personal space invasion seems to vary according to the social relationship (Sundstrom & Altman, 1976). Consistent with these findings, we recently observed that people's action-scaled perception of a space between two acquaintances is correlated with the participants' affective closeness toward these acquaintances (Morgado et al., 2011). Indeed, the closer participants felt to their classmates, the more passable the space between the classmates pictures appeared and the less space they needed to pass. These results might suggest that participants perceived the space between the two classmate pictures (i.e., the aperture width) differently because of the closeness feeling.

In the present study, we aimed to investigate further whether social relationships influence the visual perception of an aperture between a wall and an acquaintance. More precisely, participants had to estimate the width of an aperture between the picture of a wall and that of a human figure evoking a liked person or a disliked person. Participants also indicated if the aperture was wide enough to allow them to pass. Our hypothesis was that the participants from the disliked-person group should perceive smaller apertures than participants from the liked-person

group. Moreover, this study aimed to replicate the observed correlation between affective closeness and the passability judgments.

## Method

### Participants

Sixty undergraduates (52 females;  $M_{\text{age}} = 21$ ,  $SD_{\text{age}} = 3$ ) from the University of Grenoble took part in this experiment for course credit. The participants had normal or corrected-to-normal vision, as indicated by self-report. None had participated in our previous study. The present study was conducted in accordance with the Declaration of Helsinki and with the understanding and the written consent of each participant. It was approved by the local ethics committee of the LPNC (CNRS and the University of Grenoble).

### Apparatus and procedure

To manipulate social relationships, we chose to use a similar mental imagery task as the one used by Schnall et al. (2008). Participants sat down in front of a computer for the mental imagery task. Headphones provided the instructions to the participants who were randomly assigned to the disliked-person or the liked-person group (respectively,  $n = 31$  and  $n = 29$ ). Using headphones enabled the experimenter to be blind to experimental groups while increasing standardization of the instructions.

The instructions indicated that the experiment concerned visual perception of space and that participants would have to estimate the width of an aperture between a picture of a wall and a human figure. Instructions underlined that recent studies indicated that such a task is too difficult in artificial situations. Supposedly to make the task more natural, they had to imagine that the human figure was an acquaintance. At the beginning of the mental imagery task, participants had to complete a relaxation exercise. Then, participants in the disliked-person group had to choose an acquaintance who they did not like at all and who made them uncomfortable. In contrast, participants in the liked-person group had to choose an acquaintance that they liked very much and who made them feel good. Participants could take all the time they needed to choose this acquaintance and they pressed a key to hear the next instructions. Then, they had to imagine the presence of this acquaintance while thinking about their feeling toward this person, while visualizing his or her physical appearance, and while keeping in mind how they usually interact with this person. At the end of this mental imagery task, the instructions indicated that participants had now to estimate aperture width and they had to keep in mind a picture of the chosen acquaintance.

For the perceptual task, participants stood at 3.7 m in front of a white screen on which the picture of a wall and those of a human figure were projected (Figure 1). The

dimensions of the two pictures were identical (height: 169 cm, width: 41.5 cm). The instructions were projected on the screen at the beginning of this task. Throughout this task, participants had to imagine the previously chosen acquaintance in place of the human figure projected on the screen. Since the constraints of a given action influence the perception mainly when people intend to perform this action (e.g., Witt, Proffitt, & Epstein, 2005), participants had to imagine passing through the aperture between the wall and their acquaintance before each width estimation. Since arm posture seems to influence perceived aperture widths (Stefanucci & Geuss, 2009), participants had to keep their arms along their body. To estimate the aperture widths, participants completed a visual-matching task (for a similar measure see Stefanucci & Geuss, 2009). The experimenter stood at 190 cm from the participants' right side and progressively unrolled a tape measure located at 130 cm from the floor. Participants had to stop the experimenter when they considered that the length of the tape measure was equal to the aperture width. To reduce the potential experimenter effect on participants' estimations, the experimenter could not see which aperture width the participants had to estimate. Moreover, the experimenter tried hard to keep his gaze on a fixed point in the wall in front of him while unrolling the tape measure. Neither the experimenter, nor the participants could see the graduation of the tape measure during the estimations. The experimenter could only see the measure after participants were satisfied of their estimation to record it in the computer. Then, participants made a "yes" or "no" passability judgment (Warren & Whang, 1987) to indicate if the aperture was wide enough to allow them to pass through it without rotating their shoulders. The experimenter recorded this judgment and launched the next trial. Participants completed 32 trials including 4 practice trials and 28 test trials. The actual aperture widths used for the test trials ranged from 30 cm to 95 cm with a 5-cm step. The actual aperture widths used for the practice trials (31 cm, 39 cm, 52 cm, 82 cm) were randomly selected among this range of width and were the same for all the participants. The actual aperture widths were randomly presented during the practice and test trials.

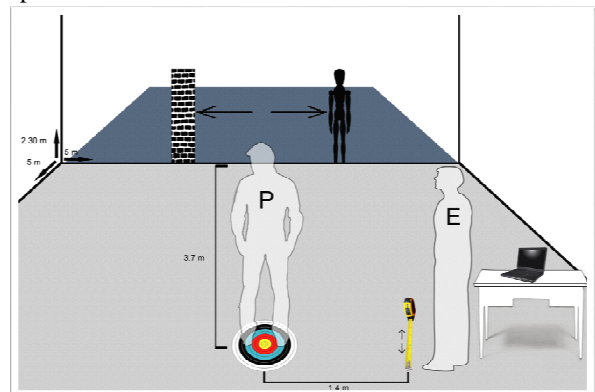


Figure 1: Experimental setup and device (P: participant; E: experimenter).

Immediately after the completion of the perceptual task, the experimenter asked participants if the overall procedure was clear and probed them for suspicion about the hypothesis. The experimenter asked two questions to the participants: (1) “In your opinion what hypothesis is tested in this study?” (2) “Do you think that some aspects of the experiment could have influenced your responses? If so, what were these aspects?” Then the experimenter recorded participants’ shoulder width as the distance between the tips of the two humerus. Finally, participants sat down and answered a post-experimental questionnaire projected on the screen. The items of this questionnaire were gathered together by themes which were presented in a fixed order: (1) impressions about the mental imagery task, (2) information about the chosen acquaintance, (3) participants’ feelings toward the acquaintance, (4) participants’ preferred interpersonal distance with the acquaintance (for a similar measure see Pedersen, 1973), (5) participants’ physical state, and participants’ mood. Items, however, were randomly presented among the themes.

## Results

We conducted a set of t-tests to check the effectiveness of our experimental manipulation with Social Relationship as a between-group factor and the different items of the post-experimental questionnaire dependent variables. The participants in the liked-person group indicated more positive feelings toward their acquaintance ( $M = 4.42$ ,  $SD = .34$ ) than those in the disliked-person group ( $M = 2.46$ ,  $SD = .36$ ),  $t(56) = 21.32$ ,  $p < .001$ ,  $\eta^2 = .89$ . In line with the literature (Sundstrom & Altman, 1976), participants in the liked-person group preferred keeping a significantly shorter interpersonal distance with the acquaintance ( $M = 30.02$ ,  $SD = 22.26$ ) than those of the disliked-person group ( $M = 141.83$ ,  $SD = 44.69$ ),  $t(56) = -12.19$ ,  $p < .001$ ,  $\eta^2 = .73$ . Participants in the liked-person group indicated having more frequent contacts with the acquaintance ( $M = 3.17$ ,  $SD = 1.05$ ) than those of the disliked person group ( $M = 1.86$ ,  $SD = .85$ ),  $t(56) = 5.19$ ,  $p < .001$ ,  $\eta^2 = .73$ . Moreover, participants in the liked-person group indicated that the pictures generated during the mental imagery task were more pleasant ( $M = 4.6$ ,  $SD = .49$ ) than those in the disliked-person group ( $M = 2.11$ ,  $SD = .59$ ),  $t(56) = 17.28$ ,  $p < .001$ ,  $\eta^2 = .84$ . There was no other significant difference for the other items of the post-experimental questionnaire (i.e., duration of the relationship, mood, vividness of the imagery task, easiness to imagine the target person, and easiness to imagine passing through the aperture). It is noteworthy, however, that it was marginally easier to imagine the liked person ( $M = 3.23$ ,  $SD = 1.22$ ) than the disliked one ( $M = 2.64$ ,  $SD = 1.25$ ),  $t(56) = 1.82$ ,  $p = .07$ ,  $\eta^2 = .06$ .

An inspection of the Studentized deleted residuals on the aperture width estimations revealed the presence of two outliers (see Judd, McClelland, & Ryan, 2009). They were excluded of the subsequent analyses. Two other participants were also excluded because of a power cut during data collection. After these exclusions, it remained 56

participants ( $n_{liked} = 29$ ,  $n_{disliked} = 27$ ). We considered participants as suspicious when they indicated that they thought that we aimed to test the effect of social relationship on the perception of aperture or when they indicated that social relationship was an aspect that influenced their estimations. In spite of our cover story, 39.29 % of our participants suspected the true purpose of the study. Moreover, there were more suspicious participants in the disliked-person group (55.56 %) than in the liked-person group (24.14 %),  $t(54) = 2.49$ ,  $p < .02$ ,  $\eta^2 = .10$ .

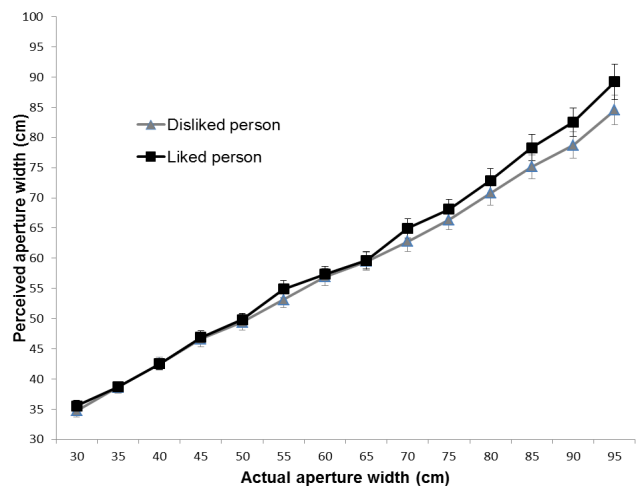


Figure 2. Perceived distance as a function of Actual Aperture Width and Social Relationship. Error bars denote standard errors of the means.

We conducted an analysis of variance (ANOVA) with Social Relationship (liked person, disliked person) as a between-subjects factor and Actual Aperture Width (30 cm, 35 cm...90 cm, 95 cm) as a within-subject factor. The Estimated Aperture Width was the dependent variable. Given that the exclusion of all the suspicious participants would lead to decrease dramatically the statistical power of the analysis, we entered Suspicion (suspicion vs. no suspicion) as a covariate in this analysis. We also entered Shoulder Width as a covariate since this variable is known to influence perceived aperture widths. This analysis revealed that participants in the disliked-person group estimated shorter aperture widths ( $M = 58.5$ ,  $SD = 1.35$ ) than those of the liked-person group ( $M = 61.5$ ,  $SD = 1.51$ ). However, this main effect of social relationship was not statistically significant,  $F(1, 51) = 2.21$ ,  $p < .14$ ,  $\eta^2 = .04$ . Neither the main effect of suspicion, nor those of shoulder width were significant ( $ps > .1$ ). The main effect of Actual Aperture width was significant,  $F(13, 663) = 7.31$ ,  $p < .001$ ,  $\eta^2 = .13$ . Interestingly, the interaction between actual aperture width and social relationship was significant,  $F(13, 663) = 2$ ,  $p < .02$ ,  $\eta^2 = .04$  (see Figure 2). This seems to reflect the fact that participants in the disliked-person group tended to estimate shorter aperture widths than those of the liked-person group for the aperture judged wide enough to pass,  $F(1, 51) = 3.08$ ,  $p < .09$ ,  $\eta^2 = .06$ , but not for those

judged too small to pass,  $F(1, 51) = .68, p < .41, \eta^2 = .01$ . Importantly, the interaction between the actual aperture width and the social relationship did not depend on suspicion ( $p = .73$ ). Moreover, these results did not change dramatically when we controlled for the easiness to imagine the target person. We also conducted an ANOVA with social relationship as a between-subject factor and the percentage of “yes” passability judgments as a dependent variable. We also entered suspicion and shoulder width in this analysis to statistically control for these variables. Although the percentage of “yes” passability judgments was smaller for the disliked-person group ( $M = 53.32, SD = 4.33$ ) than for the liked-person group ( $M = 60.36, SD = 4.89$ ), this difference was not significant ( $p > .74$ ).

Neither the correlation between the familiarity with the acquaintance and the percentage of “yes” passability judgments, nor those between the preferred interpersonal distance and the percentage of “yes” passability judgments were significant ( $r = -.08, p = .71$  and  $r = -.22, p = .28$  respectively). Interestingly, the correlation between the affective closeness and the percentage of “yes” passability judgments was significant for the participants in the disliked-person group ( $r = .64, p = .01$ ), but not for those in the liked-person group ( $r = -.42, p = .23$ ). Importantly, this pattern of correlations remained the same when we statistically controlled for the shoulder width of the participants and for the suspicion.

## Discussion

When participants intended to pass between a wall and a disliked-person stimulus, they tended to estimate shorter aperture widths compared with when they intended to pass between a wall and a liked-person stimulus, but only for passable apertures. As observed in our previous study (Morgado et al., 2011), we also observed a positive correlation between the affective closeness and percentage of “yes” passability judgments. More precisely, the closer participants felt to the acquaintance, the more passable the aperture appeared. Surprisingly, it was only true for the participants in the disliked-person group, but not for those in the liked-person group. At a first glance, these results seem consistent with the social extension of the phenotypic account of perception (Proffitt & Linknauer, 2013). According to this account, the anticipation of personal space invasion might lead to perceive shorter aperture widths in the presence of disliked persons than in the presence of liked ones.

The observed interaction between the actual aperture width and the social relationship is consistent with previous results suggesting that the constraints related to an intended action influence visual perception only when people can actually perform this action (Lessard, Linknauer, & Proffitt, 2009). The correlation between affective closeness and passability judgments observed only with disliked persons might also suggest that affective closeness is more relevant for passability with disliked persons compared with liked ones.

One might be willing to explain our results in terms of the ease to keep in mind the person stimulus. For instance, it might be easier to imagine the disliked-person than the liked-person given the literature on attention to negative stimuli (e.g., Smith, Cacioppo, Larsen, & Chartrand, 2003). If so, such a difference might explain our results. The data from our post-experimental questionnaire, however, indicated that the difference between the disliked-person and the liked-person groups for the vividness of the imagery task was not significant. In contrast, it was marginally easier to imagine the liked-person than the disliked one. Importantly, the interaction between the actual aperture width and the social relationship remained significant when we statistically controlled for the easiness to imagine the target person. In the same vein, one might also invoke mood as a potential confound in our results since mood seems to influence visual perception of space (e.g., Riener, Stefanucci, Proffitt, & Clore, 2011). However, our post-experimental did not provide any support for this alternative explanation.

Durgin et al. (2009) underlined the necessity to take into account the suspicion of the participants in studies about the influence of the action capabilities on visual perception of space. According to their concerns, the large number of suspicious participants in our sample rises another possible explanation for our results in terms of demand characteristics. Demand characteristics refers to the cues which provide an experimental hypothesis to the participants (Orne, 1962). Moreover the large number of suspicious participants in the disliked-person group suggests that these participants were more likely to be affected by demand characteristics. Thus, they could have reduce their width estimations and adjust their passability judgments in line with their guess about our hypothesis. If it was the case, one could argue that the interaction effect between the actual aperture width and the social relationship should depend on whether participants were suspicious or not. Interestingly although the interaction between actual aperture width, social relationship, and suspicion was not significant, the increasing difference with the actual aperture in estimated aperture width between the disliked-person and the liked-person groups seems to be present for the suspicious participants only. Even if these results are only descriptive, it is important to underline the fact that our study was not primarily designed to test such a three-way interaction. Considering our sample size, a lack of statistical power needed to test such an interaction might explain this non-significant result. Another important limit relies on the fact we used very basics questions to probe the suspicion of the participants. Further studies primarily designed to test the relevance of the demand characteristics in perception studies will have to use a more sophisticated post-experimental questionnaire.

One could also argue that the experimental demand in the liked-person and the disliked-person group was the same since the two groups had to imagine the presence of an acquaintance. Yet, we observed more suspicion in the

disliked-person group than in the liked-person one, which means that demand cues are not equally spread into the two groups or at least that the participants' receptivity to these cues are different between the two group. One possible explanation of this asymmetry might rely on an inconsistency between the cover story and the disliked group. More precisely, participants could have found paradoxical to imagine the presence of a dislike person to make the task more natural. Such asymmetry has important implications for studies contrasting positive and negative experimental manipulations and researchers should be encouraged to find a way to rule out this potential confound.

In spite of the limits of our study, it highlights the need of using a systematic and standardized post-experimental questionnaire in perception studies. Indeed, we think that dealing with the demand characteristic explanation need more than just indicating that participants were probed for suspicion. For instance, it seems that participants tend to admit their suspicion more in a computerized post-experimental questionnaire than in a face-to-face interview with the experimenter (Blackhart, Brown, Clark, Pierce, & Shell, 2012). Thus it is important that the perception researchers take into account such results when they probe their participants for suspicion. One could doubt of the use of questionnaire to deal with the demand characteristics for at least two reasons. The first reason is that if demand characteristics exert an implicit influence on the participants' behavior, the participants should not be aware of this influence. Thus the interest of simply asking people about this influence with a post-experimental questionnaire should be highly limited (e.g., Nisbett & Wilson, 1977). However, the fact that much of the demand bias should be implicit is not guaranteed. Moreover, even if one considers demand bias as implicit, the demand characteristics which produce this bias can be perceived explicitly by the participants. Thus using a post-experimental-questionnaire remains useful to assess the receptivity of the participants to the demand characteristics. The second reason that can lead scholars to doubt the usefulness of the post-experimental questionnaire is the fact that such questionnaire captures the impression of the participants after the experiment. It is possible that some participants did not think very much about the hypothesis during the experiment and that the post-experimental questionnaire increases their suspicion when they answer to it. Horvat (1986) observed, however, that care in the design of the questionnaire and in the coding of the responses can improve the reporting of true suspicion and decrease the reporting of false suspicion.

The use of theoretical accounts of demand bias to improve post-experimental questionnaire and experimental design is particularly relevant (e.g., Allen, 2004; for a review see also Strohmets, 2008). According to such accounts, to consider that there is a risk of demand bias, researchers have to consider three critical variables. The first variable is receptivity of the participants to the demand cues. The presence of such cues can lead the participants to guess the hypotheses. We can assess the receptivity of the participants

using a quasi-control group as proposed by Orne (1962) or with a post-experimental questionnaire. Interestingly, we can also reduce the receptivity of the participants to the critical cues by diverting their attention with deceptive cues. With such a "red herring technique", Laney et al. (2008) succeed in reducing the suspicion of the participants about their hypothesis. They used a traditional cover-story to hide the purpose of their study, but in addition they included perceptible cues suggesting that the study had another purpose (i.e., the red herring). Importantly, this red herring cannot be confounded with the true purpose of their studies so that any demand bias in favor of the red herring cannot lead the participants to confirm the true purpose.

The second variable is the participants' motivation to comply with the demand cues. Indeed, without such a motivation, the receptive participants have no reason to comply with demand cues. Allen (2004) in his post-experimental questionnaire used some items about the motivation of the participants to comply or not with what they thought was expected.

The third variable is participants' ability to voluntarily modify their responses according to the demand cues. The question of this ability is highly relevant in behavioral research and seems to be ignored by researchers working on the so called low-level processes. Such tendency might relied on a confusion between what it is studied (i.e., a low-level process) and the way by which we have access to this process (i.e., a response). Yet, even if visual perception implies low-level processes that some authors consider as cognitively impenetrable (e.g., Pylyshyn, 1999), the response of the participants might rely on a voluntary motor act. In that case, as in the cases of visual-matching estimate of or affordance judgments, participants might have the opportunity to voluntarily influence their responses. Assuming that any response used to study a low-level process is not sensitive to response bias is a strong claim and had to be examined for each response or at least for each category of response.

Finally, we observed mixed evidences supporting the idea that social relationships influence the visual perception of distance. We have, however, to qualify this conclusion according to the potential implication of a demand bias in our results. To conclude, if overgeneralizing the explanation in terms of demand bias to experiments with very different experimental design is flawed, ignoring the potential presence of a demand bias in an experiment is also an important concern.

## Acknowledgments

This research was supported by the "Agence National de la Recherche" (ANR) under Grant ConstrainPercept.

## References

- Allen, C. T. (2004). A theory-based approach for improving demand artifact assessment in advertising experiments. *Journal of Advertising*, 33(2), 63–73.

- Balcetis, E., & Dunning, D. (2010). Wishful seeing: More desire objects are seen as closer. *Psychological Science*, 21(1), 147–152.
- Blackhart, G. C., Brown, K. E., Clark, T., Pierce, D. L., & Shell, K. (2012). Assessing the adequacy of postexperimental inquiries in deception research and the factors that promote participant honesty. *Behavior research methods*, 44(1), 24–40.
- Chambon, M. (2009). Embodied perception with others' bodies in mind: Stereotype priming influence on the perception of spatial environment. *Journal of Experimental Social Psychology*, 45(1), 283–287.
- Durgin, F. H., Baird, J. A., Greenburg, M., Russell, R., Shaughnessy, K., & Waymouth, S. (2009). Who is being deceived? The experimental demands of wearing a backpack. *Psychonomic Bulletin & Review*, 16(5), 964–969.
- Harber, K. D., Yeung, D., & Iacovelli, A. (2011). Psychosocial resources, threat, and the perception of distance and height: Support for the resources and perception model. *Emotion*, 11(5), 1080–1090.
- Hayduk, L. A. (1981). The permeability of personal space. *Canadian Journal of Behavioral Science*, 13(3), 274–287.
- Hayduk, L. A. (1983). Personal space: Where we now stand. *Psychological Bulletin*, 94(2), 293–335.
- Judd, C. M., McClelland, G. H., & Ryan, C. S. (2009). *Data analysis: A model comparison approach*. Routledge/Taylor & Francis Group.
- Laney, C., Kaasa, S. O., Morris, E. K., Berkowitz, S. R., Bernstein, D. M., & Loftus, E. F. (2008). The Red Herring technique: A methodological response to the problem of demand characteristics. *Psychological Research*, 72(4), 362–375.
- Lessard, D. A., Linkenauger, S. A., & Proffitt, D. R. (2009). Look before you leap: Jumping ability affects distance perception. *Perception*, 38(12), 1863–1866.
- Lourenco, S. F., & Longo, M. R. (2009). The plasticity of near space: Evidence for contraction. *Cognition*, 112(3), 451–456.
- Morgado, N., Gentaz, E., Guinet, E., Osiurak, F., & Palluel-Germain, R. (in press). Within reach but not so reachable: Obstacles matter in visual perception of distances. *Psychonomic Bulletin & Review*.
- Morgado, N., Muller, D., Gentaz, E., & Palluel-Germain, R. (2011). Close to me? The influence of affective closeness on space perception. *Perception*, 40(7), 877–879.
- Nisbett, R. E., & Wilson, T. D. (1977). Telling more than we can know: Verbal reports on mental processes. *Psychological Review*, 84(3), 231–259.
- Orne, M. T. (1962). On the social psychology of the psychological experiment: With particular reference to demand characteristics and their implications. *American Psychologist; American Psychologist*, 17(11), 776–783.
- Pedersen, D. M. (1973). Development of a personal space measure. *Psychological Reports*, 32, 527–535.
- Proffitt, D. R., & Linkenauger, S. A. (2013). Perception viewed as a phenotypic expression. In W. Prinz, M. Beisert, & A. Herwig (Eds.), *Tutorials in Action Science*. MIT Press.
- Pylyshyn, Z. (1999). Is vision continuous with cognition?: The case for cognitive impenetrability of visual perception. *Behavioral and brain sciences*, 22(03), 341–365.
- Schnall, S., Harber, K. D., Stefanucci, J. K., & Proffitt, D. R. (2008). Social support and the perception of geographical slant. *Journal of Experimental Social Psychology*, 44(5), 1246–1255.
- Smith, N. K., Cacioppo, J. T., Larsen, J. T., & Chartrand, T. L. (2003). May I have your attention, please: electrocortical responses to positive and negative stimuli. *Neuropsychologia*, 41(2), 171–83. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/12459215>
- Stefanucci, J. K., & Geuss, M. N. (2009). Big people, little world: The body influences size perception. *Perception*, 38(12), 1782–1795.
- Strohmetz, D. B. (2008). Research Artifacts and the Social Psychology of Psychological Experiments. *Social and Personality Psychology Compass*, 2(2), 861–877.
- Sundstrom, E., & Altman, I. (1976). Interpersonal relationships and personal space: Research review and theoretical model. *Human Ecology*, 4(1), 47–67.
- Warren, W. H., & Whang, S. (1987). Visual guidance of walking through apertures: Body scaled information for affordances. *Journal of Experimental Psychology: Human Perception and Performance*, 13(3), 371–383.
- Witt, J. K., Proffitt, D. R., & Epstein, W. (2005). Tool use affects perceived distance, but only when you intend to use it. *Journal of Experimental Psychology: Human Perception and Performance*, 31(5), 880–888.