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A dual systems account of visual perception: Predicting candy consumption from distance estimates

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A B S T R A C T

A substantial amount of evidence shows that visual perception is influenced by forces that control human actions, ranging from motivation to physiological potential. However, studies have not yet provided convincing evidence that perception itself is directly involved in everyday behaviors such as eating. We suggest that this issue can be resolved by employing the dual systems account of human behavior. We tested the link between perceived distance to candies and their consumption for participants who were tired or depleted (impulsive system), versus those who were not (reflective system). Perception predicted eating only when participants were tired (Experiment 1) or depleted (Experiments 2 and 3). In contrast, a rational determinant of behavior—eating restraint towards candies—predicted eating for non-depleted individuals (Experiment 2). Finally, Experiment 3 established that perceived distance was correlated with participants' self-reported motivation to consume candies. Overall, these findings suggest that the dynamics between perception and behavior depend on the interplay of the two behavioral systems.

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1. Introduction

Researchers have traditionally assumed that visual perception is shaped by objective physical properties of the environment (Marr, 1982; Michaels & Carello, 1981). For example, how a person sees a plate of food on a dining table was considered to be determined by factors such as the angle at which the surface of this object reflects light. However, during the past two decades, researchers have produced a substantial number of findings showing that behaviorally relevant factors, including motivation (e.g. Balcetis & Dunning, 2006; Krpan & Schnall, 2014a) and one's ability to act (e.g. Bhalla & Proffitt, 1999; Proffitt, 2006; Schnall, Zadra, & Proffitt, 2010), impact the perception of everyday stimuli. For example, in a landmark study, Bhalla and Proffitt (1999) showed that people who wore a heavy backpack, and whose capacity to climb a challenging hill was thus reduced, saw this hill as steeper compared to physically unburdened people. Therefore, to understand how people perceive their surroundings, it is necessary to grasp not only objective forces such as light but also subjective physiological and psychological states.[1]

Given a large body of evidence showing that behaviorally relevant bodily states influence perception (for reviews, see Proffitt, 2013; Schnall, in press-a), one would also expect that perception is directly related to everyday behaviors such as eating, walking, or shopping. However, this relationship has been observed in very few cases, primarily in the domain of physical activity and sports (Cole, Riccio, & Balcetis, 2014; Witt & Proffitt, 2005). For example, Witt and Proffitt (2005) showed that baseball players' perception of ball size was correlated with their batting average: players who hit the ball more successfully in a previous game perceived it as larger compared to those who were not as successful. However, in the domain of motivated

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[1] In the present manuscript, we use the term visual perception synonymously with "what is seen" (Pylyshyn, 1999; p. 343). According to Pylyshyn (1999, 2003), how people see the world is determined by the interaction of early vision—a basic process involved in encoding the image directly from the eye—and later processing stages that are influenced by information from long-term memory and other cognitive systems. It is currently a point of debate whether early vision itself can be influenced by subjective physiological and psychological states, or whether this influence occurs only at later processing stages (Lupyan, 2015). Hence, it is important to point out that in the present article we do not claim that psychological states influence early vision itself; their impact on what people see may occur at later processing stages, which does not conflict major theories of perception (Pylyshyn, 1999).

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behaviors towards rewarding stimuli such as food or money, no direct relationship between perception and actions such as eating or shopping has been observed (see Balcetis, 2016; Krpan & Schnall, 2014a). Overall, although numerous researchers showed that behaviorally relevant forces, including motivation and potential for action, shape perception, it has not been convincingly demonstrated that perception is linked to behavior. To identify a potential reason behind this discrepancy, it is first necessary to gain a deeper insight into the differential forces shaping human behavior.

1.1. Understanding human behavior: The dual systems account

One of the most widely adopted approaches to understanding behavior, known as the dual systems account, posits that human actions are shaped by two distinct processes (Kahneman, 2003, 2011; Marteau, Hollands, & Fletcher, 2012; Metcalfe & Mischel, 1999; Stanovich & West, 2000; Strack & Deutsch, 2004). On the one hand, people sometimes act spontaneously, without much thinking, based on their immediate intuitions, feelings, and motivations.[2] For example, a person might be offered candies at a party and eat them because s/he feels like doing so, without thinking about the potential health-related implications. Researchers jointly refer to intuitive and motivational processes that guide such behavior as the impulsive system (Dolan et al., 2012; Kahneman, 2003; Stanovich & West, 2000; Strack & Deutsch, 2004).[3]

However, people do not always act based on their feelings and motivations; they also think carefully about the consequences of an action, and it is through this deliberate decision making process that they decide whether to do something or not (Hofmann, Friese, & Strack, 2009; Kahneman, 2003, 2011; Stanovich & West, 2000). For example, a person offered candies at a party may feel like eating them but then decide not to do so because of potential negative health consequences. Alternatively, s/he may decide to eat them after weighing different pros and cons and rationally concluding that, given an active physical lifestyle, eating candies will not negatively impact her/his health. These and other rational processes that guide behavior are jointly referred to as the reflective system (Dolan et al., 2012; Kahneman, 2003; Stanovich & West, 2000; Strack & Deutsch, 2004; Vohs, 2006).

Given that the impulsive and reflective systems control behavior through different routes, their impact on human actions depends on the circumstances in which these actions take place. The impulsive system commands behavior when people's capacity to think rationally is reduced, which usually happens when they are tired and depleted, or when they need to act quickly (Hofmann, Friese, & Strack, 2009; Kahneman, 2003, 2011). Under these conditions people are more likely to rely on their feelings and motivations because it is too costly to engage in elaborate decision making or to resist one's temptations. In contrast, whenever the capacity for rational thinking is high, which is usually the case when people are rested and have not previously engaged in cognitively taxing activities (Hofmann, Friese, & Strack, 2009), reflective processes take over. These assumptions have been supported by numerous studies (Hofmann, Friese, & Strack, 2009; Hofmann, Friese, & Wiers, 2008; Vohs, 2006; Vohs & Faber, 2007). For example, Hofmann, Rauch, and Gawronski (2007) examined conditions under which the impulsive system (automatic liking of candies as measured via an implicit association test) and the reflective system (dietary restraint standards) guide eating of candies. They showed that, after people engaged in an effortful activity that depleted them, eating was predicted by their automatic liking of candies but not by the dietary restraint standards: stronger liking was linked to increased consumption. However, when people were not depleted, eating was predicted by their dietary restraint standards but not by automatic liking: those who classified themselves as restrained eaters ate less compared to unrestrained eaters. Therefore, situational circumstances determine the impact of the impulsive versus reflective processes on behavior.

1.2. The dual systems account and the perception-behavior link

Given that the dual systems account can explain a variety of everyday actions, this approach to understanding human behavior can also be used to clarify when exactly the perception-behavior link should occur. One important insight stemming from this account is that all physiological and psychological determinants of behavior that were shown to impact visual perception can be categorized as impulsive rather than reflective processes (see Balcetis, 2016; Balcetis & Lassiter, 2010; Krpan & Schnall, 2014a; Proffitt, 2006; Proffitt & Linkenauger, 2013). Indeed, constructs such as motivation (e.g. Balcetis & Dunning, 2010; Krpan & Schnall, 2014a) or physiological potential (Proffitt, 2006; Schnall et al., 2010) are usually not associated with reasoning and rational thinking. To our knowledge, no research has yet shown that people can deliberately change their visual perception of the surroundings by changing their reasoning about objects (see Proffitt, 2013; Schnall, in press-a), which would correspond to a “reflective” impact on perception. Therefore, it is plausible that visual perception is shaped by the impulsive system but not by the reflective system.

Based on this notion, we posit that visual perception might be directly related to behavior only when this behavior is shaped by impulsive forces, but not when the reflective system takes over. To clarify this assumption, we use two different behaviors as an example: hitting a baseball (Witt & Proffitt, 2005) and eating candies (Hofmann et al., 2007). When hitting a baseball, players cannot rely on their reflective system because the ball travels too quickly to afford rational decision making, and this behavior by default relies on automatic processes driven by skill and previous experience (see Kahneman, 2003, 2011). Therefore, because the impulsive system guides both perception and behavior in this case, these two variables should be correlated, and seeing the ball as larger should be associated with a better batting average, as Witt and Proffitt (2005) indeed demonstrated.

However, capturing a direct link between perception and behavior becomes more difficult when the behavior of interest can be guided by either the impulsive or reflective system, as is the case with candy consumption (Hofmann, Friese, & Strack, 2009; Hofmann et al., 2007). Indeed, as reviewed above, for some people (e.g. those who are depleted because of previously engaging in cognitively costly activities), eating is shaped by components of the impulsive system linked to affect and motivation (Hofmann, Friese, & Strack, 2009). However, for those who are rested, eating is controlled by rational determinants such as dietary restrains standards (Hofmann et al., 2007). Because visual perception (e.g. perceived size or distance) of rewarding stimuli such as candies is guided by motivational states linked to the impulsive system (Balcetis, 2016; Krpan & Schnall, 2014a), a direct relationship between perception and candy consumption should occur only when impulsive processes determine this behavior, but not in other instances. Therefore, when it comes to actions that can be impacted by either the impulsive or reflective system and are in that sense similar to candy consumption, it may be difficult to capture the relationship with perception without understanding situational circumstances.

[2] We use the term motivation when referring to urges that are regulated by the brain's reward system (e.g. Berridge, 2009; Berridge, Robinson, & Aldridge, 2009; Kelley, 2004; Robbins & Everitt, 1996) and which most commonly occur in relation to rewarding stimuli such as sugary food, money, etc. In that sense, motivation is an intuitive rather than rational process and can be classified as an impulsive determinant of behavior (e.g. Strack & Deutsch, 2004).

[3] Not all dual systems theorists use the same terminology when referring to the two systems that guide human behavior. Indeed, some refer to the impulsive system (Strack & Deutsch, 2004) as System 1 (e.g. Kahneman, 2003; Stanovich & West, 2000) or hot system (Metcalfe & Mischel, 1999), whereas some refer to the reflective system (Strack & Deutsch, 2004) as System 2 (e.g. Kahneman, 2003; Stanovich & West, 2000) or cool system (Metcalfe & Mischel, 1999). Here we use the term the impulsive (reflective) system synonymously with different terms common in dual systems literature such as System 1 (System 2) or the hot (cool) system.