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Social and Contextual Constraints on Embodied Perception

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Abstract

A number of papers have challenged research on physiological and psychological influences on perception by claiming to show that such findings can be explained by nonperceptual factors such as demand characteristics. Relatedly, calls for separating *perception* from *judgment* have been issued. However, such efforts fail to consider key processes known to shape judgment processes: people's inability to report accurately on their judgments, conversational dynamics of experimental research contexts, and misattribution and discounting processes. Indeed, the fact that initially observed effects of embodied influences disappear is predicted by an extensive amount of literature on judgments studied within social psychology. Thus, findings from such studies suggest that the initially presumed underlying processes are at work—namely, functional considerations that are informative in the context of preparing the body for action. In this article, I provide suggestions on how to conduct research on perception within the social constraints of experimental contexts.

Keywords

perception, embodiment, context effects, economy of action, demand characteristics, attribution, misattribution

> We shall designate by the term perception all the different ways we have of getting to know the environment, from direct perception to explicit inference. (Heider, 1958, p. 27)

Fritz Heider, who is widely recognized as one of the founding fathers of modern social psychology, studied fundamental questions relating to how people make sense of their own internal states and behaviors and those of other people. Since those early days, such questions have been central to the field of social psychology, and although significant advances have been made in the intervening years, some of the early principles identified by Heider remain valid after having been put to rigorous empirical tests. One conclusion of decades of experimental work is that judgments of various kinds are shaped by social and contextual factors. But rather than constituting a flaw, this contextually embedded nature of judgment often serves a functional role. For example, the judgment effects identified by Tversky and Kahneman (e.g., 1974), initially considered as "errors and biases," were subsequently interpreted as adaptive inferences that are usually highly functional in everyday life (Gigerenzer, 1991).

Extensive research also shows that people consider their subjective feelings when they provide relevant information in a given judgment context. These include both affective and cognitive feelings (for reviews, see Clore, 1992; Schwarz, 2012). For example, people who feel happy after receiving a free gift report higher satisfaction with their consumer products (Isen, Shalker, Clark, & Karp, 1978). Similarly, a good mood induced by watching a cheerful movie leads to more positive judgments across a variety of domains compared with a bad mood induced by watching sad or aggressive movies (Forgas & Moylan, 1987). Affective feelings thus give valuable information about one's own preferences and evaluations (e.g., Clore et al., 2001). Cognitive feelings, by contrast, are not feelings about value but feelings about knowing (e.g., feelings of fluency, confusion, and boredom). One example is the experience of ease or difficulty in recalling judgment-relevant information: The ease with which one recalls examples of one's own assertiveness has a greater influence on subsequent assertiveness judgments than does the information content conveyed by those examples (Schwarz et al., 1991).

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Thus, considerable evidence suggests that judgments take into account a variety of sources of information (Schwarz, 2012).

An equally important conclusion of this work, however, is that although many subjective experiences are used in judgment, they retain their potency only as long as the source of the influence is kept outside of participants' conscious focus. Experimentally, this has been demonstrated in misattribution paradigms (e.g., Schnall, Abrahamson, & Laird, 2002; Schwarz & Clore, 1983) in which the influence of feelings disappears when attention is drawn to them. For example, people tend to experience more negative moods on cold and rainy days than they do on warm and sunny days. In one well-known experiment, people evaluated their life as a whole more positively when interviewed on warm and sunny days than they did on cold and rainy days (Schwarz & Clore, 1983). However, when the feelings about the weather were made salient, their influence on judgments of well-being vanished. Similarly, the effects of ease of recall on judgments of assertiveness disappeared when participants were led to falsely attribute their experiences of ease or difficulty to incidental background music (Schwarz et al., 1991). Thus, the misattribution paradigm has been an essential research tool in showing that feelings contribute to judgments but only as long as their informational value is not undermined.

In addition to research on the role of affective and cognitive experience in judgment, an emerging body of literature indicates that perceptual judgments are similarly influenced by experiential and contextual factors. Following the "economy of action" approach (Proffitt, 2006), researchers have discovered that factors such as the weight of a backpack (Bhalla & Proffitt, 1999) or blood glucose levels (Schnall, Zadra, & Proffitt, 2010) influence perceptions of spatial layout. However, some researchers (e.g., Durgin et al., 2009; Durgin, Klein, Spiegel, Strawser, & Williams, 2012; Shaffer, McManama, Swank, & Durgin, 2013; Woods, Philbeck, & Danoff, 2009; see also Firestone, 2013; Firestone & Scholl, in press) have questioned the validity of this evidence by claiming that these findings are due to "experimental demand characteristics." In particular, they showed that previously demonstrated effects vanished after adding manipulations intended to separate perceptual processes from judgment processes. For example, asking participants to ignore the backpack while estimating the incline of a hill was found to eliminate the influence it otherwise has on slant perception (Durgin et al., 2012). This and other findings have been interpreted to suggest that once participants are made aware of an extraneous influence on their perception (e.g., the presence of a backpack), their actual, unmediated perceptual experience is exposed, which is uninfluenced by effort-related factors such as a backpack. Indeed, Firestone and Scholl (in press) claim that such findings are unreliable because they follow from a confirmatory research strategy, which they consider a "pitfall" in past research.

In this article, I argue that previously observed effects should disappear once key aspects of the research are altered and that their disappearance indicates that the original effects are due to factors normally outside of conscious consideration. More specifically, contextual and embodied influences have an effect on judgments only as long as participants remain unaware of this influence. Once they become salient, however, deliberate efforts are undertaken to counteract these factors, therefore eliminating their impact. Indeed, it has been well-established that, first, people have little access to the reasons behind their internal states and have difficulty reporting them accurately even when motivated to do so. Second, attempts to instruct perceivers to make "objective" judgments are subject to the rules of conversation (Grice, 1957) that shape how people answer questions in experiments. Third, various critical influences on judgment processes operate only as long as they remain implicitly embedded in the flow of experience and are not made distinct by becoming the object of conscious attention. These three factors will be elaborated to place the findings intended to differentiate perception from judgment into the context of classic findings from social psychology. Before doing so, however, I will provide a brief review of the research on embodied influences on perception, as it has been the target of recent critiques.

Embodied Perception

Building on Gibson's (1979) ecological approach, research of an economy of action assumes that perception is influenced by the perceiver's capacity to navigate and act effectively in a given environment (Proffitt, 2006). In order to manage one's physical and mental resources to cope with the world, humans, and indeed all organisms, scale the world in terms of the actions afforded by their bodies. Visual perception therefore reflects not only visual perspective, but also the ability to engage with aspects of the physical environment, given one's bodily and psychological capabilities. In this view, perception is for action and reflects bodily constraints regarding action plans and resources. Consequently, action-related contingencies are also part of visual perception.

Indeed, numerous studies have shown that perceivers' potential for action changes the perception of spatial properties, including distance, slant, size and weight (for reviews, see Proffitt, 2006, 2013; Proffitt & Linkenauger, 2013; Witt, 2011a). For example, when a person is wearing a heavy backpack, fatigued, or in poor health, a hill slant is perceived to be steeper than one perceives it to

be when no such constraints are present (Bhalla & Proffitt, 1999). Similarly, participants throwing a heavy ball estimate the distance to given targets to be farther than do participants throwing a light ball, because the difficulty of hitting the target is indicative of corresponding distance (Witt, Proffitt, & Epstein, 2004). An individual holding a baton that extends the reach of one's arm finds that targets appear closer than they do when he/she is not holding such a tool (Witt, Proffitt, & Epstein, 2005). After consuming glucose, which directly increases the body's energetic resources, participants perceive a hill to be less steep (Schnall et al., 2010) and distances to be shorter (Cole & Balcetis, 2013) than they do after consuming noncaloric sweetener.

The availability of psychosocial resources has equally been shown to influence perception of the physical world. For example, participants in the presence of a friend estimate a hill to be less steep than do participants who are alone (Schnall, Harber, Stefanucci, & Proffitt, 2008). Men accompanied by other men perceive a possible opponent to be smaller than do men who are alone (Fessler & Holbrook, 2013). Furthermore, manipulations of motivational states change the perception of slant (Balcetis & Dunning, 2007; Krpan & Schnall, 2014b), distance (Cole, Balcetis, & Zhang, 2013; Krpan & Schnall, 2014a), and speed (Witt & Sugovic, 2013). Negative moods make hills appear steeper than positive moods do (Riener, Stefanucci, Proffitt, & Clore, 2011). The fear of falling leads to an overestimation of height while standing on a tall balcony and looking down to the ground (Stefanucci & Proffitt, 2009), but reminding oneself about one's positive qualities eliminates the effects of ego depletion on height perception (Huynh, Stefanucci, & Aspinwall, 2014) and of a backpack on distance perception (Shea & Masicampo, 2014). All this evidence suggests that perception of the physical world is constrained by factors that are concerned with goals, plans, and resource considerations.

"Pure" Perception Versus Judgment

A critic might contend that the processes derived from economy of action (Proffitt, 2006; Witt, 2011a) and motivated perception (Balcetis & Dunning, 2007; Cole et al., 2013) approaches reflect merely effects on post-perceptual judgments rather than "pure" perceptual processes. Thus, it may be that the observed effects are qualitatively different from other, more low-level perceptual processes, which instead may be informationally encapsulated and modular (Firestone & Scholl, in press; Fodor, 1986; Pylyshyn, 1999).

To address this issue, various methods have been used that go beyond explicit self-report. For example, to show that the earlier finding of holding a baton makes targets appear closer because it extends one's ability to reach them (Witt et al., 2005), Witt (2011b) used an indirect perceptual estimate involving triangles, based on the assumption that the end point of the triangle would seem closer and that the connecting lines of the triangle would appear more horizontal for participants holding a baton. Participants were asked to match a comparison triangle to a stimulus triangle. Indeed, the triangles appeared shorter to participants holding a baton than they did to those without, suggesting that they perceived the top of the triangles to be closer and therefore replicating the earlier results that holding a baton expands participants' subjectively experienced field of vision (Witt et al., 2005).

Furthermore, there is a considerable body of evidence to suggest that top–down processes, including current action goals of the perceiver, shape sensory and perceptual processes at a relatively low level, especially if they are relevant for facilitating anticipated action (for reviews, see Collins & Olson, 2014; Engel, Maye, Kurthen, & König, 2013; Goldstone, de Leeuw, & Landy, 2015). For example, although optical illusions may be considered to not be influenced by top–down processes, they depend on previous experience: The Müller-Lyer illusion looks different to people from different cultures (Segall, Campbell, & Kerskovits, 1963) or after training (Parker & Newbigging, 1963), and the Ames room distortion is less pronounced when viewing persons with whom one has a close relationship rather than strangers (Dion & Dion, 1976; Wittreich, 1953). The Ebbinghaus illusion is stronger when all objects belong to the same category than when they come from different categories (Coren & Enns, 1993). Color perception of objects is influenced by category membership (Goldstone, 1995) and prior knowledge about the expected color (Hansen, Olkkonen, Walter, & Gegenfurtner, 2006). The visual background on which a grey patch is presented changes lightness perception (Knill & Kersten, 1991), and a greater area of the primary visual cortex (V1) is activated when a visual illusion makes an object appear large than when it makes an object appear small (Murray, Boyaci, & Kersten, 2006). Similarly, emotional and motivational states of the perceiver influence perception. For example, being presented with fearful faces leads to heightened contrast sensitivity (Phelps, Ling, & Carrasco, 2006) and hungry participants recognize food-related words more readily than do satiated participants (Radel & Clément-Guillotin, 2012).

Perceptual processes also change as a function of experience with certain physical stimuli and associated learning across the life span. Early in life explorative action shapes the development of the visual system (Held & Hein, 1963). Similarly, in adulthood, extended exposure to certain sensory stimuli changes how they are perceived and processed on a neural level. For example,

professional musicians show cortical reorganization of sensorimotor areas as a function of experience (Münte, Altenmüller, & Jäncke, 2002), and with increased training, the same brain areas that control motor movements involved in producing music become activated when merely listening to music (Bangert, Haeusler, & Altenmüller, 2001). Thus, individual differences as a function of experience shape perception.

Indeed, a growing body of evidence on what has been termed *predictive coding* suggests that past experience and future action goals continuously reshape attention and perception at the level of neural receptive fields (for overviews, see A. Clark, 2013; Y. Huang & Rao, 2011; Mehta, 2001). In rodents, additional place cells become active in the hippocampus after they traverse a specific spatial environment (Mehta & McNaughton, 1997), and these cells subsequently show anticipatory firing patterns when encountering this environment again (Mehta, Quirk, & Wilson, 2000). Similarly, in monkeys, neurons in the primary visual cortex become specialized after performing a visual discrimination task (Wu, Piëch, & Gilbert, 2004). More generally, visual attention involves dynamically allocating receptive fields to action-relevant objects (Bundesen, Habekost, & Kyllingsbæk, 2005). Thus, increasing evidence suggests that even at the single-cell neural level, attention and perception are driven by factors such as motivation, current action goals, and individual differences including previous learning experience and other "high-level" processes. As a consequence, there is little reason to believe that there is a process of "pure" perception that always takes place in the same universal, invariant manner. Instead, top–down processes are likely to be adaptive in reducing prediction errors regarding future actions, and sensory processes in turn feed back into action plans and expectations (Lupyan, 2015; Lupyan & Clark, 2015). Therefore, rather than embodied perception constituting a special case of a conflation of perceptual and judgment processes, it is likely that perception in general is not as modular and encapsulated as some (e.g., Firestone & Scholl, in press; Pylyshyn, 1999) have proposed. An important way of examining the nature of judgments is to test the boundary conditions under which the effects occur, including the factors that lead to a lack of previously documented effects.

Making the Effects Go Away

A number of papers have been published that have demonstrated that the effects initially observed in studies conducted within the economy of action approach disappear when the original experimental paradigms are modified (Durgin et al., 2009; Durgin et al., 2012; Firestone & Scholl, 2014; Shaffer et al., 2013; Woods et al., 2009). These studies purport to uncover "experimental demand" (Durgin et al., 2009) or "social artifacts" (Durgin et al., 2012). In the second part of this article, I will demonstrate that such conclusions are unwarranted given what is known about judgment processes. In general, the methods used by critics of the account have included (a) giving participants specific instructions regarding how to arrive at their perceptual judgment, (b) encouraging participants to revise their initial judgments, and, most importantly, (c) making highly salient or explicit the perceptual influences that are normally effective only when they remain implicit.

Providing participants with elaborate instructions

Woods et al. (2009) speculated that perhaps participants "adopt a response attitude that takes this [. . .] nonperceptual factor into account rather than basing their judgments *exclusively* on perceived distance" (p. 1112). To remedy this potential problem, they devised a method to get at "objective" distance, by instructing each participant as follows:

> Base your response on how far away you think the object really is. If you think that the object appears to be at a different distance than you think it really is or if you feel that the object is at a different distance (for whatever reason), ignore those other things, and just base your answer on where you think the object really is. (Woods et al., 2009, p. 1113)

When participants were explicitly instructed to discount extraneous factors that could potentially influence distance estimates, the effect previously documented by Witt et al. (2004)—overestimating distance after throwing a heavy ball rather than a lightweight ball—was not obtained. In contrast, when participants were told to "base responses on how far away the object is, by taking all nonvisual factors into account" (Woods et al., 2009, p. 1113), participants produced the predicted effect of greater distance estimates after throwing a heavy ball, which was interpreted to indicate that the original effects were due to nonperceptual factors.

Asking participants to give perceptual estimates several times

In a different attempt to get participants to reveal their true perceptions, participants were asked to provide slant estimates on several occasions (Durgin et al., 2012). After giving slant estimates at a hill, either with or without a backpack, participants were led back to the lab and

asked a number of questions that highlighted the earlier presence of the backpack, including the following:

> How heavy (specify in pounds or kilos) do you think the backpack was?
>
> Do you think the backpack affected your judgment of the steepness of the hill?
>
> What is the steepest possible realistic estimate that you think would be a reasonable estimate for that hill when looking at it?
>
> What is the shallowest possible realistic estimate for that hill you might consider reasonable? (Durgin et al., 2012, p. 1593)

After having considered all these questions participants were asked, "How steep do you think the hill really is?" (Durgin et al., 2012, p. 1593). On their first estimate, participants who wore a backpack reported the hill to be steeper than did those without a backpack, which is consistent with the original finding (Bhalla & Proffitt, 1999). When making a second slant estimate, however, participants who had worn a backpack gave lower slant estimates in comparison with the estimates they provided the first time, at the hill.

Making the influence on perception salient

In an effort to eliminate demand effects, Durgin et al. (2009; see also Shaffer et al., 2013) gave some of their participants a specific explanation of why they were asked to put on a backpack—namely, that it ostensibly contained measuring equipment required for the study. Elaborate instructions were used to make the presence and purpose of the backpack highly obvious:

> Real electrodes were then attached to their ankles with leads that ran into the backpack. To enhance the illusion that the backpack contained working equipment, an electric fan inside the backpack emitted noise, and additional equipment was on display in the lab (including electrode gel, extra leads, and large batteries in the process of being charged). (Durgin et al., 2009, p. 965)

Replicating Bhalla and Proffitt (1999), participants in the "regular" backpack condition gave higher slant estimates than did participants in the no-backpack condition. However, those participants who were given the reason for wearing a backpack did not show an effect.

All these methods assume that once participants are given appropriate instructions, their true perceptual processes can be separated from inferential judgment biases. Unfortunately, this logic is completely at odds with the larger literature on judgment processes, as I will review next.

People Do Not Always Have Introspective Access to the Reasons Behind Their Judgments

Research on perception generally asks people to make judgments regarding what they perceive, and thus the relevant dependent measures always tap into subjective experience. However, it is well-established that the means by which people report on their perceptions are not perfect reflections of internal experiences, because many factors influence how people give their responses (cf. Schwarz, 1999). Thus, to more accurately assess individual experience, questions about perceptual judgments have to be asked in a manner that minimizes possible other confounds. Indeed, decades of research suggest that people do not have the kind of access to their own thoughts and feelings assumed in reliance on such methods: People are often unable to report accurately on their internal processes, even if they are highly motivated to do so.

One of the classic articles on this problem was entitled, "Telling More Than We Can Know" (Nisbett & Wilson, 1977) and pointed to the fact that people's reports often do not accurately reflect their internal processes, even if they themselves are convinced they are in charge of their decisions and behaviors. For example, in one study, participants chose from an array of nylon stockings. Ostensibly as part of a consumer test, they indicated which pair they preferred and for what reason. Unbeknownst to participants, however, all pairs of stockings were identical. Although they felt confident that they had objective reasons for their selection, in reality the preponderance of choices reflected a tendency to prefer items appearing on the right rather than the left or in the middle (Nisbett & Wilson, 1977). Critically, when asked, participants denied that position had anything to do with their preferences. Thus, people often give reasons for their thoughts and behaviors that are unrelated to the real underlying reasons (for a review, see Wilson & Dunn, 2004).

Thus, caution needs to be used when asking participants to hypothesize about the actual purpose of an experiment. Indeed, in his classic article on demand characteristics, Orne's (1962) noted that participants should be asked open-ended questions after the study, such as "Did you guess the study goal?" Closed

questions, on the other hand, such as asking participants "You didn't realize that the other fellows were confederates, did you?" (Orne, 1962, p. 780) suggest the expected answer instead of capturing participants' independent, spontaneous responses. Similarly, participants asked "Do you think the backpack affected your judgment of the steepness of the hill?" (Durgin et al., 2009) are likely to respond affirmatively to show that they figured it out already, so as to not come across as ignorant or incompetent. Although Durgin et al. (2009) found that the 5 participants who reported that the backpack influenced their slant estimates gave higher estimates, it is not clear that they would have had this hypothesis regarding the study purpose before having been asked that question. The same limitation applies to the study by Shaffer et al. (2013). Perhaps a better strategy might be to prompt participants to carefully consider their answers or ask them to reconsider and revise their initial response. As I will review in the next section, such a strategy is equally unsuccessful because people routinely make inferences about others' intentions that go well beyond the actual words uttered.

Conversational Dynamics Shape People's Answers in Experiments

When people communicate with one another, they draw upon their own and other people's beliefs about various states of the world (Grice, 1957; Sperber & Wilson, 1995). This shared understanding comprises the facts that speaker and audience acknowledge as true, based on those facts either having been directly perceived or inferred from the communicative context. Indeed, a majority of communicative intent is not explicitly stated. A simple example is the pragmatic intent of asking another person whether she knows what time it is, a question to which the response "yes" would not provide an appropriate answer. In other words, in communication it is often clear certain words imply a specific goal, and people read between the lines to infer that goal. Deriving appropriate inferences, however, can be effortful, and communication aims to achieve the greatest possible communicative output while expending the smallest possible processing effort—namely, to communicate only what is relevant (Sperber & Wilson, 1995). Thus, people generally only say what is necessary, and do not say too much or too little.

Because they involve social interactions, participants in research contexts draw upon the same conversational principles that they apply in daily life (H. H. Clark & Schober, 1992; Schwarz, 1994, 1996). For example, the wording and context of a question substantially changes the answer that is provided (Schwarz, 1999; Sudman, Bradburn, & Schwarz, 1996; Tourangeau, Rips, & Rasinski, 2000). As is the case for communication in general, people go beyond literal meaning and make inferences about the intention behind the question that was asked. Grice's (1957) maxim of quantity describes that speakers want to provide the appropriate amount of information without being redundant. By using strategies such as asking participants the same question about hill slant twice (as in Durgin et al., 2012), the communicative intention of the experimenter is clear: You made a mistake when you answered the experimenter's question the first time around; now you have a chance to try again and come up with a better response. This will lead participants to infer that their first estimate must have been incorrect: "For example, if a test is given twice with some intervening treatment, even the dullest college student is aware that some change is expected, particularly if the test is in some obvious way related to the treatment" (Orne, 1962, p. 779). Indeed, participants will not repeat the same answers on questions that they have answered earlier, because they assume a different answer is required from the one already provided (Strack, Schwarz, & Wänke, 1991; see also McGarrigle & Donaldson, 1974). Thus, a request to revise an answer implies that the initial answer was unsatisfactory, just as somebody saying "yes" to the question regarding the current time might be asked again to provide a proper answer.

Factors relating to conversational dynamics are also relevant when giving participants specific instructions. For example, Woods et al. (2009) encouraged some participants to take all nonvisual factors into account when making their estimates, and they gave higher estimates when throwing a heavy ball to a target than when throwing a lightweight ball. However, telling participants that you want them to consciously change their judgment says little about the processes that occur spontaneously and automatically in the absence of such instructions. Indeed, Orne (1962) acknowledged that subjects always have some implicit expectation or hypothesis about the study in which they are participating: "It should be clear that demand characteristics cannot be eliminated from experiments; all experiments will have demand characteristics, and these will always have some effect" (p. 779). Thus, it is unlikely that by introducing new instructions (e.g., Durgin et al., 2009; Durgin et al., 2012; Woods et al., 2009) potential demand characteristics can be removed. More likely, such attempts will create precisely the very demand that they intended to avoid and therefore evoke processes that have little to do with perception proper.

Importantly, the communicative processes in a social judgment context are very different from experimental demand characteristics. In his seminal paper, Orne (1962)

explicitly noted that demand characteristics, namely participants' desire to serve as a "good subject," operate on an unconscious level:

> If, on the other hand, the demand characteristics are so obvious that the subject becomes fully conscious of the expectations of the experimenter, there is a tendency to lean over backwards to be honest. We are encountering here the effect of another facet of the collect student's attitude toward science. While the student wants studies to "work," he feels he must be honest in his report; otherwise erroneous conclusions will be drawn. Therefore, if the student becomes acutely aware of the experimenter's expectations, there may be a tendency for biasing in the opposite direction. (Orne, 1962, p. 780)

Indeed, researchers have obtained such counterintuitive effects. For example, in an early experiment on conformity, participants who expressed suspicion about the study purpose showed less of a conformity effect than did unsuspicious participants (Stricker, Messick, & Jackson, 1967). Similarly, when participants were tipped off by a fellow participant (who in reality was a confederate) about the study purpose, they showed the opposite of the predicted effect: Their awareness ratings were negatively correlated with the outcome variable (Golding & Lichtenstein, 1967). In line with those early findings, participants who realized that a sugary drink was intended to influence slant perception provided lower slant estimates (Shaffer et al., 2013). Thus, awareness of an influence on one's judgment does not necessarily mean that participants "play along" and therefore produce the predicted effect.

One reason for this is that, in addition to the desire to be a "good subject" as Orne (1962) had suggested, there is a desire to come across as competent: Participants experience evaluation apprehension (Rosenberg, 1969) because they believe their performance on the task will be scrutinized by the experimenter. Such motivations can lead to attempts to present the self in a positive light (Goffman, 1959) and give socially desirable responses (Crowne & Marlowe, 1964). Indeed, when there is a conflict between conforming to the assumed hypothesis (Orne, 1962) or coming across as competent and going against the hypothesis, participants tend to opt for the latter (Newberry, 1973; Rosnow, Goodstadt, Suls, & Gitter, 1973; Sigall, Aronson, & Van Hoose, 1970). Resulting contrast effects are common because in an attempt to be "unbiased," it is difficult to know exactly how much to correct, which can result in overcorrection (Strack & Hannover, 1996; Wegener & Petty, 1997). Thus, once a participant is focally aware of what they are expected to do, various possibilities exist: They might act in line with the perceived demand, they might show no effect, or they might even show the opposite tendency depending on their own motivations and inferences (Weber & Cook, 1972). In either case, the resulting response is very different from the one they would naturally exhibit as long as they remain naive to the study purpose. Thus, instead of second-guessing their intentions, it is therefore standard practice to exclude participants who are aware of key aspects of the experimental design (Bargh & Chartrand, 2000; Page, 1973).

In light of what is known about the social dynamics of experimental situations, we can evaluate the crux of the argument put forward by Durgin et al. (2009): "If a physical burden, such as a heavy backpack, is sufficient to alter slope perception, it ought to do so even if participants believe that the backpack is an incidental part of the experimental apparatus" (p. 965). Precisely herein lies the most critical error of argument, because the research documenting misattribution effects has indeed shown that previously observed effects should go away under certain conditions: Once participants are aware of essential parts of an experimental set-up, either because they inferred what they believe to be the experimenter's intention or because the experimental protocol involves making a source of influence salient, they deliberately give very different responses from the ones they would provide while remaining unaware of purpose and procedures. Such processes of attribution and misattribution have been extensively documented in a literature spanning the last 50 years or so, as I discuss in the next section.

Attribution, Misattribution, and Judgment

The beginning of misattribution research is generally considered to be marked by Schachter and Singer's (1962) classic experiment. They injected participants with epinephrine, a substance leading to physiological arousal, or a placebo. Some participants were then given the correct information about arousal symptoms following the injection, namely a pounding heart and the possibility of the face getting hot and flushed. In contrast, other participants were misinformed and told they might experience epinephrine-irrelevant symptoms, such as itchiness or a headache. Yet another group was not given any information about what kinds of symptoms to expect. While waiting with a confederate who either acted in an angry or euphoric manner, participants who had no prior expectation about the effects of the drug were more likely to experience the same emotion as the confederate: Because they had no good explanation for being aroused, they inferred that they must be feeling either euphoric or angry as well. It is important to note, however, that this effect was not observed for participants

who had previously been told that they might experience arousal-like symptoms: They did not show any influence of the confederate's behavior on their own mood because they were able to correctly attribute their arousal to the drug when making sense of their feelings.

Thus, the main finding of this experiment was that induced arousal was interpreted based on the information available in one's immediate context. However, this was only the case as long as participants had no other explanation available for their current physical state. Building on this early work, many studies have shown that emotions can be changed when a physiological state is misattributed to an emotionally irrelevant source (for a review, see Cotton, 1981). Misattribution processes can also lead to seemingly surprising effects. For example, Younger and Doob (1978) showed that a placebo pill said to be relaxing made participants more aggressive when they were unfairly provoked in comparison with those who took a placebo pill said to be arousing: Participants who were experiencing high arousal while expecting to be relaxed by the pill unconsciously concluded that they must be especially angry and aroused relative to those who could misattribute their arousal to the pill. Thus, people make sense of their internal sensations by looking for reasons for those sensations; they are considered meaningful if experienced in the context of appropriate situational cues but are discounted if salient alternative explanations call into question the informativeness of those sensations for the judgment at hand.

In the context of perception, a preliminary finding suggests that participants find a hill to be steeper when they were told that the sugar-free drink they had received was actually glucose (Williams, Ciborowski, & Durgin, 2012): The participants' feeling that the hill was challenging and steep despite believing they were energized by the drink led to the inference that the hill must have been especially steep. Indeed, such counterintuitive "reverse" placebo effects have been documented in many contexts (Barefoot & Girodo, 1972; Brodt & Zimbardo, 1981; Ross & Olson, 1981; Schwarz, Servay, & Kumpf, 1985; Storms & Nisbett, 1970).

Overall, there is an extensive literature of attribution effects showing that people often infer their own feelings from various environmental cues. This, however, is not a conscious, deliberate process; in fact, once people become aware of the real underlying sources and reasons, their inferences and responses change accordingly. Schachter and Singer (1962) recognized early on that their "conclusions are generalizable to almost any pronounced internal state for which no appropriate explanation is given" (p. 397). Going beyond how people make sense of their emotions, this notion of attribution and misattribution has been applied to informative cues within all kinds of judgments contexts.

Much of this work is based on a seminal paper by Schwarz and Clore (1983; see also Schwarz & Clore, 2003), in which they examined the role of mood on judgments of life satisfaction. In one experiment, participants were led to believe that their answers would contribute to the construction of a Life Event Inventory because it involved giving detailed descriptions of a happy or sad experience in their recent past. In reality, this procedure served to induce a happy mood or a sad mood. In the second experiment, a similar mood induction was accomplished by testing participants on a pleasant and sunny day or a cold and rainy day. Somewhat unsurprisingly, when asked about their quality of life as a whole, both experiments showed that participants in happy moods gave higher ratings of life satisfaction than did participants in sad moods.

More important in the current context, however, the experiments also involved attribution manipulations that made salient a plausible alternative cause of participants' feelings: The first experiment was conducted in an unusual sound-proofed room covered in insulation and electrical shielding. The oddness of the room was pointed out directly to participants in a cover story suggesting that spending time in the room might make them feel tense or relaxed. In the second experiment, a phone survey, the interviewer pretended to be calling from a different city to have a reason for asking some of the participants about the weather in their city on that day. The intention of this seemingly casual remark was to make obvious the likely actual cause for their feelings, namely the weather. In an even more blatant version of this misattribution manipulation, participants were told that the researchers were "interested in how the weather affects people's mood" (Schwarz & Clore, 1983, p. 519). Both experiments showed that the effects of mood on judgments of life satisfaction disappeared once participants were provided with a potential alternative reason for their mood—namely the sound-proofed room in the first study or the sunny or rainy weather in the second study. It is interesting to note that when participants were asked about their mood at the end of the study, it did not make a difference whether they had been reminded of the external influence or not. Stated differently, participants' subjective feelings remained the same, but what changed was the relevance of these feelings to the judgment: When seemingly linked to the odd room or the lousy weather, participants implicitly took into account that negative feelings were no longer informative regarding the judgment of satisfaction with their lives as a whole.

Similar attribution processes take place in the context of metacognitive feelings that are experienced as relevant in various judgment contexts (for reviews, see Greifeneder, Bless, & Pham, 2011; Schwarz, 2012). For example, participants interpret perceptual fluency in recognition tasks as

indicative of familiarity. If a target word is preceded by the same word that is flashed very briefly outside of conscious awareness, participants are more likely to mistake the word itself as a previously encountered word and therefore say they "recognize" it (Jacoby & Whitehouse, 1989). This effect, however, disappears when the duration of the word is increased so that participants become conscious of the priming. These findings and many others (e.g., Bernstein & Welch, 1991; Gellatly, Banton, & Woods, 1995; Joordens & Merikle, 1992; Westerman, 2001) suggest that when people make recognition judgments and decide whether they had previously seen a stimulus, they use the ease with which the item comes to mind as a cue to its familiarity. Again, however, this only works as long as the relevance of this cue is not called into question by becoming salient, in which case people actively disregard it.

All this evidence suggests that people's judgments, whether affective, cognitive, or perceptual, are influenced by various factors that carry informative meaning: Good moods indicate a positive state of the world; bad moods indicate a negative state of the world. A feeling of familiarity indicates one has previously seen a stimulus, a lack of familiarity indicates that it is novel. Similarly, physical capabilities and associated resources indicate that actions in the environment would be easy to accomplish, whereas experienced effort and a lack of resources suggests the opposite. All these are functionally adaptive considerations: It is useful to be cautious about one's environment, for example, when a feeling of fear suggests danger or when a sense of effort suggests that climbing up a hill would be challenging and therefore should be reconsidered. However, people are highly capable of recognizing that such feelings may be inappropriate in situations where the sources of these feelings is made salient, and as a consequence, they correct their judgments.

Attributional Processes Versus Experimental Demand Characteristics

Methods used to study attribution and misattribution can be subtle, such as merely asking casually "By the way, how is the weather down there?" (p. 519), or more blatant, such as explicitly saying that the study investigates the influence of the weather on people's mood; both types of manipulations had the same effect in Schwarz and Clore (1983). An even more blatant manipulation was used by Durgin and colleagues (2009). They ensured that the presence and purpose of the backpack was salient by attaching real electrodes to participants and connecting them to the backpack. To further draw attention to this aspect of the study, an electric fan inside the backpack produced noise, and various pieces of additional equipment were prominently on display in the lab. Therefore what Durgin and colleagues (2009) labelled the "low demand" condition was practically identical to the manipulations used in countless misattribution studies. Similarly, in an effort to "reduce the experimental demand of wearing a heavy backpack" (p. 1584), Durgin et al. (2012) conducted a further study that again made the presence of the backpack salient, this time by asking participants to ignore its influence on their judgments:

> In a previous experiment we found that if we asked people to wear a backpack they nearly all assumed that we intended the backpack to affect their judgments. Since most subjects want to be cooperative, many of them altered their estimates to try to help us out. We are trying to find out if there is a way to make people just report what they see rather than trying to be compliant with what they think we want them to say. As far as we know, wearing a heavy backpack does not affect your visual system, so please simply estimate the slope of the hill. That is, make the best estimate you can based only on what you see. (p. 1585)

Again the original effect was replicated without such instructions, but it disappeared for participants who were giving the misattribution instructions. The researchers further used a glucose manipulation and administered a drink either containing sugar or not, as previously used by Schnall et al. (2010). In their most direct test of the glucose hypothesis in Study 1, Schnall et al. (2010) had established that participants were unable to tell whether the drink contained sugar or not and therefore were blind to the manipulation involving a black-currant-flavored juice drink. Using Coke and Diet Coke as in Schnall's (2010) Study 2, Durgin et al. (2012) took into account whether participants said they were able to taste whether the drink contained sugar or not.[1] Participants who could not tell what was in the drink gave lower slant estimates when they had received sugar in comparison with the participants who had not received sugar, thus replicating the finding by Schnall et al. (2010). Thus, as long as participants were blind to condition and giving intuitive perceptual judgments, participants in Durgin et al.'s (2012) experiment who consumed sugar estimated the hill to be less steep in comparison with those who had consumed a non-sugar sweetener. However, and consistent with the misattribution logic outlined above, once participants' attention was drawn to the fact that other factors might be influencing their perception (after being reminded of the presence of the backpack), this effect was no longer present. A subsequent study by Cole and Balcetis (2013) with a larger sample used a double-blind

design and replicated the glucose effect with distance perception while participants were unable to correctly identify whether the drink contained sugar, and their accuracy of guessing sugar content did not predict the effect of the manipulation.

In the context of attribution and misattribution processes, we can reconsider the finding of a backpack manipulation that involved making half of the participants aware of the backpack (Durgin et al., 2012). All participants were asked to give two estimates, one while at the hill and another later while back in the lab. Only participants whose attention had not previously been drawn to the presence of the backpack revised their second responses to be lower than their initial estimates. It is likely that participants who were already focally aware of the presence of the backpack had stripped their judgment of all possible extraneous influences ("remember, the backpack should not influence your judgment"): They had already corrected their judgment, and their estimates were consequently relatively low. The only group that had not given extensive thought of how they arrived at the judgment was the group that was not yet focally aware of the backpack. Once it was made highly salient by having been asked various questions concerning the study, including whether the backpack had affected their judgments, they were practically in the same situation as the participants who were reminded of the backpack right from the start, and indeed, their slant estimates were identical.

Using a similar approach, Firestone and Scholl (2014) first replicated Stefanucci and Geuss's (2009) finding that an aperture looks more narrow to participants holding a rod horizontally across their body, which would make moving through difficult. Once again, after explicitly drawing participants' attention to the presence of the rod by telling them that it was intended to improve their balance, after "the experimenter also pretended to carefully choose the rod from a salient array of differently sized rods in the room, and it was explained that the researchers were testing poles of different sizes" (p. 44), the original effect was eliminated. The fact that the initially observed effects disappear or are altered is to be expected given the extensive literature on judgment processes studied within social psychology. The fundamental distinction is between what has been called *experimental demand characteristics* (Orne, 1962), and *attribution/misattribution* (e.g., Schwarz & Clore, 1983). The former refers to participants trying to figure out the goal of the experiment and acting accordingly, whereas the latter terms refer to people implicitly taking into account various influences on their judgments and appropriately correct for them once such influences are considered incidental and no longer informative.

Moving Forward: Taking Into Account the Social and Contextual Constraints of Perceptual Judgments

Although it has been demanded for future research to clearly delineate perception and judgment as separate processes (Firestone & Scholl, in press), the research reviewed in this article suggests that arriving at such a separation is not feasible. Nevertheless, research can be conducted that takes into account the insights from work on judgment processes—in particular, pragmatic rules of communication. Indeed, because experiments follow the same rules as other conversational contexts (Schwarz, 1996), instructions need to be given that take into account the specific social context and what participants might infer beyond what is explicitly stated. It is impossible to eliminate demand characteristics (Orne, 1962), so studies introducing elaborate instructions, such as reasons for experimental procedures, may create more problems than they can solve. Participants cannot provide an unmediated experience but only a reported sense of what they perceive based on a variety of cues that they implicitly take into account while ruling out information that might be considered irrelevant or that may potentially confound their judgment.

How can researchers fully capture the nature of perceptual experiences, which often take into account input about the actor's bodily capabilities, goals, and other action-relevant considerations? When asking research participants to give estimates about size, slant, distance, and various other perceptual properties, one must take into account well-established processes in social judgment and decision-making contexts. Importantly, studies need to be designed such that they minimize the potential of participants guessing the true purpose of the research. Many such studies have already been conducted, and their results cannot be explained by demand characteristics or other artifacts. Indeed, despite their critiques, none of the skeptics (e.g., Durgin et al., 2009; Durgin et al., 2012; Firestone, 2013; Firestone & Scholl, in press) have put forward any alternative theoretical account that could explain those findings, which come in two forms: studies that measure individual differences and relate them to perceptual outcomes, and studies for which the objective is difficult or impossible to discern by participants because the experiment involves nonobvious manipulations and predictions.

Individual differences and perception

Early findings suggested that elderly or fatigued participants find hills to be steeper than young or rested participants (Bhalla & Proffitt, 1999; Proffitt, Bhalla, Gossweiler,

& Midgett, 1995). Many additional related findings have been obtained (e.g., Proffitt, 2013). For example, participants with wide shoulders find the apertures of hallways to be smaller than do participants with narrow shoulders (Stefanucci & Geuss, 2009). Similarly, women perceive staircases to be steeper than do men, presumably due to lower physical strength relative to body mass (Taylor-Covill & Eves, 2013). Evidence also suggests that individual differences with respect to people's social roles in relationships with others influence perception. Lee and Schnall (2014) found that a low sense of social power, defined as experiencing a general lack of control over one's own and others' resources, is associated with increased perceptions of weight when lifting a heavy box. Thus, both stable physical characteristics and personality-based individual differences have reliably been found to influence the perception of the physical world.

Nontransparent or counterintuitive predictions

Getting directly at energetic concerns underlying perception, the glucose finding first obtained by Schnall et al. (2010) has been extended to a distance-perception paradigm in which both experimenter and participants were blind to the glucose and placebo conditions (Cole & Balcetis, 2013). Furthermore, people who are presumed to be low on glucose because they actively select high-energy food and drink when given a choice estimate hills to be steeper than do people who select low-energy alternatives (Taylor-Covill & Eves, 2014). Beyond glucose, when energy expenditure associated with walking was manipulated on treadmill walking, distances were estimated as farther under conditions that required high volumes of oxygen (White, Shockley, & Riley, 2013).

In addition, researchers have recently begun using manipulations that make it unlikely for participants to infer the study hypothesis. For example, Lee and Schnall (2014) employed a posture manipulation that ostensibly involved testing the comfort of an economic office chair, whereas in reality it induced either a powerful or a powerless posture. Postexperimental questioning indicated that participants were unaware of this intention, just as in previous research using this method (Carney, Cuddy, & Yap, 2010; L. Huang, Galinsky, Gruenfeld, & Guillory, 2011). Participants who were induced to feel powerless estimated the weight of boxes filled with books to be greater than did participants who felt powerful or were in a neutral condition (Lee & Schnall, 2014).

Similarly, while participants were making hill slant estimates, we manipulated approach and avoidance orientation in nontransparent ways (Krpan & Schnall, 2014b). In one study, participants pressed against a stepladder either by flexing the arm, therefore producing the motor behavior of approach, or by extending the arm, therefore producing avoidance (cf. Cacioppo, Priester, & Berntson, 1993). In another study, participants completed a paper-and-pencil maze task by either helping a mouse at the center find the way out to reach a cheese or by helping the mouse to escape from an owl, which has been shown to induce approach or avoidance, respectively (Friedman & Förster, 2001). For both types of approach motivation, participants estimated the hill to be steeper than did those in avoidance motivation or a control condition, but this effect was moderated by participants' physical condition on that day, with only relatively fit participants showing the effect. Thus, in the face of approaching a steep, challenging hill, perception serves to discourage impending action when it may be costly, but only for participants for whom undertaking this action is a realistic possibility. Furthermore, consistent with the misattribution logic, when instructing participants in the approach condition that they would definitely not have to climb up the hill, the effect disappeared (Krpan & Schnall, 2014b). Again, this effect was only obtained for participants for whom climbing the steep hill was feasible in the first place because they were relatively fit. That is, similar to the effects documented by Durgin and colleagues (2009; Durgin et al., 2012), once the implied meaning of the approach cue was called into question, it no longer provided informative input in the context of perception. When questioned afterward, not a single participant was able to correctly identify what the manipulations intended, much less formulate the hypothesis that approach should lead to higher estimates in comparison with the avoidance or control conditions. Similarly, approach and avoidance behaviors consistently influence distance estimates to valenced objects while participants are completely unaware of experimental predictions (Krpan & Schnall, 2014a).

Convergence between perception and action

As has been argued for other areas of psychology (e.g., Baumeister, Vohs, & Funder, 2007), self-reports provide only one way of capturing experience. Indeed, to get a more comprehensive understanding of what factors influence perception, appropriate behavioral measures should be used. In particular, the core claim of the economy of action account is that environments that are effortful to traverse involve perceptual estimates that discourage subsequent action (Proffitt, 2006; Schnall et al., 2010). For example, the assumption of findings such as reduced

fitness being associated with increased slant estimates is that it occurs because unfit people are less able to climb a hill than are their fit counterparts (Bhalla & Proffitt, 1999). A critical question therefore is whether perception indeed shapes behavior, for example, such that people with certain physical characteristics are more or less likely to engage in corresponding actions.

An extensive review of 43 studies examined the likelihood of people using stairs or escalators as a function of effort-related considerations (Eves, 2014). As would be predicted from the economy of action account, people for whom taking the stairs would be relatively challenging—namely, women, the elderly, those carrying more weight in the form of body fat or heavy shopping bags—chose to take escalators adjacent to stairs more often. This involved naturally occurring behavior in urban environments such as shopping malls and train stations, and the relevant studies were observational, allowing no scope for experimental demand. Related research more directly showed that, in the face of inclines, people indeed act in ways that are consistent with the ways in which they see them: People who avoided stairs and chose an escalator instead reported them to be steeper than did people who had chosen to climb the stairs (Eves, Thorpe, Lewis, & Taylor-Covill, 2014). Overall, there is now a considerable body of evidence for which results cannot be explained by experimental demand characteristics, and in the absence of any viable alternatives, the only parsimonious account currently available relates to the economy of action (Proffitt, 2006).

Conclusion

Findings supporting an embodied account of perception have been criticized for entailing demand characteristics. However, support for interpretations relating to demand characteristics has relied on manipulations that are based on the assumption that once participants are given appropriate instructions, their "true" perceptual processes can be separated from experimental demand or inferential judgment processes. Such an assumption is inappropriate given people's inability to introspect the reasons behind their judgments. Further, perceptual judgments have to be considered within well-established pragmatic and conversational rules of making sense of questions in given social contexts. Finally, given what is known about attribution and misattribution processes, the findings that are interpreted to show experimental demand in fact reflect well-established phenomena in judgments processes: Like other judgments, perceptual judgments take into account contextual and experiential factors. The precise manner in which such factors influence perception depends on their perceived informational value. In most everyday situations, people use whatever information they experience as relevant in a judgment context and they therefore incorporate it. However, making people aware of the incidental nature of such experiences undermines their informational value and elicits correction. A full appreciation of the social constraints on perceptual judgment therefore reveals that perceptual processes function in much the same manner as other processes involving subjective feeling and judgment: They take place outside of people's conscious awareness and serve adaptive functions because they reflect action-relevant circumstances in the social and physical worlds.

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Note

1. The single experiment reported in Durgin et al. (2012) involved 37 participants. In addition to assigning them to four experimental conditions, participants were split based on whether they reported tasting the presence of sugar in the drink or not. These analyses involving taste are therefore based on very small sample sizes, with an average of 4.63 participants in each of eight conditions. Findings involving such few participants need to be considered with caution; nevertheless, they are discussed at face value in this article.

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