emotion review

Emotion Review
Vol. 1, No. 2 (Apr. 2009) 140–150

ISSN 1754-0739
DOI: 10.1177/1754073908100439
http://emr.sagepub.com

Reach For What You Like: The Body's Role in Shaping Preferences

Raedy M. Ping
Department of Psychology, The University of Chicago, USA

Sonica Dhillon
Department of Psychology, Northwestern University, USA

Sian L. Beilock
Department of Psychology, The University of Chicago, USA

Abstract

The position of individuals' bodies (e.g., holding a pencil in the mouth in a way that either facilitates or inhibits smiling musculature) can influence their emotional reactions to the stimuli they encounter, and can even impact their explicit preferences for one item over another. In this article we begin by reviewing the literature demonstrating these effects, explore mechanisms to explain this body-preference link, and introduce new work from our lab that asks whether one's bodily or motor experiences might also shape preferences in situations where the body is not contorted in a particular position, or when there is no intention to act. Such work suggests that one consequence of perceiving an object is the automatic and covert motor simulation of acting on this object. This, in turn, provides individuals with information about how easy or hard this action would be. It transpires that we like to do what is easy, and we also prefer objects that are easier to act on. The notion that judgments of object likeability are driven by motoric information furthers embodied cognition theories by demonstrating that even our preferences are grounded in action.

Keywords
affordances, embodiment, preferences

People often make judgments about the valence, pleasantness, or likeability of objects and other stimuli they encounter. These judgments can occur even before a stimulus is processed for meaning (Zajonc, 1980). But, what drives people's judgments of how much they like an object or how pleasant they deem it to be? Preferences for one object over another have been shown to be based on perceptual features such as symmetry, high figure-ground contrast, object size, and typicality. Moreover, previous experience interacting with an object can increase the perceptual ease or fluency of processing it, which in turn increases positive affect towards the item in question (for a review, see Reber, Schwarz, & Winkielman, 2004).

In the current work we review and introduce evidence that preference and valence judgments about stimuli in one's environment are also driven, at least in part, by the motor system. We begin by turning to research showing that the active body—by way of specific facial expressions, head movements, and approach-avoidance arm movements—impacts individuals' valence and preference judgments of both *valenced* (i.e., with an inherent emotional content) and *non-valenced* stimuli. We then introduce evidence that, even when a person is not moving or has no explicit intention to act, the motor system can drive preferences for objects in one's environment.

Before we begin, it is important to be explicit about what we mean by terms such as *preference* and how they are connected to related terms such as *emotion*. This will not only help you, the reader, to understand where we, the authors, are coming from, but it will help to clarify how we use these terms in relation to other articles in this special section. In our view, an individual's preference for a particular stimulus, or how much a

Author note: Research supported by IES Grant R305H050004 and NSF Grant BCS-0601148 to Sian Beilock.
Corresponding author: Sian L. Beilock, Department of Psychology, 5848 South University Avenue, The University of Chicago, Chicago, IL 60637, USA.
Email: beilock@uchicago.edu

person likes one object over another, results from an initial emotional belief or reaction to that stimulus (i.e., an appraisal of the stimulus with respect to positivity or negativity drawn from previous experience, aesthetics, etc.; see Schwartz & Clore, 1996) coupled with bodily feedback related to the stimulus in question. If the feedback from the body validates the initial emotional belief about the stimulus, beliefs may be enhanced, if not, they may be modified or weakened. Emotions can be thought of as the co-occurrence of evaluation in "thought, feeling, physiology, expression, and so on" (Clore & Schnall, 2008, p. 211) and we think that this can be modified by information about the ease of interacting with the stimuli in question, or by information brought about by the body being in a particular state previously associated with positivity or negativity. The end result is a preference for one item or another. Let us try to convince you of this as well.

Recent evidence that largely falls under the heading of embodied cognition has demonstrated a tight link between perception and action (e.g., Barsalou, 2008). Perceiving an object is thought to automatically induce a mental simulation of how one might act on that object, even when there is no explicit intention to act in the perceiver (e.g., Rieger, 2004, 2007; Tucker & Ellis, 1998). If this simulation gives rise to information about how easy or difficult it *would be* to interact with an object, and individuals have a tendency to want to complete actions that are easier or more fluent to instantiate, then it follows that preferences for one item over another may be driven by the motor system. Here we review work consistent with these ideas and conclude by presenting a new study that provides support for this notion. Specifically, we demonstrate that people prefer objects that, if acted upon, would be easier to manipulate. Together, this work demonstrates that the body is relevant to more than overt action and that there are close ties between affective and action systems that should be further explored.

The Acting Body and Valenced Stimuli

Action-to-Judgment

Holding or moving one's face or body in a way associated with a positive or negative affective state can impact the judgments a person makes about the valence of visual stimuli they encounter. For example, people judge comics as funnier when they hold their facial muscles in a position similar to smiling in comparison to when they hold their facial muscles in a position similar to frowning. Specifically, Strack, Martin and Stepper (1988) had subjects hold a pen between their teeth (which uses the same musculature activated in smiling) or between their lips (which inhibits the musculature used in smiling) while reading a series of comic strips. Subjects who held the pen with their teeth judged the comics to be funnier than those who held the pen in their lips. Although the subjects were not technically smiling, and were not aware of the link between their facial expressions and their judgments, simply activating the muscles used in smiling resulted in increased humor judgments of the positively-valenced comic strips.

Similar results hold for negatively-valenced visual stimuli. Activating the muscles used to frown, for example, results in more negative judgments of negatively-valenced items. Larsen, Kasimatis and Frey (1992) attached golf tees to subjects' brows and instructed the participants to either pull the tips of the golf tees together (activating the musculature associated with frowning) or hold the tips apart (neutral) as they judged the sadness of photographs. People who pulled the golf tees together judged sad-themed pictures as sadder than those who did not. In each of these studies, holding one's facial musculature in a way that was compatible with the valence (positive or negative) of the stimuli increased the intensity of valence judgments for those stimuli.

Bodily postures can have positive and negative associations that appear to influence preferences and emotional reactions to items individuals encounter. Why might this be the case? According to Glenberg and colleagues, we index words and phrases to the physical or perceptual situations that those words represent (see Glenberg, Webster, Mouilso, Havas, & Lindeman, 2009). Because of this, experiencing a specific emotion is a necessary part of understanding language about emotion. Part of experiencing emotions includes physical states; having one's body in a particular configuration is part of the bodily state corresponding to a particular emotion or feeling (Havas, Glenberg & Rinck, 2007). To the extent that perceiving positive and negative information activates a simulation of the bodily states used to express this affective content, when a person's body is in a state that is congruent with what they perceive, evaluations of stimuli in the environment (whether positive or negative) may be enhanced. If so, such effects should not be limited to pictures or comics, but should extend to stimuli that may be more symbolic in nature as well (e.g., language comprehension) – provided that the symbolic stimuli makes reference to an emotional state that can be enhanced by one's bodily position. And, indeed, this appears to be the case.

For example, the above class of non-obtrusive facial muscle manipulations also affects comprehension and judgments of emotionally-valenced linguistic stimuli. People are faster at reading positively-valenced sentences (e.g., "The college president announces your name, and you proudly step onto the stage") and then judging their pleasantness when they are holding a pen between their teeth (mimicking a smile) in comparison to when they are holding it between their lips (mimicking a frown; Havas et al., 2007). People are also faster at reading negatively-valenced sentences (e.g., "The police car rapidly pulls up behind you, siren blaring") and judging their pleasantness—or lack thereof—when they are holding a pen between their lips than when holding it between their teeth. Such findings suggest that the congruency between facial musculature and sentence valence may actually aid understanding of language and intensify valence judgments made about what one reads (Havas et al., 2007). This is despite the fact that participants are not aware of the fact that they are "smiling" or "frowning." In another study, Glenberg and colleagues had subjects either pull a lever toward them (an affiliative motion) or push it away (an aggressive motion) three hundred times before judging the sensibility of emotionally valenced sentences (Glenberg et al., 2009). After fatiguing the aggressive action system in this way, individuals (here, men) were slower to judge the sensibility of angry sentences. Men, it seems, rely on physical simulations by the aggressive system in order to understand angry language. Crawford (2009) also presents evidence that even metaphoric language about affect is based in perceptual and motor systems, such that language about positive affect is associated with being spatially higher.

Moreover, effects such as those presented above go beyond the evaluation of valenced information and extend to the generation of positively and negatively valenced information as well. Strack and Förster (1997, 1998) asked subjects to either hold one of their arms in flexion (which is associated with positive, or approach behavior) or extension (associated with negative, or avoidance behavior) and to write names of celebrities they liked, disliked, or felt neutral about. People who held the arm in flexion were able to generate more names of liked celebrities. In contrast, those who held the arm in extension were able to generate more names of disliked celebrities. These studies suggest that not only do body movements affect how subjects *judge* valenced stimuli, but that body movements can also affect the *generation* of valenced stimuli (e.g., a liked celebrity).

Thus far we have provided evidence that moving or holding one's body in a position that is congruent with either a positive or negative affective state impacts the evaluation of already valenced stimuli one encounters—this occurs for pictures as well as language comprehension. But, do such affect-congruent movements do more? In most Western cultures, side-to-side head shaking (horizontal head movement) is associated with producing counterarguments while listening to another speaker, whereas vertical (nodding) head movements are associated with favorable thoughts about a speaker's message. Wells and Petty (1980) had college students make either horizontal or vertical head movements while listening to a message arguing for a tuition increase (which is, of course, counterattitudinal to the beliefs held by most college students) or a proattitudinal message arguing for a tuition reduction. Subjects in the vertical head movement condition were more likely to agree with the counterattitudinal message than subjects in the horizontal head movement condition. Simply nodding one's head made individuals more likely to agree with or have a preference for the counterattitudinal message.

Judgment-to-Action

Can we turn it around? If our body movements affect how we judge valenced stimuli, can valenced stimuli impact our actions? The answer appears to be "yes." In the above Wells and Petty (1980) study, subjects in the counterattitudinal message condition actually had more difficulty making the vertical head movement, while subjects in the proattitudinal message condition had more difficulty making the horizontal head movement. Not only do actions associated with positivity/negativity or acceptance/rejection affect people's interpretation of information they encounter, but this information also impacts individuals' ability to act.

Likewise, evaluations of positive stimuli (e.g., positive words) have been shown to enhance approach motor behaviours, while evaluations of negative stimuli have been shown to aid avoidance motor behaviors. Chen and Bargh (1999) had some subjects respond by pulling a joystick toward them (a toward-the-body pulling motion associated with approach behaviors) if they deemed an emotionally-valenced word to be positive and push it away from them (an away-from-the-body pushing motion associated with avoidance behaviors) if they deemed a word to be negative. Other subjects produced the opposite pattern—toward if the word was negative and away if it was positive. Results demonstrated that participants were faster to respond to positive words by pulling and negative words by pushing. When the valence of the word matched the valence of the arm movement, response times were facilitated. To show that these effects can occur even in the absence of the requirement to explicitly judge the valence of the word, in a second study, Chen and Bargh presented words at random time intervals. In one block, subjects task was to always pull the joystick when they saw any word. In a second block, subjects' task was to always push the joystick in response to any word. In the pulling block, people were faster to perform the required action in response to positive words. In contrast, in the pushing block, individuals were faster to perform the required action (i.e., a push) in response to negative words. Even when judging the valence of a presented word is not required, when there is congruence between the affective quality of a word and the arm motion used to respond, the motion is facilitated.

The Acting Body and Non-Valenced Stimuli

Thus far we have reviewed evidence that acting bodies impact and are impacted by stimuli that have some kind of inherent valence (e.g., positive or negative words, funny or sad pictures, pleasant or unpleasant sentences, etc.). Next, we consider evidence concerning whether the acting body can actually impact likeability and emotional attributions about neutral stimuli—that is, stimuli devoid of an obvious affective content. The question is, can the way in which one moves do more than merely enhance how one might process already-affectively rich stimuli, but instead take a stimulus without obviously valenced associations and provide them? To the extent that bodily states give rise to affective information (e.g., positivity or negativity), then encountering neutral objects during such actions may lead to the formation of object preferences that are linked to these bodily states or motor behaviors.

There seems to be some support for this idea. For instance, in a study of the effect of head movements on attitude formations of neutral objects, the movement of one's head was shown to impact object choice. Tom, Pettersen, Lau, Burton, and Cook (1991) assigned participants to either a vertical or a horizontal head movement condition. In the vertical condition, subjects were asked to move their head up and down under the guise of testing the quality of headphones. In the horizontal condition, subjects were asked to move their head side-to-side for the same purpose. A pen was also placed on the table in front of the subject—ostensibly for use when filling out later questionnaires. At the end of the study, subjects were offered the opportunity to choose, from several pens, one to take home in return for their study participation. Subjects who made vertical head movements (congruent with positivity or agreement) preferred the pen that had been sitting on the table in front of them. In contrast, subjects in the horizontal head movement condition (i.e., a movement more inline with negativity or disagreement) preferred to take a different, new, pen.

Similar results have been found using neutral non-words as stimuli. For example, people who were asked to indicate whether they liked or disliked neutral non-words preferred words seen when holding their arms in flexion over those seen when holding their arms in extension (Priester, Cacioppo, & Petty, 1996). As mentioned above, arm flexion is thought to be associated with an approach behaviors and positive affect, while arm extension is thought to be related to avoidance behaviors and negative affect.

Arm flexion and extension have also been shown to impact ratings for novel pictorial stimuli (novel Chinese characters for non-Chinese speakers). Cacioppo, Priester, and Berntson (1993) found that subjects preferred Chinese characters that were seen while holding their arms in flexion over those seen while holding their arms in extension. Questionnaires about mood revealed no differences between the conditions; people who held their arms in flexion were not simply in a better mood overall. Rather, participants attributed positive affect or liking specifically to the novel neutral stimuli that they were judging as a result of holding their body in a position consistent with an approach or generally positive state.

Although the above effects have been taken to suggest that there are relations between an acting body and preferences or evaluations of neutral stimuli, there are likely to be boundary conditions to this relation. For example, it should be noted that that arm flexion or extension alone may be insufficient to create affective associations with the stimuli one is presented with. Cacioppo et al. (1993) demonstrated that arm contraction influenced stimuli evaluation—but only when participants performed the action while judging evaluative features of the ideographs. These effects were not observed when participants instead judged non-evaluative features (e.g., the complexity of the stimulus). Moreover, Centerbar and Clore (2006) have recently argued that neutral stimuli alone do not show an approach/avoidance contingent effect. Rather, these researchers suggest that likeability or preference for a stimulus arises from having one's body in a state that is compatible with the initial stimulus valence.

Nonetheless, overtly behaving in ways consistent with positive and negative states (e.g., facilitating or inhibiting the muscles typically associated with smiling without requiring subjects to actually pose in a smiling face) does seem to impact affective responses to objects individuals encounter, and vice versa. Such work supports a link between motor activity and affect (Strack et al., 1988). But are such movements necessary? In the next section we review work demonstrating that covert sensorimotor simulation of acting on stimuli can influence likeability judgments of stimuli—even with no intention to act—as long as individuals have developed relevant associations between what they perceive and how it can be acted on. This work takes a new step in the demonstration of how the body influences our understanding of objects and events—a step that includes the preferences we have for the stimuli we encounter.

The Non-Acting Body

Although there is a significant amount of research demonstrating that an acting body impacts individuals' preferences and affective reactions towards objects and stimuli in their environment, less work has focused on whether preferences can be tied to the body even when there is no intention to act. Recent work that, broadly speaking, falls under the heading of embodied cognition may be able to shed some light on this issue. Such work has demonstrated that there is a tight link between perception and action—such that both performing and perceiving an action draws on some of the same underlying cognitive and neural representations, or common codes (Prinz, 1997). This embodied viewpoint has roots in ecological psychology's refutation of a distinction between perception and action (Gibson, 1979) and finds support across multiple levels of psychological inquiry.

According to this embodied perspective, seeing another person acting results in the activation of the sensorimotor programs and procedures involved in performing the very same actions oneself (e.g., Beilock, 2008). Likewise, perceiving an object that one can interact with results in a mental simulation of acting on the object in question (e.g., Gerlach, Law, & Paulson, 2002; Tucker & Ellis, 1998). If this simulation gives rise to information about how easy or difficult it would be to interact with an object, and individuals have a tendency to want to complete actions that are easier or more fluent to instantiate, then it follows that preferences for one item over another may be driven by the motor system.

Not only do these perception-action links impact online perception of objects and other people, they also ground thought more broadly. For example, research suggests that the comprehension of language describing specific actions or events activates motor simulations of the events in question (Beilock, Lyons, Mattarella-Micke, Nusbaum, & Small, 2008; Glenberg & Kaschak, 2002; Hauk, Johnsrude, & Pulvermüller, 2004; Klatzky, Pellegrino, Mccloskey, & Doherty, 1989; Zwaan & Taylor, 2006). Likewise, understanding the emotions that other people display is believed to involve a simulation of those emotions in ourselves. For example, individuals watching facial expressions morph from one to another are slower to detect a change when they are prevented from covertly mimicking the expression by being asked to hold a pen in their mouth (Niedenthal, Brauer, Halberstadt, & Innes-Ker, 2001). Although the body may not be directly active during these types of perceptual activities, part of understanding these stimuli appears to involve the covert motor simulation of the movements one is observing. As a result, when the motor system is occupied with another task (e.g., holding a pen in one's mouth), the ability to detect emotional expression changes is slowed. In general, social information seems to be processed, in part, through activation of our own emotional processes (see Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005, for a review).

In this section we begin by exploring a number of predictions that can be derived from embodied theories postulating tight coupling between perception and action. We then move on to explore how such perception-action links might impact preferences for the objects and events individuals encounter.

Action Prediction

To the extent that there is overlap in the cognitive and neural systems that subserve the observation and production of action, it then follows that predicting the outcomes of self-produced actions should be easier than predicting the outcomes of actions produced by others. In essence, predictions should be best when the systems used to predict and produce reside in the same individual. This is exactly what has been found. When watching videos of people throwing darts at targets, individuals are better at judging where the darts they have thrown will land than darts thrown by others (Knoblich & Flach, 2001). Moreover, Repp and Knoblich (2004) found that expert pianists, who played unfamiliar musical excerpts on a soundless keyboard, were later able to distinguish their own playing from that of others, even when tempo and dynamic information was removed from the recordings such that they could judge differences based only on expressive aspects of the playing. Similarly, non-musicians can recognize the sound of their own clapping, even when the clapping stimuli are stripped of all information except for temporal information (Flach, Knoblich, & Prinz, 2004). In addition, although people have more experience watching the actions of friends, individuals are actually better at recognizing their own movements from point-light displays than that of close companions (Loula, Prasad, Harber, & Shiffrar, 2005). These results are best explained by the idea that much of the way we understand the actions we perceive (visually or auditorily) is through simulation by our own motor system. If that system is the same one that created the action to begin with, it is easier for us to recognize. One possible function of this overlap is that, if we represent others' actions just as our own, it is easier to coordinate movement with them (see Knoblich & Sebanz, 2006 for a review).

Action Understanding

Reed and colleagues suggest that we represent our own bodies as well as other people's bodies through a body schema, which is a body-specific representation that is spatially organized, and based on visual feedback from other bodies as well as proprioceptive feedback from our own (e.g., Reed & Farah, 1995; Reed & McGoldrick, 2007). If the body schema is activated both when producing and observing actions, there should be consequences for acting while simultaneously observing another action. A number of studies have found that, depending on the timing of the action–observation overlap, acting while observing action results in either facilitation or inhibition of understanding. Jacobs and Shiffrar (2005) found that people who were simultaneously walking on a treadmill were less accurate at judging the speed of a point-light walker than people who were riding a bike or who were stationary. Moreover, Hamilton, Wolpert, and Frith (2004) found that people's judgments of the weight of a box that someone else was lifting was affected by their own simultaneous box lifting. Individuals judge the other person's box to be heavier when they are lifting a lighter box and lighter when they are lifting a heavier box. In these cases, inhibition of action understanding occurs because visual and motor inputs are concurrently activated and the resources needed to both perceive and produce are taxed. However, when visual and motor inputs activate the same part of the body schema and there is enough processing time to reconcile the two, facilitation begins to occur.

Reed and McGoldrick (2007) had people judge whether pictures of two sequentially presented body postures were the same or different—in some of the pictures, the legs moved, in others, the arms moved. In a secondary task, people moved either their arms or their legs. When the inter-stimulus interval (ISI) between the first body posture and the second body posture was short (2 seconds), people were less accurate in detecting changes in arm posture while moving their arms and less accurate in detecting changes in leg posture while moving their legs (inhibition in action understanding as a result of moving the same part of the body). When the ISI was longer (5 seconds), people were more accurate at noticing differences between the two postures when they were also moving the same body part—facilitation of action understanding as a result of moving the same part of the body (see also Reed & Farah, 1995).

Thus, when visual and motor inputs activate the same part of the body schema, inhibition of action understanding occurs, unless enough time is available to overcome the initial inhibition. In that case, facilitation of action understanding occurs. Evidence such as that presented above strongly suggests the presence of a body schema and corresponding sensorimotor information that is activated both when acting and when observing the actions that others produce.

Object Perception and Imagination

It is not just action observation that appears to activate a motor simulation in the observer; perception of objects also implicates the motor system, such that seeing an object primes actions that the object affords (Gerlach et al., 2002; Grafton, Fadiga, Arbib, & Rizzolatti, 1997; Tucker & Ellis, 1998). When individuals perceive an object with a handle, the motor act that is associated with reaching out and grasping that handle is automatically activated, even when the object is not going to be acted on (Tucker & Ellis, 1998). Left ventral premotor cortex is activated when observing tools (Grafton et al., 1997) and more strongly activated when viewing objects that are easily manipulable than when viewing objects that are not (Gerlach et al., 2002). Premotor cortex and ventral premotor cortex in particular is thought to be involved in the planning of movements (Grafton & Hamilton, 2007).

Not only is the motor system recruited during object perception, it is also active when *imagining* the actions of objects. Mental rotation tasks are affected by simultaneous physical rotation of a joystick: people are faster to solve mental rotation problems when making a joystick movement in the same direction implied by the mental rotation task than when making a different-direction joystick rotation (Wexler, Kosslyn, & Berthoz, 1998).

This suggests that the same system involved in mentally rotating an object in the mind's eye is also involved in performing physical movements in the rotated direction. Moreover, people are also faster to answer sensibility judgments of actions involving objects when the hand shape they are currently maintaining is compatible with the object action than when it is not (Klatzky et al., 1989). As an example, people are faster to judge the sensibility of the phrase "play a bongo drum" when they have been primed with a flat palm hand shape than a pinching hand shape. Finally, when people are asked to imagine objects and name their parts, they tend to name parts that are acted on before other parts (Borghi, 2004). Part of what perceiving and thinking about an object involves is the activation of motor plans and actions commonly associated with the object in question.

Object Preferences

However, could this motoric information do more? If perceiving an object gives rise to information about how easy that object would be to interact with, then the level of motor fluency afforded by an object might impact judgments about it. If we tend to prefer or feel positive about tasks and activities that conserve energy in general (Beilock & Holt, 2007), and simply perceiving an object tells us about how difficult it would be to act on it, then individuals who are asked to make judgments about how much they like a particular object or stimulus might prefer objects that are easy to interact with—even when there is no intention to act. We have tested this possibility in studies where we ask people to make a judgment about their preference for stimuli they encounter.

Beilock and Holt (2007) had both expert and novice typists indicate which of two letter dyads they preferred. If typed using standard touch-typing procedures, one of the dyads would be typed with two different fingers (e.g., FK) and the other dyad would be typed using one finger (e.g., FV). Each dyad pair presented to participants always involved one dyad from each category—a paradigm first used by Van den Bergh, Vrana, and Eelen (1990). Because typing is thought to involve the overlap of successive key strokes (Rumelhart & Norman, 1982), typing two letters with the same finger should result in more motor interference than typing two letters with different fingers, as the former case requires that the same digit essentially be in two places at once (or in very close succession). In other words, since making two movements with two different fingers results in less motor interference than making two movements with the same finger, dyads that would be typed with two different fingers should be easier to type than dyads that would be typed with the same finger.

As might be expected if people prefer stimuli that are easier, or require less motor interference or energy expenditure to instantiate, expert typists preferred the letter dyads that would be typed with two different fingers significantly more than chance would predict alone. Novice typists did not show this preference. Interestingly, there was no actual typing involved in this preference judgment task. Recent work has shown that an integral part of letter processing for experienced typists is the motor simulation of typing the letters themselves. Specifically, in a Stroop-like task, Rieger (2004, 2007) found that typing experts' manual responses were faster when the finger used to indicate the color of a letter was congruent with the finger typically used to type the letter. Such work suggests that when typing experts perceive letters, they automatically activate motor plans for typing them. If typing experience results in the association between specific letters and the motor programs used to type them, and perceiving letters automatically activates these motor plans (Rieger, 2004; see also Prinz's common coding theory, 1997), then such covert simulation of typing should provide information about the relative interference involved in acting on the letters one is presented with. And, if individuals prefer to act in ways that reduce interference, they should prefer letter dyads that, if acted on, would result in the least amount of motor interference. This is exactly what Beilock and Holt (2007) found.

To explicitly test the above ideas, while making their preference judgments on some trials, expert and novice typists were asked to hold a finger press pattern in memory that involved the same fingers that would be used to type the presented dyads. If holding this pattern utilizes motor system resources that could otherwise be used to inform typists' preference judgments, such preferences should disappear—which is exactly what occurred. A second experiment showed that this motor interference was specific to the digits actually involved in typing the dyads. When expert typists held a motor pattern in memory involving fingers *not* used to type the dyads, the preference remained. Thus, covert mental simulation of acting on the information one is presented with not only impacts preference judgments, but this influence is limited to information motorically resonant with the specific effectors involved in the simulated action.

Akin to the highly connected association between seeing letter dyads and simulating typing motions in expert typists, when we see an object with a handle we automatically activate the motor plan associated with reaching out and grasping that handle, even when we are not planning to act on the object (Tucker & Ellis, 1998). When simply moving objects, people consider the eventual outcome of the move in planning their initial grasps (Cohen & Rosenbaum, 2004). Since we are used to eventually using objects that we initially grasp, people tend to grasp objects by their handles as if they were going to use them—even when the handles are pointing away from them and they have to twist their arm in a cumbersome fashion (Creem & Proffitt, 2001). Although simply moving an object from one location to another does not require grasping it by the handle (i.e., one could pick up a fork by the tines to move it), because individuals are experts at using manmade objects with handles such as tools and utensils, they go out of their way to grasp them as if they were going to use them. In fact, possibly as a result of the experience we have in picking up objects, the presence of the hand near an object serves to focus attention to targets around that hand more so than targets farther away. In essence, our experience acting in the world appears to result in action-centered frames of reference for spatial attention (Reed, Grubb, & Steele, 2006).

If people prefer stimuli that are easier to act on or instantiate, it may be that individuals who are planning to act on objects would prefer objects whose handles are oriented in a way that make them easier to reach out and grasp. If so, this would provide evidence that something as seemingly unrelated as the position of an object actually affects how much we like that object. Below we describe a new study that tested this idea. We explored the following question: Does the way the body can interact with objects, based solely on object position relative to the body, affect preferences for these objects?

Participants were asked to choose between one of two objects—one positioned so that its handle was pointed toward them (easy-to-grasp orientation) and one positioned so that its handle was pointed away from them (difficult-to-grasp orientation). We asked subjects to either (a) choose the object they like and indicate their preference by moving it to a specified location, (b) choose the object they dislike and indicate their dispreference by moving it a specified location, or (c) simply choose to move one of the objects. We predicted that people would grasp objects by their handles (replicating work by Creem & Proffitt, 2001), and when asked to choose the object they liked best, that they would be more likely than chance to choose objects whose handles are pointed toward them—objects that, if acted upon in a functional manner (i.e., in terms of how one would use the object), would be easier to grasp. Moreover, when asked to decide which object they *dislike* the most, people should not be as likely to choose the easy-to-grasp object.

Target objects consisted of 16 everyday kitchen utensils that all had clearly demarcated handles. Utensils were either all black (plastic and rubber) or were black and silver (plastic, rubber, and metal). Filler stimuli were also included to lessen the possibility that subjects would explicitly connect the purpose of the study to object handle orientation (see below for more detail). Filler objects consisted of 16 everyday household items from other categories (personal hygiene, tools, etc.). See Appendix 1 for a list of target and filler objects.

The experiment began with a moving task that involved moving each of the target and filler objects from one location to another. Participants (all right-handed, 45 in total) were seated at a chair on one side of a table with the experimenter seated across the table on the other side. All stimuli were situated out of the participant's sight. On each trial, the experimenter placed one of the 32 stimuli (16 targets and 16 fillers) directly in front of the participant. The participant's task was to pick up the object with his or her dominant (right) hand and move it to a box located on the far right side of the table. Each participant moved each of the objects two times, once in an easy-to-grasp orientation and once in a difficult-to-grasp orientation.

On trials where the object was placed in an easy-to-grasp orientation, the object was placed at a roughly 135-degree angle on the table, with the handle pointing *toward* the participant's right hand. When the object was placed in a difficult-to-grasp orientation, the object was placed at the same angle, with the handle pointing *away* from the participant's right hand. The easy-to-grasp orientation required less movement and contortion of one's wrist than the hard-to-grasp orientation in which—to pick up the object by its handle—individuals had to reach around it. This part of the study was videotaped, and participants' responses were later coded according to whether they grasped the object by the handle or by some other object part. The goal of the moving task was twofold: first, it allowed us to determine how often individuals did pick up objects by their handles—a replication of Creem and Proffitt (2001). Second, it provided participants with practice manipulating the objects for the main choice task—see below.

After each object had been moved twice, once in the easy-to-grasp and once in the hard-to-grasp orientation, participants performed the choice task. Here, two objects were placed on the table in front of them (one slightly to the left of the participant and one slightly to the right) and individuals were told to choose one of them to move to the box on the far right. Participants were assigned to one of three conditions (N = 15 in each condition): *neutral*, *like*, or *dislike.* In the *neutral* condition participants were not asked to make any explicit preference judgments about the objects. They were simply asked to, as quickly as possible, pick up and move one of the two objects with their dominant (right) hand and place it in the box. Participants in the *like* condition were asked to, as quickly as possible, choose which item they liked the most and then to indicate their preference by moving this object with their dominant (right) hand to the box on the right. Participants in the *dislike* condition were asked to, as quickly as possible, choose which item they disliked the most and then to indicate their dispreference by moving this object with their dominant (right) hand to the box on the right.

On the 16 target trials, participants chose between one of two kitchen objects, whose handles pointed in different directions. One object was in the easy-to-grasp orientation, and one was in the difficult-to-grasp orientation. Half of the time, the easy-to-grasp object was on the participant's right side; for the other half, it was on the left. On 16 filler trials, participants chose between one of two filler objects; both handles pointed in the same direction. Half of the time, both filler objects were in the easy-to-grasp orientation; the other half, they were both in the difficult-to-grasp orientation. In both the target and filler trials, each object was presented twice, paired with a different object on each presentation. These pairings between objects within the target and filler trials were randomized across individuals and presented in a random order to each individual. This choice task was also videotaped. Participants' responses were later coded in terms of which object they chose.

As mentioned above, the filler trials, where the handles of both objects faced the same direction, were included in an attempt to lessen the possibility that participants would explicitly connect the preference judgment task with the fact that the target objects were presented with their handles in different orientations. That is, the filler items were included in order to obscure any explicit relation between handle orientation and object preference. Filler item performance was not analyzed.

After completing the choice task, each participant filled out questionnaires asking them to describe the factors they used in making their choices, as well as their best guess about the purpose of the study. These questions were coded according to whether the participant mentioned using handle orientation as a factor in their choice making, or if they guessed that the purpose of the study was about handle orientation.

Should we find a preference for easy-to-grasp objects, then we would want to ensure that any preference was not a result of objects being easier to process and recognize in one orientation over another. We included a check for this in our procedure, a naming task that required subjects to name each target object in each orientation as quickly and accurately as possible at the end of the experiment. Black and white photographs of each target object were presented on a computer screen twice. One photograph depicted the object in the easy-to-grasp orientation. One photograph depicted the object in the difficult-to-grasp orientation. Photographs were presented screen-center and remained on the screen until participants responded by voicing the name of the object into a microphone. Objects were presented in a fixed randomized order across participants. Individuals were asked to verbally name each object as quickly as possible. Their responses were manually recorded by the experimenter, while their response times were measured by the computer.

Our findings show that when simply asked to move objects from one location to another, subjects grasped the objects by their handles, even when the handles were pointed away from them. Overall, individuals grasped objects by their handles about 75% of the time (M = 74.51%, SE = 2.64%). It should be noted that the proportion of objects grasped by their handles did differ as a function of whether the object was oriented in an easy-to-grasp or hard-to-grasp orientation. People grasped easy-to-grasp handles about 91% of the time (M = 91.39%, SE = 2.03%), while they grasped difficult-to-grasp handles 58% of the time (M = 57.58%, SE = 4.23%). This difference was significant, $F(1, 44) = 68.55$, $p < .001$. However, even when objects were presented in the difficult-to-grasp orientation, individuals were more likely than chance to reach out and grasp objects by their handles, replicating the results of Creem and Proffitt (2001).

In the choice task, subjects were asked to move one of two objects. On target trials of interest, one of the objects was positioned in an easy-to-grasp orientation, while the other was in a difficult-to-grasp orientation. Percentage of trials where subjects chose the easy-to-grasp object are shown in Figure 1. Subjects in the *neutral* and *like* conditions chose to move the easy-to-grasp object at a rate higher than would be expected by chance alone (*neutral* condition: M = 73.00%, SE = 4.99%, $t(14) = 4.61$, $p < .01$; *like* condition: M = 63.07%, SE = 4.97%, $t(14) = 2.63$, $p < .05$). Subjects in the *dislike* condition did not show a preference for easy-to-grasp objects: they chose the easy-to-grasp object about half of the time (M = 50.80%, SE = 2.49%), a rate not significantly different from chance, $t(14) = .32$, *ns*. A one-way ANOVA revealed a main effect of condition, $F(2, 42) = 6.64$, $p < .01$. Least Significant Difference (LSD) post-hoc contrasts showed a significant difference between the *dislike* and *neutral* conditions ($p < .01$), and a difference between the *like* and *dislike* conditions ($p = .05$). There was no significant difference in proportion of easy to grasp items selected between the *like* and *neutral* conditions ($p > .1$).

There were some subjects who indicated on the post-experimental questionnaire that they used handle orientation to make their object choice or that they guessed that the experiment was about handle orientation. To test whether handle orientation was an explicit factor involved in people's decisions of objects they *liked* or *disliked*, we repeated these analyses excluding subjects in those conditions who mentioned handle orientation on post-experimental questionnaires. We found the same pattern of results: subjects in the *like* condition (N = 10) chose the easy-to-grasp object at a rate reliably higher than chance (M = 62.00%, SE = 4.35%; $t(9) = 2.76$, $p < .05$). Again, subjects in the *dislike* condition (N = 13) did not (M = 50.46%, SE = 2.86%, $t(12) = .16$, *ns*). Subjects in the *like* condition were more likely than subjects in the *dislike* condition to choose the easy-to-grasp object, $t(21) = 2.31$, $p < .05$.

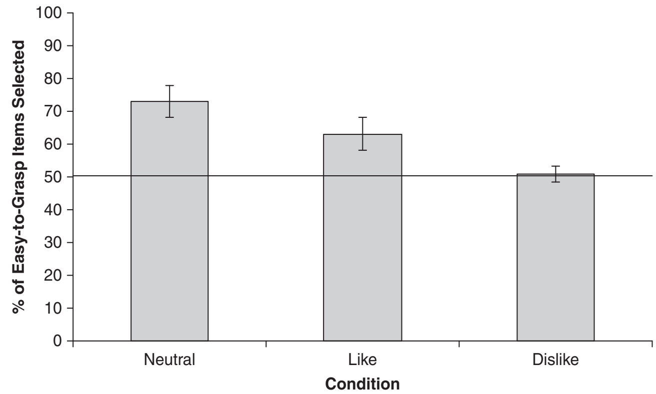

Figure 1. Proportion of easy-to-grasp objects chosen during the choice task. Error bars are standard errors. Chance is 50%.

Finally, we looked at how likely individuals were to grasp objects by their handles in the moving task and whether this had any relation to their likelihood of choosing objects that would be easier to act on (i.e., easy-to-grasp objects) in the *like* condition and choosing objects that would be harder to act on (i.e., harder-to-grasp objects) in the *dislike* condition. To do this, we first looked at correlations between an individual's tendency to grasp objects by the handle in the moving task and their tendency to choose the easy-to-grasp object in the choice task separately for the *dislike* condition and the *like* conditions.

There was a significant negative correlation for people in the *dislike* condition ($r = -.70$, $p < .01$). The more likely one was to grasp the target objects by the handle in the moving task, the less likely they were to choose the easy-to-grasp item (or the more likely they were to choose the hard-to-grasp item) when asked to pick which item they disliked the most. The opposite pattern, although not significant, was seen in the *like* condition ($r = .33$, $p = .35$). Here, the more likely one was to grasp the target objects by the handle in the moving task, the more likely they were to choose the easy-to-grasp item when asked to pick which item they liked the most. Moreover, these correlations were significantly different from each other, as demonstrated by regressing the proportion of easy-to-grasp objects chosen in the lieability conditions (i.e., *dislike* or *like* condition), on the proportion of objects grasped by the handle in the moving task, likeability condition (dummy coded), and their interaction, $\beta = 2.80$, $t = 2.67$, $p < .02$. Such findings suggest that those individuals most likely to move objects by the handle—and thus most likely to conform to our a priori assumptions about which objects would be easier or harder to grasp—were also most likely to pick the object that was congruent with the preference task (i.e., the easier-to-grasp object in the *like* condition and the harder-to-grasp object in the *dislike* condition).

To ensure that our results were not simply due to differences in object recognition based on orientation, participants were asked to complete an object naming task. Subjects were very accurate at the name task (easy-to-grasp orientation: M = 88.09%, SE = 1.77%; difficult-to-grasp orientation: M = 89.18%, SE = 1.57%). There was no difference in naming accuracy as a function of object orientation, $F(1, 45) = 1.31$, *ns*. When taking reaction time to (correctly) name objects as the dependent variable, subjects were actually faster to name difficult-to-grasp objects (M = 1299.98 ms, SE = 56.21) than to name easy-to-grasp objects (M = 1459.20, SE = 65.96), $F(1, 44) = 13.69$, $p < .001$. This means that preferences for easy-to-grasp objects were not based on ease of recognition.

In this new study we investigated the idea that people's preferences for objects they encounter can, in part, be driven by how easy it would be to act on them. When presented with two common kitchen objects—one in an easy-to-grasp orientation and one in a hard-to-grasp orientation—and asked to pick one of the two objects to move (i.e., the *neutral* condition), individuals were more likely than chance to choose an object that was easier (i.e., required less exertion or movement) to act on. This same pattern of results was obtained when individuals were not merely asked to pick one of two objects, but instead asked to choose the object they liked most. However, when subjects were asked to choose the object they disliked, easy-to-grasp objects were not preferred. This effect was not a result of ease of object recognition: people were not faster to name easy- over difficult-to-grasp objects. Additionally, this preference need not be explicit. Even subjects who did not notice that the experiment had anything to do with handle orientation showed a preference for easy-to-grasp over difficult-to-grasp objects. Thus, even when subjects claimed to be making their preference decisions on factors like object size, color, etc. or past experiences with the objects, it seems that action associations may also be contributing to how likeable an object is judged to be.

In our study, people often grasped objects by the handle, even when that handle was difficult to reach out and grasp (see Creem & Proffitt, 2001 for similar results). Moreover, the extent to which individuals grasped objects by the handles when merely asked to move them predicted whether they would be more likely to prefer easy-to-grasp objects in the *like* condition or hard-to-grasp objects in the *dislike* condition. Those individuals most likely to act on objects in terms of their functional end were most likely to prefer objects that would be easiest to use and dislike objects that would be hardest to use.

One might wonder why participants in the *dislike* condition did not choose the hard-to-grasp object more often than chance—rather than just failing to show the easy-to-grasp object preference seen in the *neutral* and *like* conditions. It may be that two processes are at work in our task. First, seeing objects automatically activates plans for action and, given that people prefer to act in ways that create the least amount of motor interference or are the easiest to perform (Beilock & Holt, 2007), there is an inherent preference to reach out and grab the easier-to-grasp item. In the *neutral* and *like* conditions, such a preference is in line with the second process at work in our task—task instruction. In these conditions, no instructions at all and instructions to grasp the item that you like best are congruent with the tendency to do what is easiest. In the *dislike* condition, however, this is not the case. Here individuals may have an inherent negative affect towards the hard-to-grasp object given the difficulty of simulating acting on it, but also are compelled to act in the way that takes the least effort—driving them toward the easy-to-grasp object. Asking participants to complete a motor plan that contradicts how they would act on neutral stimuli is in effect pitting the two processes against each other and potentially leading to no clear dispreference for one orientation over the other.

How important is it that subjects were planning to manipulate objects after they made their preference judgments? In other words, would the same pattern of results emerge if we only allow participants to look at the objects and make preference judgments rather than ask them to move the object after they have made their choice? In previous studies regarding the role of the motor system in dyad judgments of expert typists, preferences were the result of an automatic simulation of how one would type the dyads, without any intention to type (Beilock & Holt, 2007). Thus, it seems possible that other highly associated movements, like grasping objects by handles, should result in similar pattern of results without having to handle the objects. Or, perhaps this preference judgment is strongest within the context of moving objects because this is the situation in which plans to act are activated most strongly and thus are most informative. Further research in our lab. is exploring these possibilities.

General Discussion

In this review we present evidence that even a non-acting body impacts subjective feelings of likeability for initially neutral stimuli. Factors as seemingly unrelated to preference as object orientation or which fingers might be used to type letters actually impact preferences of stimuli one encounters—even when there is no intention to act. We propose that such effects may be best explained by "motor fluency" (Yang, Gallo, & Beilock, under review). Motor plans to act are automatically activated when we perceive stimuli in our environment (e.g., Rieger, 2004, 2007; Tucker & Ellis, 1998). This activation gives us information about how easy or fluent it would be to interact with the stimuli in question, even if we do not have an explicit intention to act. If people prefer stimuli that are easier or more fluent to process (e.g., Winkielman & Cacioppo, 2001; Zajonc, 1980), then they should choose objects that would be the easiest to manipulate. In this way, the non-acting motor system may inform our preference judgments of stimuli on an everyday basis.

This notion of motor fluency adds to an already rich body of literature on the role of the body in terms of preference and emotional judgments. Stimuli that have inherent positive or negative affective properties influence the actions we make. Conversely, actions associated with positive or negative affect (approach/avoidance arm movements, smiling vs. frowning, head nodding vs. side-to-side shaking) impact valence judgments about already valenced words and pictures, as well as judgments about neutral information. Here, we provide new evidence that even a non-acting motor system can impact judgments and preferences about everyday, neutral stimuli. Typing experience influences preferences for particular letter dyads and our extensive experience over a lifetime of interacting with an assortment of everyday objects impacts our preferences for those objects. We make preference judgments on a daily basis, and from the work reviewed above, it seems that these higher-level cognitive judgments are intimately tied to the motor system. This is especially true when we move or hold our bodies in a valenced way, but also holds when there is no movement at all. Not only is perception grounded in action, but it seems that our preferences are as well.

References

Barsalou, L. W. (2008). Grounded cognition. *Annual Review of Psychology*, *59*, 617–645.

Beilock, S. L. (2008). Beyond the playing field: Sport psychology meets embodied cognition. *International Review of Sport and Exercise Psychology*, *1*(1), 19–30.

Beilock, S. L., & Holt, L. E. (2007). Embodied preference judgments: Can likeability be driven by the motor system? *Psychological Science*, *18*, 51–57.

Beilock, S. L., Lyons, I. M., Mattarella-Micke, A., Nusbaum, H. C., & Small, S. L. (2008). Sports experience changes the neural processing of action language. *Proceedings of the National Academy of Sciences, USA*, *105*, 13269–13273.

Borghi, A. M. (2004). Objects, concepts, and action: Extracting affordances from objects' parts. *Acta Psychologica*, *115*(1), 69–96.

Cacioppo, J. T., Priester, J. R., & Berntson, G. G. (1993). Rudimentary determinants of attitudes. II: Arm flexion and extension have differential effects on attitudes. *Journal of Personality and Social Psychology*, *65*, 5–17.

Centerbar, D., & Clore, G. L. (2006). Do approach-avoidance actions create attitudes? *Psychological Science*, *17*, 22–29.

Chen, M., & Bargh, J. A. (1999). Consequences of automatic evaluation: Immediate behavioral predispositions to approach or avoid the stimulus. *Personality and Social Psychology Bulletin*, *25*, 215–224.

Clore, G. L., & Schnall, S. (2008). Affective coherence: Affect as embodied evidence in attitude, advertising, and art. In G. R. Semin & E. R. Smith (Eds.), *Embodied grounding: Social, cognitive, affective and neuroscientific approaches* (pp. 211–236). New York: Cambridge University Press.

Cohen, R. G., & Rosenbaum, D. A. (2004). Where objects are grasped reveals how grasps are planned: Generation and recall of grasps. *Experimental Brain Research*, *157*, 486–495.

Crawford, L. E. (2009). Conceptual metaphors of affect. *Emotion Review, 1*(2), 129–139.

Creem, S. H., & Proffitt, D. R. (2001). Grasping objects by their handles: A necessary interaction between cognition and action. *Journal of Experimental Psychology: Human Perception and Performance*, *27*, 218–228.

Flach, R., Knoblich, G., & Prinz, W. (2004). Recognizing one's own clapping: The role of temporal cues in self-recognition. *Psychological Research*, *11*, 147–156.

Gerlach, C., Law, I., & Paulson, O. B. (2002). When action turns into words: Activation of motor-based knowledge during categorization of manipulable objects. *Journal of Cognitive Neuroscience*, *14*, 1230–1239.

Gibson, J. J. (1979). *The ecological approach to visual perception*. London: Erlbaum.

Glenberg, A. M., & Kaschak, M. P. (2002). Grounding language in action. *Psychonomic Bulletin & Review*, *9*, 558–565.

Glenberg, A. M., Webster, B., Mouilso, E., Havas, D., & Lindeman, L. (2009). Gender, emotion, and the embodiment of language comprehension. *Emotion Review, 1*(2), 151–161.

Grafton, S., Fadiga, L., Arbib, M., & Rizzolatti, G. (1997). Premotor cortex activation during observation and naming of familiar tools. *Neuroimage*, *6*, 231–236.

Grafton, S. T., & Hamilton, A. F. (2007). Evidence for a distributed hierarchy of action representation in the brain. *Human Movement Science*, *26*, 590–616.

Hamilton, A., Wolpert, D. M., & Frith, U. (2004). Your own action influences how you perceive another person's action. *Current Biology*, *14*, 493–498.

Hauk, O., Johnsrude, I., & Pulvermüller, F. (2004). Somatotopic representation of action words in the motor and premotor cortex. *Neuron*, *41*, 301–307.

Havas, D. A., Glenberg, A. M., & Rinck, M. (2007). Emotion simulation during language comprehension. *Psychonomic Bulletin & Review*, *14*(3), 436–441.

Jacobs, A., & Shiffrar, M. (2005). Walking perception by walking observers. *Journal of Experimental Psychology: Human Perception and Performance*, *31*, 157–169.

Klatzky, R., Pellegrino, J., Mccloskey, B., & Doherty, S. (1989). Can you squeeze a tomato? The role of motor representations in semantic sensibility judgments. *Journal of Memory and Language*, *28*(1), 56–77.

Knoblich, G., & Flach, R. (2001). Predicting the effects of actions: Interactions of perception and action. *Psychological Science*, *12*, 467–472.

Knoblich, G., & Sebanz, N. (2006). The social nature of perception and action. *Current Directions in Psychological Science*, *15*(3), 99–104.

Larsen, R. J., Kasimatis, M., & Frey, K. (1992). Facilitating the furrowed brow: An unobtrusive test of the facial feedback hypothesis applied to unpleasant affect. *Cognition & Emotion, 6*, 321–338.

Loula, F., Prasad, S., Harber, K., & Shiffrar, M. (2005). Recognizing people from their movement. *Journal of Experimental Psychology: Human Perception and Performance*, *31*, 210–220.

Niedenthal, P. M., Barsalou, L. W., Winkielman, P., Krauth-Gruber, S., & Ric, F. (2005). Embodiment in attitudes, social perception, and emotion. *Personality and Social Psychology Review*, *9*(3), 184–211.

Niedenthal, P. M., Brauer, M., Halberstadt, J. B., & Innes-Ker, A. H. (2001). When did her smile drop? Facial mimicry and the influence of emotional state on the detection of change in emotional expression. *Cognition & Emotion*, *15*, 853–864.

Priester, J. R., Cacioppo, J. T., & Petty, R. E. (1996). The influence of motor processes on attitudes toward novel versus familiar semantic stimuli. *Personality and Social Psychology Bulletin*, *22,* 442–447.

Prinz, W. (1997). Perception and action planning. *European Journal of Cognitive Psychology*, *9*, 129–154.

Reber, R., Schwarz, N., & Winkielman, P. (2004). Processing fluency and aesthetic pleasure: Is beauty in the perceiver's processing experience? *Personality and Social Psychology Review*, *8*, 364–382.

Reed, C. L., & Farah, M. J. (1995). The psychological reality of the body schema: A test with normal participants. *Journal of Experimental Psychology: Human Perception and Performance*, *21*, 334–343.

Reed, C. L., Grubb, J. D., & Steele, C. (2006). Hands up: Attentional prioritization of space near the hand. *Journal of Experimental Psychology: Human Perception and Performance*, *32*(1), 166–177.

Reed, C. L., & McGoldrick, J. E. (2007). Action during body perception: Processing time affects self–other correspondences. *Social Neuroscience*, *2*(2), 134–149.

Repp, B. H., & Knoblich, G. (2004). Perceiving action identity: How pianists recognize their own performances. *Psychological Science*, *15*, 604–609.

Rieger, M. (2004). Automatic keypress activation in skilled typing. *Journal of Experimental Psychology: Human Perception and Performance*, *30*, 555–565.

Rieger, M. (2007). Letters as visual action-effects in skilled typing. *Acta Psychologica*, *126*(2), 138–153.

Rumelhart, D. E., & Norman, D. A. (1982). Simulating a skilled typist: A study of skilled cognitive-motor performance. *Cognitive Science*, *6*, 1–36.

Schwarz, N., & Clore, G. L. (1996). Feelings and phenomenal experiences. In E. T. Higgins & A. W. Kruglanski (Eds.), *Social psychology: Handbook of basic principles* (pp. 433–465). New York: Guilford.

Strack, F., & Förster, J. (1997). Motor actions in retrieval of valenced information: A motor congruence effect. *Perceptual and Motor Skills*, *85*, 1419–1427.

Strack, F., & Förster, J. (1998). Motor actions in retrieval of valenced information: II. Boundary conditions for motor congruence effects. *Perceptual and Motor Skills*, *86*, 1423–1426.

Strack, F., Martin, L., & Stepper, S. (1988). Inhibiting and facilitating conditions of the human smile: A nonobtrusive test of the facial feedback hypothesis. *Journal of Personality and Social Psychology*, *54*, 768–777.

Tom, G., Pettersen, P., Lau, T., Burton, T., & Cook, J. (1991). The role of overt head movement in the formation of affect. *Basic and Applied Social Psychology*, *12*, 281–289.

Tucker, M., & Ellis, R. (1998). On the relations between seen objects and components of potential actions. *Journal of Experimental Psychology: Human Perception and Performance*, *24*(3), 830–846.

Van den Bergh, O., Vrana, S., & Eelen, P. (1990). Letters from the heart: Affective categorization of letter combinations in typists and nontypists. *Journal of Experimental Psychology: Learning, Memory, Cognition*, *16*, 1153–1161.

Wells, G. L., & Petty, R. E. (1980). The effects of overt head movements on persuasion: Compatibility and incompatibility of responses. *Basic and Applied Social Psychology*, *1*, 219–230.

Wexler, M., Kosslyn, S. M., & Berthoz, A. (1998). Motor processes in mental rotation. *Cognition*, *68*(1), 77–94.

Winkielman, P., & Cacioppo, J. T. (2001). Mind at ease puts a smile on your face: Psychophysiological evidence that processing facilitation elicits positive affect. *Journal of Personality and Social Psychology*, *81*, 989–1000.

Yang, S., Gallo, D. A., & Beilock, S. L. (under review). Embodied memory judgments: A case of motor fluency.

Zajonc, R. B. (1980). Feeling and thinking: Preferences need no inferences. *American Psychologist*, *35*, 151–175.

Zwaan, R. A., & Taylor, L. J. (2006). Seeing, acting, understanding: Motor resonance in language comprehension. *Journal of Experimental Psychology: General*, *135*(1), 1–11.

Appendix 1: List of Objects Used as Stimuli

Target Objects

Basting Brush, Bottle Opener, Butter Knife, Fork, Grater, Ice Cream Scoop, Icing Spreader, Ladle, Measuring Cup, Pasta Server, Pizza Cutter, Potato Masher, Spatula, Spoon, Vegetable Peeler, Whisk.

Filler Objects

Artist Brush, Comb, Dish Brush, Flash Light, Hair Brush, Hammer, Letter Opener, Magnifying Glass, Paint Brush, Putty Knife, Razor, Screw Driver, Spade, Toothbrush, Wire Brush, Wrench.