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Cognitive framing in action

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ABSTRACT

Cognitive framing effects have been widely reported in higher-level decision-making and have been ascribed to rules of thumb for quick thinking. No such demonstrations have been reported for physical action, as far as we know, but they would be expected if cognition for physical action is fundamentally similar to cognition for higher-level decision-making. To test for such effects, we asked participants to reach for a horizontally-oriented pipe to move it from one height to another while turning the pipe 180° to bring one end (the "business end") to a target on the left or right. From a physical perspective, participants could have always rotated the pipe in the same angular direction no matter which end was the business end; a given participant could have always turned the pipe clockwise or counter-clockwise. Instead, our participants turned the business end counter-clockwise for left targets and clockwise for right targets. Thus, the way the identical physical task was framed altered the way it was performed. This finding is consistent with the hypothesis that cognition for physical action is fundamentally similar to cognition for higher-level decision-making. A tantalizing possibility is that higher-level decision heuristics have roots in the control of physical action, a hypothesis that accords with embodied views of cognition.

1. Introduction

One of the most exciting developments in the study of cognition has been the discovery of cognitive framing effects. A famous example relates to deciding between bets presented in two ways. In one setup, participants start with $300 and choose between getting $100 for sure or winning $200 with probability .5. In that case, though the expected outcome is the same for both options ($400), people strongly prefer the first option, the "sure thing," rather than the gamble. In the other setup, participants start with $500 and choose between losing $100 for sure or losing $200 with probability .5. In that case, though the expected outcome is again the same for both options (again $400), people strongly prefer the second option, the "gamble" rather than the sure loss. This classic outcome shows that the way a choice is framed changes what is chosen (Tversky & Kahneman, 1986).

The many examples of cognitive framing effects that have been reported in the literature have focused on questions surrounding large-scale issues such as choosing medical treatments or deciding on business investments. To the best of our knowledge, framing effects have not yet been discovered in the context of the planning of physical actions. This fact is surprising when one considers that Kahneman (2011) argued that the heuristics captured by cognitive framing reflect "fast thinking," the kind needed to make rapid decisions in everyday life, including in the savannahs and jungles from which humans evolved. If Kahneman's argument is correct, cognitive framing should appear in physical action planning because many of the decisions faced by our evolutionary ancestors were physical in nature. Kahneman made no mention of such effects in his book, probably reflecting his specialization in higher-level thinking rather than perceptual-motor skills.

We were interested in whether cognitive framing effects apply to physical action. Our interest in this question arose from a long-standing interest in our laboratory in the cognitive bases of physical action planning and control. Many studies in our lab have shown that even simple physical actions, like reaching for an object or flipping an inverted glass, reflect sophisticated planning comparable to that of so-called higher cognitive processes.

In one line of work, Jax and Rosenbaum (2007) and van der Wel, Fleckenstein, Jax, and Rosenbaum (2007) found that reaching around a barrier to a target influenced the curvature of reaching paths that followed, even when no barrier was present. This phenomenon, called *hand path priming*, suggested that actions performed in the recent past influence the planning and execution of current actions.

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In other work, our lab provided evidence that just as actions in the past can influence present actions, actions planned for the future can also influence present actions. One anticipatory phenomenon is the *end-state comfort* effect. This is the tendency to grasp objects in an initially awkward posture to end in a more comfortable manner. For example, when flipping an inverted glass to fill it with water, people tend to grasp the glass with an initially awkward, thumb-down posture to end the movement in a more comfortable, easy-to-control thumb-up posture (Rosenbaum et al., 1990). Similar effects emerge when people grasp and move an elongated object, such as a standing toilet plunger, to different heights. People tend to grasp the shaft lower when moving the plunger to a higher target, and to grasp the shaft higher when moving the plunger to a lower target—the so-called *grasp-height* effect (Cohen & Rosenbaum, 2004). Both the end-state comfort effect and the grasp-height effect ensure that the actor ends in a comfortable, easy-to-control, mid-range arm posture. For reviews of this work and related work from our and other laboratories, see Rosenbaum, Chapman, Weigelt, Weiss, and van der Wel (2012) and Rosenbaum, Herbort, van der Wel, and Weiss (2014).

Results like these show that cognition and action go hand in hand. In fact, the rich cognitive substrates that underlie physical action have led some researchers to claim that intellectual abilities are fundamentally similar to, and possibly rooted in, perceptual-motor control (Calvin, 1994; Piaget, 1954; Rosenbaum, Carlson, & Gilmore, 2001). Consideration of this possibility led to the main question in the present study: If the cognitive substrates of physical action planning and intellectual planning are fundamentally similar, then are physical actions subject to cognitive framing effects?

To pursue this question, we need to say what a cognitive framing effect is. Following Levin, Schneider, and Gaeth (1998), we defined a framing effect as a change in the way a task is carried out depending on how the task is presented. Said another way and focusing on the way we pursued the question at hand here—is physical action planning subject to cognitive framing?—we defined a cognitive framing effect as one in which the same task is physically performed in different ways depending on how the task is presented. To the best of our knowledge, no such effects have been reported, though as we argue in Section 5, some previously observed phenomena can be understood, in hindsight, to have reflected cognitive framing in physical action planning.

2. Experiment 1

The task we used entailed bimanual object manipulation. We pursued this task for two main reasons. One was that research on bimanual movements has revealed a strong preference for bimanual symmetry (e.g., Hughes, Haddad, Franz, Zelaznik, & Ryu, 2011; Huhn, Schimpf, & van der Wel, 2014; Janssen, Beuting, Meulenbroek, & Steenbergen, 2009; Kelso, 1984; Kelso, Southard, & Goodman, 1979; Kunde & Weigelt, 2005; Marteniuk, MacKenzie, & Baba, 1984; Mechsner, Kerzel, Knoblich, & Prinz, 2001; Mechsner & Knoblich, 2004; Oliveira & Ivry, 2008; Rosenbaum, Dawson, & Challis, 2006; Van der Wel & Rosenbaum, 2010; Weigelt, Kunde, & Prinz, 2006). We thought that if cognitive framing effects apply to physical actions, they would appear in bimanual movement control.

Second, very little research has been done on the manipulation of large objects requiring, or potentially requiring, use of two hands. Most of the work on bimanual control that has been done on object manipulation has focused on the manipulation of two objects with two hands (one object per hand). Studies using that task have yielded evidence for the bimanual-symmetry preference referred to above (Huhn et al., 2014; Janssen et al., 2009; Kunde & Weigelt, 2005; Van der Wel & Rosenbaum, 2010). We were interested in what would happen when people moved a large object with two hands. We thought cognitive factors might play an important role here not just on general grounds that skilled action requires knowledge, but also on the grounds that one study has already shown that the end-state comfort effect, a cognitive planning effect for one-hand object manipulation, also holds for manipulation of large objects requiring two hands (Lam, McFee, Chua, & Weeks, 2006).

2.1. Method

The setup we used is shown in Fig. 1. The apparatus consisted of a PVC pipe with green tape around one end and blue tape around the other. The pipe rested in gaps between wooden boards on either side of a door, with letters above the gaps on both sides of the door.

In each trial, the participant stood facing the apparatus with his or her hands down by his or her sides, at which time the experimenter announced the task to be performed (in a manner described below). The task always involved removing the pipe from its initial height, flipping the pipe, and bringing the pipe to a new height. Because the pipe was always flipped, the end that was on the left was always brought to a target on the right and vice versa. After the participant brought the pipe to the target, s/he let go of the pipe and brought his or her hands back to his or her side in anticipation of the next trial.

Participants were divided into two instruction groups. One group heard the color name of the pipe end that would be moved followed by the name of the target to which it would be moved (e.g., "Green end to blue A"). The other group heard the name of the target to which a pipe end would be moved followed by the color name of pipe end that would be brought there (e.g., "Blue A gets green end"). We used these two instruction orders to see whether the sequence of instructions would affect the likelihood of using one strategy or the other. We thought the order of instructions might influence the choices, consistent with a cognitive framing account. For example, calling attention to the business end of the pipe followed by the target could have primed a rotation in the angular direction of the arc from the business end to the target. Conversely, calling attention to the target followed by the business end could have primed a rotation in the angular direction of the arc from the target to the business end. Such an outcome would have been consistent with verbally mediating cognitive framing. On the other hand not finding such an outcome would not disconfirm cognitive framing; it would merely fail to provide support for verbally mediated cognitive framing.

To return to the most important point, the critical feature of our task was that from a physical perspective, every pipe transfer from one height to another could be achieved in just one way, either clockwise or counter-clockwise. If the way the pipe was transferred from a given starting height to a given target height depended on whether the left business end went to a right target or the right business end went to a left target, that would be a framing effect.

2.1.1. Participants

The experiment had 48 participants (36 females; mean age 19.77 years, range 18–25), 24 of whom were assigned to one instruction group and the other 24 of whom were assigned to the other instruction group. The assignment of participants to instruction groups was random. All participants were volunteers from the Penn State community and none reported neurological disorders. Participants completed a short form of the Edinburgh handedness inventory (Oldfield, 1971). Of the participants, 47 reported being right-handed.