Motivated Distance Perception Serves Action Regulation

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THE CONTROL WITHIN: MOTIVATION AND ITS REGULATION

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Abstract

This chapter synthesizes a growing body of research demonstrating that visual perception of the environment, including distance, is systematically altered. We call upon both classic and emerging theories to speculate that visual perception is biased, at least in part, to regulate action. Just as actual proximity to relevant targets promotes a readiness to engage in action with those objects, we theorize that perceived proximity serves the same function. People may perceive objects as closer when those objects call for action. We review research suggesting that desirable and threatening objects, both of which require behavioral responses, appear closer than comparison objects. We comment on the theoretical roots of this hypothesis and the ways in which current research improves upon the shortcomings of previous investigations. Further, we speculate on mechanisms that contribute to these perceptual biases and call for future research to test the classic notion that “seeing is for doing.”

KEYWORDS: regulation, motivation, perception, desire, threat

In nearly every aspect of life, there is a fundamental need to act. People must act in order to survive, to advance, to meet their goals, and to avoid pitfalls along the way. Hungry people act to quiet the rumblings in their stomachs. Ostracized individuals act to restore feelings of social inclusion. Frightened people act to circumvent the dangers that prompt their fear. And aspiring doctors, artists, clinicians, and researchers act to earn the credentials their fields require for entry. People must move, react, and respond when the situation requires it.

Many situations require action, and immediate behavioral responses may be warranted. As a result, people may be best served by having a system in place that is sensitive to changing situational demands and that prompts action when action is needed. Fortunately, people do have such a system—the motivated perceptual system (see Balcetis & Dunning, 2007, 2010; Dunning & Balcetis, in press). We argue that people possess a perceptual system that is adaptively designed to aid them in solving the regulatory challenges of everyday life and is particularly sensitive and responsive to needs to act, which vary as the contents of the environment and people's internal states fluctuate. The perceptual system assesses whether environments call for action (e.g. to acquire desirable goods, to defend against threats) and produces visual experiences that prompt and guide appropriate behavioral responses. Just as people's muscles and minds gear up physiologically when action is needed, we argue that people see the world in ways that facilitate action when action is needed. As a result, as they scan their surrounding the world, people may not see the world as it really is (see Balcetis & Lassiter, 2010). Perception does not haphazardly shift at the whim of chance, but instead is systematically biased in accordance with action needs in ways that promote appropriate behavioral responses.

Physiological Preparation for Action

As a basis for this theory, we first turn to physiology. Before taking the first steps to meet

their needs, bodies physiologically prepare for action. For instance, when standing in the stalls minutes before a race begins, thoroughbred horses' hearts beat over 2.3 times faster relative to when they were back in the stables before the race (Mukai, Takahashi, Eto, Ohmura, Tsubone, & Hiraga, 2007). Similarly, just before sprinting up a flight of stairs, humans' heart rates accelerate steadily until 1-sec prior to starting (Stern, 1976). Moreover, in the lab, people's bodies gear up to act when they anticipate that their actions will reap reward. People's pupils dilate, which increases visual sensitivity (Bijleveld, Custers, & Aarts, 2009), and their systolic blood pressure rises (Wright & Dill, 1993). People's heart rates climb and they start to sweat when they anticipate receiving a significant financial payoff if they act quickly (Low, Lang, Smith, & Bradley, 2008). Bodies prepare for action to reap reward.

Additionally, bodies prepare for action to defend against threats (Lazarus, 1966). In dogs and cats, hindlimb blood flow increases when frightened (Martin, Sutherland, & Zbozyna, 1976). In sheep, heart rate climbs by over 300% just before a wolf attack (Clark, 2012)[1]. In people, heart rate, blood pressure, and cortisol levels increase when preparing to defend against physical harm (Lerner, Gonzalez, Dahl, Hariri, & Taylor, 2005; Prkachin, Williams-Avery, Zwaal, & Mills, 1999), and also when preparing for a social threat (Dickerson, Mycek, & Zaldivar, 2008). Similarly, people begin to sweat when they gear up to face physical peril; their bodies and brains become evermore vigilant to whatever threatens them (Low, Lang, Smith, & Bradley, 2008). For example, neurons in subcortical brain regions associated with reflexive action and defensive behavior fire away when threats are present (Pichon, de Gelder, & Grezes, 2012). Across animal

[1] As an interesting side note, collars on sheep's necks that monitor heart rate may soon be capable of sending a text message to farmers alerting them to the presence of predators (Clark, 2012).

species, when confronted with either the possibility of reward or the possibility of harm, bodies ready for and regulate action.

Moreover, as the need to act increases, physiological preparation intensifies. For instance, as monetary rewards loomed progressively closer, heart rate, skin conductance responses, and patterns of brain activity indexed increasing preparation for action (Low, Lang, Smith, & Bradley, 2008). Likewise, bodies physiologically prepare to defend against threats as the threat nears and becomes more imminent. Adult and infant humans display behavioral (King, Dykeman, Redgrave, & Dean, 1992), cardiac, and neurological signs that suggest their bodies are preparing to act when threats appear to close in on them (Fanselow, 1994; Mobbs et al., 2007). Approaching threats activate similar defensive behaviors in monkeys, pigeons, turtles, frogs, goldfish, and locusts (see Fotowat & Gabbiani, 2011, for a review). Such preparation for action can lead to actual changes in behavior; hungry rats act faster when they close in on a food reward (Crespi 1942). As rewards and threats move from remote to proximal, multiple markers suggest bodies are ready to act to meet regulatory needs.

Perceptual System Assists with Preparation for Action

Thus, decades of research across multiple species, using physiological, neurological, and behavioral measures, converge on the conclusion that rewards and threats call bodies to action. Moreover, as rewards and threats come close and loom large, the need and subsequent preparation for action intensifies. In our program of research, we build upon this solid empirical foundation. We propose that if readiness to engage in action increases as the proximity of a reward or threat increases, people may be best served by misperceiving rewarding or threatening targets as more proximal. By seeing objects as closer, the body may prepare for action sooner and may more readily attain rewards or defend against harm.

In this chapter, we review a growing body of work that suggests people perceive objects as closer when those objects are related to reward or threat given the need to act in response to possible rewards and threats. Using multiple paradigms, we demonstrate that objects that call for action appear closer than objects that do not. In the first section, we review research suggesting that desirable objects related to approach and acquisition tendencies appear closer than less desirable objects. In the second section, we review research suggesting that threatening objects related to defensive behavioral tendencies appear closer than non-threatening objects. These two lines of work converge to suggest that when an object requires action, people misperceive that object as closer. Perception, at least of distance, appears responsive to the regulatory needs of the perceiver to engage in action.

Revisiting the Gibson, New Look, and Economy of Action Perspectives

To suggest that perception is implicated in the regulation of action adds to theoretical perspectives that predate ours. Linking perception to action finds theoretical roots in an ecological approach articulated by Gibson and others (e.g., Allport, 1989; Gibson, 1979; Tucker & Ellis, 1998). The ecological approach proposed that people perceive the environment in light of how they are acting within it (Gibson, 1950). As people move through space, objects cross their field of view at a certain speed and in specific directions. This relative motion between observers and objects suggests properties of the object that people could perceive. For instance, a round object whose diameter grows larger at a rapid rate may be perceived (perhaps rightfully so) as a quickly approaching baseball.

Although both the theory of motivated perception and the ecological approach tie action to vision, they differ in the time point during which they discuss action's relevance to perception. Our theory focuses on the effects of anticipated action; it focuses on the consequences for

perception of people's plans for engaging in the environment. The ecological approach to perception, instead, articulates mechanisms by which actions affect perception in real time, as people and objects move within a space. The ecological approach investigates the consequences for perception of behaviors currently in progress. Nonetheless, both theories assume perception is tied to action.

Additionally, our motivated perception approach shares commonalities with the New Look perspective, developed in the mid-20th century (Bruner, 1957). The New Look also suggests that perceivers' needs, in addition to their wants, desires, and fears, influence visual perception. The approach further articulates that to facilitate appropriate action, people maintain a readiness to perceive objects in the environment that can satisfy needs. For example, as participants' hunger grew, they were more likely to interpret ambiguous objects as food (Levine, Chein, & Murphy, 1942). Unfortunately, research from the original New Look perspective suffered from methodological and theoretical shortcomings that rendered the conclusions from empirical findings tenuous (Erdelyi, 1974). For instance, it was unclear whether needs affected visual perception or later-stage processes, like judgments, better thought of as cognition (Carter & Schooler, 1949). Further, it was unclear whether needs were responsible for perceptual bias or whether, instead, it was memory, frequency of exposure, or target familiarity that affected vision (Adkins, 1956).

Finally, our motivated perception approach shares commonalities with a contemporary perspective articulating the effects of physiological energy on perception of the environment (see Proffitt, 2006). In their economy of action account, Proffitt and colleagues argue that perceptual experiences help people plan their actions within environments given the energy they have available to traverse them. When energy is depleted, environments appear more extreme.

Distances appear longer and hills appear steeper. Indeed, people reporting chronic fatigue perceived hills as steeper (Schnall, Zadra, & Proffitt, 2010) and patients experiencing chronic pain perceived targets to be further away than people without pain (Witt, Linkenauger, Bakdash, Augustyn, Cook, & Proffitt, 2009). When energy is low, anticipated effort high, or the ability to act difficult, environments appear more extreme, perhaps to discourage action.

Moreover, the economy of action account suggests the effort required to traverse a distance only affects perception when the anticipated effort is relevant to the perceptual experience (Witt, Proffitt, & Epstein, 2010). For instance, distances look farther to people who believe walking will be effortful but only if they intend to walk to the target. Distances do not appear as far if those same people intend to simply throw a beanbag at the target (Witt et al., 2004). Perception appears sensitive to the energetic costs of traversing a space, but functional perceptual biases emerge only to the extent that a person anticipates tapping in to those energy reserves. Just as our motivated perception account argues that perception is sensitive to motivational needs to act, the economy of action perspective suggests perceptual biases are also sensitive to the energetic resources required and available for action.

Desire and Perceptions

Armed with a firm foundation in classic research but improved theory and scientific rigor relative to the historic perspectives, we have reopened and expanded upon the question of whether perception is influenced by values, needs, and desires. Compared to the New Look of the 1940's and 50's, we test a more modern theoretical framework about potential relationships between regulatory needs to act and perceptual experiences. We began our investigation into the links between perceptual bias and the regulation of action by testing how people perceive distances to desirable objects. In doing so, we built upon classic goal gradient research exploring

relationships between motivation and distance. The research showed that desirable objects energized approach behaviors to the extent that those objects were located in close proximity to the perceiver (Dollard & Miller, 1950). For instance, animals in a maze ran faster and pulled harder against restraints when they were actually closer to a food reward (Crespi, 1942; Brown, 1948).

If it is true that proximity is related to action as suggested by classic research, we theorized that people may underestimate the distance that separates them from an object when that object is desired and calls for action. We predicted that people's inclination to act in response to a desirable object may relate to perceptions of proximity. Food to the hungry, money to the cash-strapped, or a friend to the lonely may appear closer than they do to those who finished dinner, won the lottery, or just enjoyed a party. People may perceive objects as closer if those objects are desirable ones they wish to approach or acquire.

To test whether desirable objects appear closer than less desirable objects, we began by manipulating the visceral need state of perceivers, which we expected would affect the desirability of a target object. First, we manipulated thirst by asking some participants to consume a serving of dry salty pretzels that constituted 40% of their daily intake of sodium and others to drink four 8-oz glasses of water (Balcetis & Dunning, 2010, Study 1). We then asked participants to estimate how many inches away a bottle of water was, using a 1-inch line as a reference. Thirsty participants reported the water was very desirable and estimated that it was 25.1-in away. Quenched participants, on the other hand, reported the water as less desirable and estimated that it was 28-in away. The object, when it was considered desirable because of its ability to satisfy a visceral need, appeared significantly closer than the same object when it was considered undesirable.

We argue that desirability led to perceived proximity, but it is possible that a general state of arousal varied between the thirsty and quenched groups. High arousal does shift how people process the focal and peripheral objects in their environments (see meta-analysis by Steblay, 1992). However, it is unlikely that general arousal alone led people to perceive the water as closer when thirsty compared to quenched. Just because they were thirsty does not mean people were also experiencing greater levels of arousal. Indeed, people can feel thirsty without feeling increased arousal (Messing & Campbell, 1971). Rats will press a bar to receive water indicating they are thirsty, but heart rate does not correlate with thirst, suggesting the state of thirst is not necessarily associated with common indicators of general arousal (Hahn, Stern, & Fehr, 1964).

In addition, even if thirst had produced greater arousal, general arousal alone is unlikely to produce perceived proximity. To support this claim, we measured participants' visceral states and tested perceptions of distance to one of two objects (Balcetis, 2006). Specifically, we gathered some participants who were entering a dining hall before dinner, were hungry, and were arguably experiencing arousal. They estimated the distance to either two warm, delicious pieces of pizza or to a boring and untempting stack of paper cups. We compared these estimates to those made by participants who were leaving the dining hall after finishing dinner, were satisfied, and arguably not experiencing arousal.

With this design, we could simultaneously test the effects of object desirability as well as participants' arousal on perceived distance. We found that hungry participants estimated that two delicious slices of pizza were about 21-in away while other hungry diners estimated a boring stack of cups were 28-in away. This tendency to perceive the pizza as closer disappeared after hunger was satisfied. Participants leaving the dining hall after dinner estimated that both the pizza and cups were about 28-in away. If general arousal alone led to perceived proximity, then

any focal object should have appeared closer to hungry participants compared to satisfied participants. However, this was not the case. Only those participants who were hungry and estimating distance to pizza perceived the target as closer.

Desirability need not stem from visceral needs in order to produce perceived proximity. Objects considered psychologically desirable also appear closer than objects considered psychologically undesirable. For instance, a mere piece of paper that provides positive self-relevant feedback can appear closer than a piece of paper that provides negative feedback (Balcetis & Dunning, 2010, Study 2b). In a study demonstrating this, college students completed a bogus personality test supposedly evaluating a most valued characteristic among our student sample—their sense of humor. The experimenter then ostensibly graded the test. For some participants, on the front page of the test, the experimenter printed an A, indicating participants had a stellar sense of humor and were among the funniest in the study. However, for other participants, on the front of the test, the experimenter printed a D+, indicating participants had a poor sense of humor and were among the least funny in the study. Then, the experimenter hung the graded personality test on the wall and asked participants to estimate the distance to the piece of paper, using a 1-in line as a reference. While participants looking at the unflattering feedback estimated the paper was 43-in away, participants looking at the flattering feedback estimated is closer, at only 36-in. Importantly, these effects do not seem to be the direct result of changes in mood. Environments do at times appear less extreme (e.g. hills less steep) when people are in good moods (Riener, Stefanucci, Proffitt, & Clore, 2003). Although our participants did tend to be in a better mood after receiving positive rather than negative feedback, distance estimates did not correlate with mood.

Moreover, it is not numerical judgments of distance alone that are affected. Instead, people also act ways in that suggest their perceptual experience has actually changed. When we measured distance perception by testing people's behaviors in response to desirable objects, we found that action-based measures of perception converge with judgments that require participants translate perceptual experiences into numeric reports. In one experiment (Cole & Balcetis, in press, Study 1), some participants saw a $100 bill in a picture frame on the ground in front of them. They knew that later on, they might win that $100 bill if they drew a lucky card from a deck. Other participants saw an empty picture frame on the ground and were told nothing about a drawing. Participants assessed the distance that separated them from either the desirable or neutral picture frame. Rather than providing a numeric estimate to represent their perceptual experience, participants tossed a beanbag at the picture frame. Participants were instructed to hit the object with their beanbag, and the beanbag was rubber so it would not slip when it hit the carpeted floor. Because there were no consequences tied to their toss, we considered the place where the beanbag landed to solely reflect participants' perceptions of distance to the object. If, as we suspected, participants perceived the desirable frame housing the $100 bill as closer than the empty frame, then the beanbag should land closer to participants. Our prediction was supported. Participants undertossed the beanbag by 2.4-in when the frame contained a $100 bill and overtossed by 11.3-in when the frame was empty. This action-based measure suggested the desirable object appeared closer than the less desirable object.

Further, it does not seem that participants were systematically or consciously altering their responses when tossing the beanbag (Balcetis & Dunning, 2010, Study 3a). In a different study, participants tossed a beanbag at a Visa gift card. We told some participants that the gift card held a $25 value, and we told others that its value was already used up. This time, we made

participants' reward contingent on their toss. Participants knew that if they hit the gift card, they would win it. Participants again perceived the more desirable object to be closer than the less desirable object. The beanbag landed 9-in shy of the card when it held a $25 value but landed within an inch of the card, on average, when it had no value. In other words, participants seemed generally able to hit the card when it was valueless but on average undertossed the beanbag when it held financial value, suggesting they perceived the desirable object as closer. These results suggest people not only report that desirable objects appear closer, they also act as though the objects are closer. Moreover, participants were probably not systematically altering their responses to maximize payoff. If they were, they should have (and could have) hit the $25 gift card with the beanbag. Instead, results from this study and other evidence suggest that the desirability of the object, and the need to act in response to the object, influenced participants' actual perceptual experiences outside of their awareness.

Finally, we argue that the need to act, not simply the strength of participants' appraisal or opinion of the object in the environment, leads people to perceive desirable objects as closer. To test this, we measured perceptions of distance to objects that evoked strong affective reactions but that differed in the behavioral responses they called for. Specifically, participants viewed one of two objects on a table across from them. Half of the participants saw a package of colorfully wrapped chocolates, while the other half saw a plastic bag containing what was described as a freshly collected sample of dog feces. Unsurprisingly, but importantly, pre-test participants reported having more positive opinions about the chocolate than the feces, but in an absolute sense, the intensity of their feelings was actually slightly stronger about the feces than the chocolate. That is, participants felt more strongly about the feces than they felt about the chocolate.

On the wall above the table, two strips of tape were separated by 90.5-in of wall space. Participants completed a distance-matching task. Participants adjusted their own position by walking towards or away from either the chocolates or the feces until they believed the distance between themselves and the object was equal to the distance between the two pieces of tape on the wall. When they were finished adjusting, the distance between participants and the target object constituted participants' distance estimate.

We predicted that participants would experience the desirable chocolates as closer than the feces. In order to match the distance represented by the tape on the wall participants should paradoxically position themselves further from the chocolate than the feces. If, however, participants perceived the object about which they held a stronger attitude as closer, they should position themselves further from the feces than the chocolate. Again, we found that the desirable appeared closer than the undesirable object. Participants positioned themselves about 101-in away from the chocolates and 88-in away from the feces. We argue that because the chocolates appeared closer, participants needed to stand further away to match the set, referent distance. Again, while participants reported being in a more positive mood when viewing chocolates rather than feces, participants' mood did not predict distance estimates in any way.

Converging Evidence

Beyond the work emanating from our labs, additional evidence converges on the suggestion that visual perception, desirability, and action are linked. Football kickers who score more points estimate the field goalposts are wider apart (Witt & Dorsch, 2009). Golfers who played better estimate the hole size was larger (Witt, Linkenauger, Bakdash, & Proffitt, 2008), and softball players who hit well estimated that the ball is bigger (Witt & Proffitt, 2005) than their less accomplished counterparts. Improved performance correlates with perceptual

overestimation (Witt, 2011). Perhaps those who see the hole as larger or the ball as bigger simply have an easier time hitting their mark. Indeed, reactions from baseball's biggest stars corroborate this sentiment. When Mickey Mantle hit a 565-foot home run he claimed, "I just saw the ball as big as a grapefruit." Alternatively, Joe "Ducky" Medwick of the St. Louis Cardinals commented about his slump that he was "swinging at aspirins," and Ty Cobb described the legendary Walter Johnson's pitching, claiming "his fastball looked about the size of a watermelon seed and it hissed at you as it passed." Perception, and more specifically systematic misperceptions, seem related to action.

Summary

In our own research, perceptions of distance to an object depend, at least in part, on subjective qualities of the object and states internal to the perceiver. Desirable objects appear closer than less desirable objects. Whether desirability comes from an object's capacity to satisfy a visceral need or a psychological one, perceivers see the object as closer than they otherwise would if the object was construed as less desirable or the perceivers' needs were made less salient. These systematic differences in perceptual experience may be adaptive. When desirable objects are actually close, approach behaviors aimed at acquiring those objects and assisting regulation intensify (Dollard & Miller, 1950). Perhaps mere perceptions of proximity similarly facilitate approach actions toward these objects, thus motivating optimal behavioral responses geared toward obtaining desirable objects. If the perceptual system is optimized to serve perceivers' needs, rewarding and desirable objects in the environment should be, and in fact are, perceived as closer than less rewarding objects.

Threats and Perceptions

As a second approach to studying the links between perceptual bias and the regulation of action, we tested how people perceive distances to threatening objects. Just as people must act to take advantage of opportunities for reward, it is also imperative that people act to defend against approaching threats and looming dangers. We propose that threatening objects that require immediate action might appear close to guide effective, even essential, action. If the need to act contributes to perceived proximity, then threatening objects should appear closer than other negative objects that do not require immediate action, such as disgusting objects.

Indeed, threatening objects typically require quick behavioral responses. For example, in July 2011, during mating season, a 7.5-ft long boa constrictor in the U.K. broke through the lock on its tank and went missing after a 3-week fast. Abbigayle Harding, the snake's owner, along with the police, quickly devoted her efforts to mitigating the threat to the school kids and neighbors nearby. Residents were warned that the 'hungry and unfriendly' snake could climb trees from where it might pounce on, bite, and attack prey. Clearly such an incident warranted immediate action, likely to a degree that, say, a gross rubbish bin, toilet, or soiled carpet in need of cleaning likely never would[2]. Both fear and disgust may be associated with negative feelings and avoidance tendencies, but fear typically necessitates active mobilization to withdraw from or dispel potential threats, whereas disgust does not.

In fact, physiological differences in the body's reactions to fear and revulsion support the assertion that threats call for immediate action whereas disgusting objects do not. Compared with fear, disgust generally is associated with a more static avoidance of objects and reduced readiness to act (Stanley & Knight, 2004). For instance, compared with fear, disgust is much less

[2] Although the police, vigilant to protect the neighborhood, forbade school children from playing in the park next door to where they assumed the snake would flee, Harding eventually found the boa under her kitchen sink.

strongly tied to anticipated effort and exertion (Smith & Ellsworth, 1985). In contrast, feelings of fear increase activity in the sympathetic nervous system, prompting the body to mobilize for action. However, disgust activates parasympathetic responses, actually decreasing heart rate, blood pressure, and respiration and thereby suppressing action responses (Woody & Teachman, 2000). As measured by neuroendocrine stress responses, fear increases blood pressure and cortisol, the hormonal marker of stress, whereas disgust lowers blood pressure and cortisol levels (Lerner, Gonzalez, Dahl, Hariri, & Taylor, 2005). Increased blood pressure and cortisol suggest the body is prepared to take action when threats are present. These biological markers suggest that although both disgust and fear are aversive states of arousal, fear is a motivating force that prompts action.

If perception of distance is responsive to needs to regulate action, and if perceived proximity is related to increased action, then threatening objects should be perceived as closer than disgusting or neutral objects because threats require more immediate responses than do contaminants. In one line of research, we tested these assumptions. In our first study, we put participants in a relatively small room across from a live tarantula that was walking around, unimpeded, on a tabletop (Cole, Balcetis, & Dunning, in press). Participants reported the degree to which they felt threatened. They also reported the degree to which they felt disgusted. Finally, using a 1-in line as a reference, they reported the number of inches separating them from the tarantula. When statistically isolating the effect of fear from the effect of disgust, we found that the more threatened participants felt, the closer they perceived the tarantula. Importantly, this effect was not simply due to increased feelings of negativity, since stronger feelings of disgust actually led participants to estimate the tarantula was further away. Feelings of fear but not disgust produced perceptions of proximity to the tarantula.

In a second study (Cole, Balcetis, & Dunning, in press), we experimentally manipulated participants' affective experiences to test the causal effect of threat on perceptions of distance. Female participants knew they would soon sit in a small room with a man as part of a study about first impressions. Before interacting with him, they watched a video he supposedly just made describing himself. Some participants watched him describe how he loved the feeling of a gun in his hand and how he felt his anger was bottled up inside without a way for release. Other participants watched him describe a summer job at a fast food restaurant that he found annoying, which led him to urinate into customers' sodas before serving them. Other participants watched him describe his class schedule. Then, participants went to meet the man in the video. After being seated, we measured participants' heart rate to assess general arousal.

Before chatting, participants estimated the distance separating them from the man. Perceptions of distance depended on what participants learned about the man beforehand. The threatening man appeared, on average, 55-in away, within the average person's arm reach. However, the disgusting man appeared 78-in away and the harmless man who discussed coursework appeared 74-in away. Experimentally induced threat but not disgust led to perceived proximity, even adjusting for arousal as measured by heart rate. Data from these two studies support the assumption that the regulatory need to act led objects considered threats to appear closer than objects considered disgusting or neutral.

Converging Evidence

Additional evidence converges on the hypothesis that the need to act in response to a threat produces a perceptual bias that facilitates action. For instance, the threat of falling caused people to overestimate how far it was to the ground when they stood on a balcony ledge (Stefanucci & Proffitt, 2009). Moreover, spider phobics, who suffer strong subjective

experiences of fear, perceived the speed of a spider moving toward them as faster than did nonphobic peers (Riskind, Moore, & Bowlby, 1995). Images of threatening objects appeared physically bigger than neutral or positive images (van Ulzen, Semin, Oudejans, & Beek, 2008). Arguably, seeing the distance to the ground as farther, the speed of a scary spider as faster, and other biases encourages people to respond faster. Across these studies, threat leads to exaggerated perceptual experiences, which may facilitate or expedite appropriate responses to those threats.

Summary

In our own studies, perceptions of distance depend, at least in part, on the degree to which a perceiver feels frightened. Objects considered threatening appeared closer than objects considered disgusting or neutral. Again, we argue that these systematic differences in perceptual experience may be adaptive. When threatening objects are actually close, behaviors meant to avoid possible harm intensify, and misrepresentations of proximity may similarly facilitate actions meant to mitigate the threat. Exaggerating the proximity of the threat may promote adaptive actions meant to protect against danger. Similarly, exaggerating the length of the fall when looking over the balcony's edge, or the speed of a threatening spider moving closer, may also promote adaptive actions meant to secure one's safety. If the perceptual system is sensitive to serve perceivers' needs, threatening contents of the environment should be, and in fact are, perceived as closer than non-threats.

Possible Mechanisms

Because this work is still in its infancy, researchers have yet to pinpoint the precise mechanisms that contribute to systematic biases in perceived proximity. Emerging research has hinted at a few possibilities.

Arousal and Distance Perception

While arousal itself does not fully explain the effects of desirability and threat on perceived proximity, arousal does contribute to perceptual bias when perceiving distance. For instance, participants estimated that the distance to the ground off a 2-story balcony was further after viewing 30 emotionally arousing images compared to neutral images (Stefanucci & Storbeck, 2009). Interestingly, however, perception of horizontal distance was not influenced by emotional arousal. Further, if directed to up-regulate their emotional experience and intensify their feelings while viewing the emotionally arousing images, heights appeared greater than if directed to down-regulate their emotional experiences. While difficult to isolate the effects of emotional states from general arousal, it is possible that arousal contributes to and is implicated in perceptual experience.

Although a contributing factor to bias in perceptual experience, the causal role arousal plays within our developing theory is unclear. One reason this might be the case is that arousal assumes many forms, and the specific way in which arousal affects perception may depend on how one conceptualizes arousal. One way to conceptualize arousal is as a sort of amplifier, strengthening the link between emotions and perception. Arousal, coming from imagery or up-regulation, might intensify emotional experiences, which affect perceptual experiences. Indeed, participants perceived the distance across a bed of nails as longer if they just imagined falling into it than if they just imagined successfully jumping over it (Stefanucci, Gagnon, Tompkins, & Bullock, 2012).

Another way to conceptualize arousal is as a source of energy. Arousal might provide a boost of energy physiologically (Brown, 1961), and such energy may affect perceptual experiences (Proffitt, 2006). For instance, male participants who viewed highly arousing pictures

of nude females, an aimed gun, and skydivers experienced a 6% increase above baseline levels of circulating blood glucose whereas participants who viewed less arousing pictures of a fork, farmland, and cows experienced only a 1% increase (Blake, Varnhagen, & Parent, 2001). Arousal may be a source of energy, and energy is related to perception of the environment.

Indeed, we experimentally manipulated the energy participants had available and found a causal effect of insufficient energy on perceptions of distance (Cole & Balcetis, in press). First, we depleted blood glucose levels for all participants by having them complete a cognitively demanding and boring focused attention task. Next, we asked some participants to consume Kool-Aid sweetened with sugar, which increases blood glucose and available energy. We asked other participants to consume Kool-Aid sweetened with Splenda, a non-caloric sugar substitute, which has no effect on available energy. Participants, experimenters, and the supervising graduate student were all blind to energy condition. After drinking, participants estimated the distance to a target by tossing a beanbag with the intention to hit it. Participants who consumed sugar undertossed the beanbag by 2.4-in, on average, while participants who consumed Splenda overtossed the beanbag by 10.7-in. Although participants could not accurately guess at above chance levels whether they consumed sugar or Splenda, they saw the target as closer after receiving an energy boost compared to when energy levels remained low. Across self-reported and manipulated measures of energy, it seems that perception takes into account available energy.

If theorists consider arousal to have measurable effects on energy, then it is possible that arousal is related to perceptual biases that serve action-regulation. If arousal creates energy and ample sources of energy produce perceived proximity, then it is plausible that arousal should be considered and studied as a contributing mechanism by which perceptual experiences are biased.

However, given the multiple operational definitions of arousal, the precise nature of the correlational and causal effect of arousal is yet to be determined.

Attention and Distance Perception

Another psychological mechanism that may contribute to perceived proximity is attention. Eye gaze is directed to and focused on select elements in the environment at the expense of others (Posner & Peterson, 1990). Often, attention is fixated on objects relevant to the perceiver's current desires (Fox, Russo, Bowles, & Dutton, 2001; Maner, Gailliot, Rouby, & Miller, 2007). For instance, when people feel positive and experience approach motivations, they narrowly focus visual attention (Gable & Harmon-Jones, 2010) and reduce global-level information processing (Gable & Harmon-Jones, 2008). For instance, when pictures of desirable foods (e.g., delicious desserts) appeared in the center of a computer screen, observers' attention narrowed, leading them to better recognize words presented in the center of the screen than words presented at the periphery. Likewise, heterosexual individuals interested in finding a sexual partner had their visual attention captured by photographs of very attractive members of the opposite sex more so than photographs of only mildly attractive opposite sex individuals or photographs depicting same-sex individuals (Maner et al., 2007). Visual attention is directed to and captured by desirable targets.

Likewise, people orient attention towards threatening targets. Threatening objects capture and narrow the scope of visual attention (Chajut & Algom, 2003). When participants scan a collection of faces of the same person with the goal of identifying the one discrepant facial expression, participants are able to locate the target more quickly when the target face is angry than happy (Hansen & Hansen, 1988). People suffering from anxiety attend to personally

threatening rather than neutral information (Pineles & Mineka, 2005). Attention is also allocated to threats.

One consequence of attentional orienting and capture may be biased perceptions of distance. It is possible that distances appear shorter when attention is narrowly focused on a target object. Indeed, some research suggests narrowly attending to a target location distorts perception of the surrounding space (Wardak, Denève, & Ben Hamed, 2011). When restricting an observer's visual field to the area directly around a target, distance is underestimated; narrowed focus on a distant target provides limited access to depth cues, which are necessary for coding distance accurately (Wu, Ooi, & He, 2004). In some of our own data, hungry participants who focused on chocolate chip cookies estimated that they were 15% closer than did participants with a more expansive focus of attention (Balcetis, 2006). Desirable and threatening objects capture attention, and narrowed attention leads to underestimation of distance. Future research should explore whether narrowly focusing on and maintaining attention to desirable and threatening objects is a mechanism by which they appear closer.

Conclusion

Major League Baseball has seen its share of unlikely athletes. Eddie Gaedel, the shortest player in the history of MLB, weighed 65 pounds and stood 3-ft 7-in tall. Walter Young, the heaviest player, tipped the scales at 322 pounds. Pete Gray and Jim Abbott played with one arm, Joe Nuxhall was just 15 years old, William Hoy was deaf, and Satchel Paige played until he was almost 60. Major League baseball has seen players overcome their relative disadvantages. However, Major League Baseball is unlikely to see a player who is blind. People can overcome many physical hurdles, but without sight, players would not know when to swing the bat, where

to position their glove to catch the ball, or how hit their mark when running the bases[3]. In baseball, as in many facets of life, the regulation of action is inextricably linked to visual perception of the surrounding world.

Seeing is for doing. This classic assertion has found renewed interest among researchers interested in studying how people meet their regulatory needs. In this chapter, we summarize new research suggesting perception, at least of distance, is sensitive to changing needs to act in response to the contents of the environment. Desired objects warrant action. Threatening objects warrant action. We argue, based on classic research relating actual proximity to the encouragement of action, that desirable and threatening objects appear closer than disgusting or neutral ones because both desires and threats call for action.

This chapter and the research described within add to a growing theory modeling the ways in which perception relates to and promotes action (see Witt, 2011). Although in this chapter we have focused primarily on distance perception as it relates to desires and threats, when we broaden our scope, additional evidence attesting to the functional nature of perceptual bias for the regulation of action mounts. For instance, slopes and distances appear greater to the elderly, sick, overweight, and tired compared to their younger, fitter, and more energized counterparts (Proffitt, 2006). Additionally, objects appear bigger when they can satisfy an active goal, which makes them easier to detect in the environment (Veltkamp, Aarts, & Custers, 2008). Converging evidence suggests a link between perceptual biases and action regulation.

[3] Of course, the National Beep Baseball Association was designed explicitly to include visually impaired athletes in the sport. Sighted players wear blindfolds, and fully and partially blind players field and bat by relying on noises emitted by the bases and the ball. Even though adapted to rely on auditory cues rather than visual ones, sighted spotters are still required to call out where the ball is headed, and sighted pitchers and catchers do not wear blindfolds.

As this theory continues to develop and empirical evidence continues to mount, inevitably researchers will find the relationship between perceptions of the environment and the regulation of action to be more complex than we have depicted. Indeed, as we have demonstrated, the need to act may bias perception. But, importantly, perception may also in turn alter the need, want, or inclination to act. The next generation of research exploring the links between perception and action should seek to provide empirical evidence for the effects of biased perceptions on action tendencies. A functional system that is sensitive to the regulatory needs of perceivers should also help to facilitate those needs. Testing measurable effects on action that stem from perceptions, or misperceptions, of the environment is an important next step for researchers developing theory about how perception and action influence one another. Perception and action are most likely dynamically interdependent and inextricably linked.

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