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Embodiment in Judgment and Choice

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This article discusses the role of embodiment in judgment and choice to (a) attain clarity on conceptual and methodological issues by presenting a literature review of prior empirical research on embodiment, (b) gain an integrative view on the topic of embodiment in judgment and choice by proposing somatic marker theory as a unifying conceptual framework for bridging cognition and affect in terms of embodiment, and (c) discuss and clarify ideas and directions for further research on the topic.

Keywords: embodiment, embodied affect, embodied cognition, somatic marker theory, decision neuroscience

Research on embodiment explores the role of bodily perceptions, its possible emotional roots, and effects on downstream cognitive processing such as judgment and choice. The central role of bodily perceptions has been advanced by the theory of embodied cognition (sometimes referred to as grounded cognition). This theory typically holds that the body exerts a strong influence on shaping an individual's cognitive representations (Barsalou, 2008; Glenberg, 1997; Malter, 1996). For example, early research on embodiment wondered why nodding one's head (vs. shaking it) influences the degree to which one agrees with a persuasive message (Wells & Petty, 1980) or why standing upright (vs. slumping) increases persistence on an in-

solvable puzzle task (Riskind & Gotay, 1982). More recent research indicated that moving one's eyes helps to solve brainteasers (Thomas & Lleras, 2007), that moving one's hand facilitated solving math problems and increased math performance (Broaders, Cook, Mitchell, & Goldin-Meadow, 2007; Goldin-Meadow, Cook, & Mitchell, 2009), and that firming one's muscles also firmed one's willpower and improved self-regulation (Hung & Labroo, 2011).

Yet, despite considerable progress toward understanding embodiment, several important conceptual and methodological questions remain unanswered. First, a central open question pertains to the psychological mechanisms underlying these bodily effects on cognitive representations. Do emotions function as the bridge between bodily perceptions and downstream cognitive processing such as judgment and choice and, possibly, assume a mediating role? Or, can emotions in fact be considered as bodily perceptions? For over a century, researchers have argued whether emotions should be understood as either perceptions of changes in bodily states (e.g., James, 1884; Lange, 1885) or cognitive appraisals (e.g., Frijda, Kuipers, & Schure, 1989; Smith & Ellsworth, 1985). Specifically, bodily perception theory argues that emotions may arise without the intervening process of cognitive appraisal but purely on the basis of physiological changes in the body (James,1884; Lange, 1885) and motor actions such as muscle flexion/extension or facial expressions (Maxwell & Davidson, 2007; Niedenthal, 2007). For example, a person feels content from eating because of being physically filled and one feels sad because of crying. On the contrary, cognitive appraisal theory posits that emotions are often elicited by mentally evaluating (appraising) certain objects or events in the environment in terms of their congruence with one's goals (Roseman & Smith, 2001). For example, happiness occurs after indulging in a delicious meal because it contributes to one's eating goals. Guilt is elicited in consumers after overeating because it violates goals of staying healthy and slim.

We suggest that both views—emotions as cognitive appraisals and emotions as bodily perceptions—seem to be partly right. Recent advances in affective neuroscience indicate that the brain carries out bodily perceptions and cognitive appraisals simultaneously, integrating them with cognitive representations such as concepts and beliefs (Bechara & Damasio, 2005; Bechara, 2005; Reimann & Bechara, 2010) and helping modify and guide downstream judgments and decision-making (Bechara, Damasio, Tranel, & Damasio, 1997). We extend the notion of cognitive appraisal theory of emotion and argue that bodily feedback is necessary for accurately appraising the goal-congruence of an object or event. For example, standing upright (vs. slumping) leads

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individuals to evaluate an achievement with greater pride (Stepper & Strack, 1993) and, thus, may foster performance-related goals. Individuals who sat on ergonomic chairs (vs. a smaller, forward-tilted chair) appraised the situation as a more powerful leader (Huang, Galinsky, Gruenfeld, & Guillory, 2011), supporting goals of getting ahead in life. We also extend theories of embodied cognition and grounded cognition by arguing that emotions play a crucial role in the effect of bodily perceptions on cognitive representations.

Second, related to the bodily perception-cognitive appraisal debate and revealed by the present integrative review of prior studies, the field of embodiment still lacks a unifying physiological theory that integrates both cognition and affect in embodiment. This gap may be due to the notion that prior research under the label of embodied cognition postulated that knowledge and thoughts arise from interaction with the environment without explicitly considering the role of emotions (Glenberg, 1997; Glenberg, Robertson, Kaschak, & Malter, 2003). Are these embodied cognitions purely "embodied cognitions of affect" in the sense of cognitive appraisal theory? The present research will address this gap by proposing somatic marker theory (Damasio, 1994) as a unifying conceptual framework for embodiment in judgment and choice.

In the following section, we review prior empirical studies on embodiment, which primarily focus on: (a) effects of body movement such as facial expressions on change in emotional states (e.g., Laird, 1974), and (b) effects of body movement such as head movement on cognitive activities, bypassing emotions (e.g., Wells & Petty, 1980). Both embodied approaches are in line with the Jamesian view of emotion, which argues that a range of bodily states—visceral changes, facial expressions, and muscle action—can cause the brain to interpret emotion (James, 1884, 1894). In the present research, we argue beyond James and take the Damasian perspective, which posits that these bodily states may not necessarily be experienced on the spot, but can be remembered (Bechara & Damasio, 2005; Damasio, 1994) and mentally simulated (Barsalou, 1999). This view—proposed in somatic marker theory (Damasio, 1994)—allows for an integration of both bodily perceptions and cognitive appraisals. It is argued that cognitive appraisal is a necessary stage between bodily perception and downstream processing that triggers behaviors. Although these filtering appraisal processes can be brief and nonconscious, they need to be recognized (Damasio, 2010). We further argue that the mechanisms of embodiment have a profound impact on downstream processes of judgments and choice such that more embodiment leads to more advantageous decisions (Bechara et al., 1997), helps in resisting the temptation of drugs (Bechara, 2005) or calorie-rich foods (Hung & Labroo, 2011), and supports a more effective prediction of future consequences (Bechara, Damasio, Damasio, & Anderson, 1994).

Third, does embodiment only apply to certain types of behavior or does it apply more broadly as an overarching phenomenon? For example, previous work has studied embodiment in a wide variety of consumer behaviors, including appraisals of physical products such as food (Labroo & Nielsen, 2010) and more abstract services such as donations (Hung & Labroo, 2011). To answer this question, we conducted an in-depth review of empirical findings, summarizing articles on embodiment published in psychology and consumer research journals since 1974. The findings suggest that embodiment is an overarching phenomenon that applies across many different domains.

Fourth, which methodological approaches work most effectively in the study of embodiment and its role in judgment and choice? Scholars have devised a broad spectrum of strategies to manipulate and measure embodiment, ranging from muscle action (e.g., arm flexion and extension or movement of head or hand), to facial expressions, to the recording of neurophysiological processes such as heart rate, skin conductance, and brain activity. Most prior research focused on manipulating body movement.

Taken together, this article aims to (a) attain clarity on the key conceptual and methodological issues in embodiment, (b) develop an integrative view of the role of embodiment in judgment and choice by proposing somatic marker theory as a unifying conceptual framework that bridges both embodied cognition and affect, and (c) discuss ideas and directions for further research on the topic. We expect that embodiment theory will contribute significantly to the extant

literature as it helps to integrate previously competing views of emotion as either cognitive appraisals or perceptions of bodily changes.

Literature Review

In our literature review, we focused on empirical studies of embodiment, published in leading journals in psychology and consumer research, including the *Journal of Consumer Research*, *Journal of Consumer Psychology*, *Psychological Science*, *Journal of Personality and Social Psychology*, *Basic and Applied Social Psychology*, *Motivation and Emotion*, *Cognition & Emotion*, *Emotion*, *Personality and Social Psychology Bulletin*, *Journal of Experimental Psychology: General*, *Psychonomic Bulletin & Review*, and *Journal of Experimental Social Psychology*.

Our literature search started with the first issues of the 1970 volume of each journal, up to and including the current issue of the 2011 volume. The first relevant article was published in 1974. We used the keywords "embodiment," "embodied," "embodied cognition," "embodied affect," and "grounded cognition" to identify relevant articles. We acknowledge that many more published articles are related to the idea of embodiment (e.g., studies on touch and taste and how these senses influence downstream mechanisms of judgment and choice); however, articles that did not explicitly state the aforementioned keywords (e.g., Peck & Childers, 2003), that did not contain empirical studies (e.g., Rosa & Malter, 2003), or that appeared in non-psychology journals (e.g., Kreuzbauer & Malter, 2005), were not included in the present review. Table 1 summarizes all identified articles, sorted chronologically and displaying the authors' names, journal name, year of publication, focal topic, methodology applied, sample size, and key findings.

Overall, 93% of the reviewed studies manipulated some form of bodily movement, while 7% manipulated sensory perception. Further, of those studies manipulating body movement, we found that (a) 51% of the studies had participants evaluate objects (e.g., positive vs. negative words or products) following the manipulation, (b) 23% of the studies had participants undertake some form of behavior (e.g., perform a task or choose a food) following the manipulation, (c) 15% of the studies asked participants to engage in some form of problem-solving (e.g., spatial reasoning or memory task) following the manipulation, and (d) 11% of the studies asked participants to engage in some form of self-perception evaluation (e.g., self-esteem or willpower) following the manipulation.

Moreover, of those studies manipulating sensory perception (rather than bodily movement), (a) 67% of the studies had participants evaluate objects (e.g., consumer products) following the manipulation and (b) 33% of the studies asked participants to report their emotional state following the manipulation. The major findings in each category are summarized below.

Body Movement

Given the large percentage of studies that manipulate body movement, we investigated which specific body parts were the focus of the physical manipulation. We subdivided body movement by the anatomical regions of the human body. It was found that studies manipulating body movement focus on three distinct regions of the body: (a) movement of the head, including face and eye movement; (b) movement of the upper limbs, including both arms, and the lower limbs, including both legs; and (c) movement of the whole body.

Movement of head, face, and eyes. One of the earlier articles on embodiment revealed that different head movements have distinct effects on cognition. Specifically, it was shown that vertical movement augments cognitive activity in the form of higher agreement to external content in contrast to horizontal head movement (Wells & Petty, 1980). Other research in this stream found that given strong message arguments, nodding produces more persuasion than shaking does (Briñol & Petty, 2003). Förster (2004) found that induced head nodding further strengthens favorable evaluation of positively valenced objects, but does not alter the evaluation of negatively valenced objects. While head shaking (as opposed to head nodding) does not affect the evaluation of positive objects, it further strengthens unfavorable evaluation of negatively valenced objects.

In addition to manipulating head movement in research on embodiment, experiments have often manipulated facial expressions. For example, it was found that manipulation of expression in the human face is sufficient to produce changes in

Table 1
Literature Review on Embodiment in Judgment and Choice

Author, year	Journal	Focal topic	Method	Sample size	Results
Laird (1974)	*Journal of Personality and Social Psychology*	What is the effect of expressive behavior on emotional experience?	Experiments	Study 1: $n = 65$, Study 2: $n = 26$	Manipulation of expression in subjects' face is sufficient to produce changes in subjective experience of emotion.
Tourangeau and Ellsworth (1979)	*Journal of Personality and Social Psychology*	What is the role of facial expression in the experience of emotion?	Experiment	$n = 128$	Adopting an emotional facial expression does not appear to be sufficient to produce the emotion. Emotional expression does not seem necessary for emotional feelings.
Wells and Petty (1980)	*Basic and Applied Social Psychology*	Can overt head movement augment or inhibit cognitive activities?	Experiment	$n = 72$	Subjects with instructed vertical head movement agree to external content more than subjects in a horizontal head-movement condition.
Riskind and Gotay (1982)	*Motivation and Emotion*	What is the effect of physical posture on motivation and emotion?	Experiments	Study 1: $n = 20$, Study 2: $n = 20$, Study 3: $n = 28$, Study 4: $n = 41$	Physical posture has a significant residual aftereffect on performance on a subsequent task. Suggestion that physical posture of body can affect emotional experience and behavior.
Strack, Martin, and Stepper (1988)	*Journal of Personality and Social Psychology*	Does the facial activity influence affective responses?	Experiments	Study 1: $n = 92$, Study 2: $n = 83$	Participants report more intense humor responses when smiling is facilitated than under inhibited conditions. Facial feedback operates on the affective and not the cognitive component of humor responses.
Duclos et al. (1989)	*Journal of Personality and Social Psychology*	What is the effect of facial expression and posture on emotional experience?	Experiments	Study 1: $n = 74$, Study 2: $n = 74$	Emotional facial expression induces changes in feelings corresponding to the behavior.
Larsen, Kasimatis, and Frey (1992)	*Cognition & Emotion*	Do muscle contractions in the face influence emotional experience?	Experiment	$n = 30$	Muscle contraction in the face contributes to subjects' emotional reactions to unpleasant affective stimuli.
Cacioppo, Priester, and Berntson (1993)	*Journal of Personality and Social Psychology*	What is the effect of arm flexion and extension on attitudes?	Experiments	Study 1: $n = 44$, Study 2: $n = 44$, Study 3: $n = 44$, Study 4: $n = 29$, Study 5: $n = 29$, Study 6: $n = 82$	Subject's rate objects more positive during arm flexion and more negative during arm extension. Attitudinal effects of body movement (arm flexion and extension) are triggered by active motor processes.

Table 1 (*continued*)

Author, year	Journal	Focal topic	Method	Sample size	Results
Stepper and Strack (1993)	*Journal of Personality and Social Psychology*	Can emotional and nonemotional feelings be influenced by uninterpreted proprioceptive input?	Experiments	Study 1: $n = 99$, Study 2: $n = 72$	Success at an achievement task leads to greater feelings of pride if the outcome was received in an upright position rather than a slumped posture. Nonemotional feelings of effort can be influenced by contraction of the forehead muscle.
Dimberg, Thunberg, and Elmehed (2000)	*Psychological Science*	Are there any unconscious facial reactions to emotional facial expressions?	Experiment	$n = 120$	Both positive and negative emotional reactions can be unconsciously evoked by facial expressions.
Neumann and Strack (2000)	*Journal of Personality and Social Psychology*	Do approach and avoidance behavior exert a direct impact on the categorization of affective information?	Experiment	$n = 25$	Participants categorize positive words more quickly than negative words while flexing the arm and negative words more quickly than positive words while extending the arm.
Knoblich and Flach (2001)	*Psychological Science*	Can perceptual input be linked with the action system to predict future outcomes of actions?	Experiment	$n = 104$	Individual attention can be coupled with that of another person to predict future actions and their effects. Prediction is more accurate when participants observed their own actions.
Soussignan (2002)	*Emotion*	What is the impact of Duchenne and non-Duchenne smiles on emotional experience?	Experiment	$n = 96$	The Duchenne smile results in the formation of positive feelings.
Briñol and Petty (2003)	*Journal of Personality and Social Psychology*	Can overt head movement affect attitude changes?	Experiments	Study 1: $n = 82$, Study 2: $n = 147$, Study 3: $n = 89$	With strong message arguments, nodding produces more persuasion than shaking. The reverse occurs when message arguments are weak.
Grant and Spivey (2003)	*Psychological Science*	What is the influence of manipulated eye movement on problem solving?	Experiments	Study 1: $n = 14$, Study 2: $n = 81$	Eye movements appear to reflect cognition during problem solving. Manipulation of visual field enables differences in solutions.
Joy and Sherry (2003)	*Journal of Consumer Research*	How do embodiment processes shape consumers reasoning?	Field Study	$n = 30$	The body-dependent order of presentation provides limitations on how an object or event is perceived. The body is implicated in affective states through the language used to express them. Participants using more abstract language to express their aesthetic encounters are no less embodied than subjects using less complex and more emotional language.

(*table continues*)

Table 1 (*continued*)

Author, year	Journal	Focal topic	Method	Sample size	Results
Schnall and Laird (2003)	*Cognition & Emotion*	What is the influence of practiced expression on emotional experience?	Experiment	$n = 46$	Practicing expressions affect feelings and episodic memory, even after repetition.
Förster (2004)	*Journal of Consumer Psychology*	How does body feedback influence consumers' evaluation of products?	Experiments	Study 1: $n = 43$, Study 2: $n = 94$	Induced head nodding leads to a more favorable evaluation of positively valenced products, but does not affect the evaluation of negatively valenced products. Head shaking leads to a more unfavorable evaluation of negatively valenced products, but does not affect the evaluation of positive ones. Arm flexion leads to a more favorable evaluation of positively valenced products, but has no effect on negatively valenced products. Arm extension leads to a more unfavorable evaluation of negatively valenced products, but has no effect on positively valenced products.
Meier and Robinson (2004)	*Psychological Science*	What is the link between affect and vertical position?	Experiments	Study 1: $n = 34$, Study 2: $n = 82$, Study 3: $n = 82$	Evaluation of positive stimuli is faster when a stimulus is in the up rather than the down position. Positive evaluations activate higher areas of visual space, but negative evaluations activate lower areas of visual space. However, spatial positions do not activate evaluations.
Markman and Brendl (2005)	*Psychological Science*	What are the roles of perceptual and motor activity on evaluation?	Experiment	$n = 108$	Results show that perceptual and motor activities are not sufficient to account for cognitive processing. The compatibility effect depends more on perception in space than the actual physical location.
Flack (2006)	*Cognition & Emotion*	What are the feedback effects of facial expression and bodily posture on emotional feelings?	Experiment	$n = 52$	Facial expressions and bodily postures produce specific effects on emotional feelings.
Rosa, Garbarino, and Malter (2006)	*Journal of Consumer Psychology*	What is the influence of body-related information on the purchase of products?	Survey	$n = 668$	Body esteem and body boundary aberration influence consumer involvement and purchase intention.

Table 1 (*continued*)

Author, year	Journal	Focal topic	Method	Sample size	Results
Beilock and Holt (2007)	*Psychological Science*	Are preferences driven by our motor system?	Experiments	Studies 1 and 2: $n = 29$	Hidden sensorimotor simulation of stimulus-relevant actions influences the affective judgments about these stimuli. Whenever such simulation is not possible, the effect disappears.
Broaders et al. (2007)	*Journal of Experimental Psychology: General*	Does forced gesturing reveal implicit knowledge in children?	Experiments	Study 1: $n = 106$, Study 2: $n = 70$	Subjects developed novel and correct problem-solving strategies and implicit ideas when forced to gesture.
Thomas and Lleras (2007)	*Psychonomic Bulletin & Review*	Is there an implicit compatibility between spatial cognition and eye movement?	Experiment	$n = 99$	Eye movement patterns can influence thought in spatial reasoning tasks.
Centerbar et al. (2008)	*Journal of Personality and Social Psychology*	What is the effect of affective information on cognitive performance?	Experiments	Study 1: $n = 219$, Study 2: $n = 100$, Study 3: $n = 87$, Study 4: $n = 286$, Study 5: $n = 371$	The performance on a memory task depends on the agreement between cognitively processed content and experienced body action.
Zhong and Leonardelli (2008)	*Psychological Science*	Does social exclusion feel cold?	Experiments	Study 1: $n = 65$, Study 2: $n = 52$	Participants felt cold and seek for warmth when being socially excluded through a recall of past experience or virtual interaction.
Casasanto (2009)	*Journal of Experimental Psychology: General*	Do body differences influence our thoughts?	Experiments	Study 1: $n = 219$, Study 2: $n = 100$, Study 3: $n = 87$, Study 4: $n = 286$, Study 5: $n = 371$	Subjects with body differences (right- and left-handers), who interact with their physical environments in systematically different ways, form correspondingly different mental representations.
Chandler and Schwarz (2009)	*Journal of Experimental Social Psychology*	How do body movements influence thoughts and feelings?	Experiments	Study 1: $n = 54$, Study 2: $n = 71$	Participants engaged in specific body movements while processing information of the target person consequently rated the target different than participants who were engaged in different body movements.
Goldin-Meadow, Cook, and Mitchell (2009)	*Psychological Science*	How does gesturing help in learning?	Experiment	$n = 128$	Subjects required to produce correct gestures learn more than subjects required to produce partially correct gestures, who learn more than subjects required to produce no gestures. Body movements are involved in processing old ideas and creating new ones.

(*table continues*)

Table 1 (*continued*)

Author, year	Journal	Focal topic	Method	Sample size	Results
Jostmann, Lakens, and Schubert (2009)	*Psychological Science*	What is the link between the bodily experience of weight and cognition?	Experiments	Study 1: $n = 40$, Study 2: $n = 51$, Study 3: $n = 49$, Study 4: $n = 40$	Experiencing heavy weight increases the perceived importance of an issue. Weight makes participants invest more cognitive effort when dealing with abstract issues.
Niedenthal et al. (2009)	*Journal of Personality and Social Psychology*	How do individuals access knowledge about emotion?	Experiments	Studies 1 and 2: $n = 45$, Study 3: $n = 30$, Study 4: $n = 18$	Embodiment of specific emotions in an emotion-focused but not a perceptual-focused processing task. Suggestion of a causal, rather than a correlational role for embodiment in emotion processing. Emotions embodied in conceptual tasks are context-dependent situated simulations rather than associated emotional reactions.
Schubert and Koole (2009)	*Journal of Experimental Social Psychology*	What is the effect of gesturing on the self-concept?	Experiments	Study 1: $n = 71$, Study 2: $n = 76$	Making a powerful gesture leads male subjects to perceive themselves as more assertive and esteemed, while female subjects do not reveal this effect.
Beilock and Goldin-Meadow (2010)	*Psychological Science*	How does gesturing change our thoughts?	Experiments	Study 1: $n = 26$, Study 2: $n = 20$	Gesturing adds action information to subjects' mental representations of the task they explain.
Carney et al. (2010)	*Psychological Science*	Can expansive (constrictive) postures cause feelings of power (weakness)?	Experiment	$n = 42$	Posture can activate a sense of power and produces behavioral changes.
Labroo and Nielsen (2010)	*Journal of Consumer Research*	Is an outcome rewarding from the bodily sensation of approaching it?	Experiments	Study 1: $n = 55$, Study 2: $n = 158$, Study 3: $n = 178$	A positive effect of embodied movement in space toward an otherwise aversive product. Positive effects of psychological movement in time, using evaluative conditioning procedures, to associated stimuli in memory.
Lee and Schwarz (2010a)	*Psychological Science*	Is moral purity really independent of motor modality?	Experiment	$n = 87$	Embodiment of moral purity is specific to the motor modality involved in a moral transgression. The embodiment of moral purity can even be extended to virtuous acts.
Sherman, Gangi, and White (2010)	*Journal of Experimental Social Psychology*	Does the activation of the motor system during health persuasion lead to healthier behavior?	Experiments	Study 1: $n = 65$, Study 2: $n = 66$	Minor, health-relevant motor manipulations can enable health behavior changes. Motor activities during persuasion can lead to consistent intentions of behavioral changes.

Table 1 (*continued*)

Author, year	Journal	Focal topic	Method	Sample size	Results
Eskine, Kacinik, and Prinz (2011)	*Psychological Science*	What is the effect of taste perception on moral judgments?	Experiment	$n = 57$	Taste perception significantly affects moral judgments.
Huang et al. (2011)	*Psychological Science*	What is the influence of body posture and role on behavior and thought?	Experiments	Study 1: $n = 77$, Study 2: $n = 77$, Study 3: $n = 57$	Posture has a stronger effect than role power on behavior and thought. Power is grounded in bodily states.
Hung and Labroo (2011)	*Journal of Consumer Research*	What is the role of embodied cognition in self-regulation?	Experiments	Study 1: $n = 54$, Study 2: $n = 47$, Study 3: $n = 91$, Study 4: $n = 66$, Study 5: $n = 98$	Firming muscles while engaging in self-control facilitates self-control. Confirmation of existing research that prior self-regulatory efforts lead to decrements in subsequent exertions of self-control. Online willpower thoughts mediate self-control, self-reports of expended willpower do not. Suggestion that the impact of the body on the mind in the context of self-control is an automatic memory-activation process rather than a self-perception.
Risen and Critcher (2011)	*Journal of Personality and Social Psychology*	Do visceral states influence our thoughts?	Experiments	Study 1: $n = 67$, Study 2: $n = 84$, Study 3: $n = 33$, Study 4: $n = 52$, Study 5: $n = 83$, Study 6a: $n = 20$, Study 6b: $n = 65$	Visceral states can implicitly influence consequential scientific beliefs. When participants experienced a match between their own visceral state and a visceral state associated with an outcome, that they were judging, the outcome was believed to be more likely.

subjective experience of emotion (Laird, 1974). Other research on facial expression highlights the role of certain emotional states in the evaluation process: For example, participants reported more intense humor when smiling is facilitated than under inhibited conditions (Strack, Martin, & Stepper, 1988), and it was shown that altering facial expressions changes the corresponding reported feelings (Flack, 2006; Larsen, Kasimatis, & Frey, 1992; Soussignan, 2002).

Experiments manipulating eye movement show that eye movement appears to reflect cognition during problem solving (Grant & Spivey, 2003). Evaluation of positive stimuli is faster when stimuli are in the upper rather than the lower position of the beholders' visual space (Meier & Robinson, 2004) and patterns of eye movement can influence thoughts in spatial reasoning (Thomas & Lleras, 2007).

Movement of upper and lower limbs. Previous embodiment research has also manipulated the movement of the upper and lower limbs. Specifically, we identified studies of arm movement, hand movement, and combinations in the form of more complex gesturing as well as one study involving leg movement. For example, arm flexion and arm extension were found to impact attitudes (Cacioppo, Priester, & Berntson, 1993). More specifically, the authors found that participants rate objects more positively during arm flexion and more negatively during arm extension. Further investigations by Neumann and Strack (2000) detected faster categorization of positive words than negative words while flexing the arm and a faster categorization of negative words than positive words while extending the arm. Furthermore, lifting a heavy weight with one's arms increases the perceived importance of an issue (Jostmann, Lakens, & Schubert, 2009) and performing immoral acts with one's hands leads to a desire to sanitize them (Lee & Schwarz, 2010a).

Other research in this area has investigated the role of gesturing and its impact on cognitive processing in humans. Goldin-Meadow, Cook, and Mitchell (2009) confirmed the findings of Broaders et al. (2007) that gesturing is involved in processing old ideas and in developing novel problem-solving strategies. Moreover, Hung and Labroo (2011) conducted a study on lower limbs, namely on calf muscles, and showed that muscle firming augments willpower and enables self-control.

Movement of whole body. The third category of manipulating body movement involves the whole body, mainly the physical posture of participants. In various experiments, researchers found that manipulation of body posture has a significant residual effect on performance on a subsequent task (Riskind & Gotay, 1982; Stepper & Strack, 1993), that posture can activate a sense of power and produces behavioral changes (Carney, Cuddy, & Yap, 2010), and that a powerful posture has a stronger effect than role power on behavior and thought (Huang et al., 2011).

Sensory Perception

Studies on embodiment that manipulated participants' sensory perception (i.e., defined for our purposes as the registration of sensory information by one of the five senses: vision, hearing, taste, smell, and touch) were prevalent to a much lesser extent than those studies manipulating body movement. Again, we note that our literature search focused on studies that explicitly listed keywords such as "embodied" or "embodiment." There is a large literature on sensory phenomena that manipulates sensory input but does not make any claims about embodied cognition or embodied emotion. Among the sensory studies that did investigate embodiment, Niedenthal, Winkielman, Mondillon, and Vermeulen (2009) showed across four experiments that responses (e.g., facial muscular responses) are embodied when processing emotions (e.g., emotional words) and do not reflect automatic responses to emotional stimuli. Further, Zhong and Leonardelli (2008) found that induced social exclusion literally feels cold, which lead participants to desire warm foods and drinks. In sum, it appears that few studies to date have explicitly related sensory perception to embodied cognition or embodied emotion. Thus, future research may further manipulate sensory perceptions to shed more light on this matter and investigate the bodily grounding of sensory perception and its relation to cognition and affect.

Discussion

The present literature review reveals that the early studies on embodiment focused on the impact of body movement on some form of

cognitive processing such as evaluation or problem-solving. Prior to 1982, most studies did not consider emotional processing as a relevant factor in embodiment. Possible explanations may be that (a) the early studies approached embodiment from the viewpoint of the cognitive tradition and (b) the majority of studies operationalized embodiment as body movement, which may have a less obvious link to emotional processing than later studies that operationalized embodiment as sensory perception.

Taken together, most of the reviewed studies have not sought an underlying psychological process that connects embodiment (i.e., body movement) on the input side to its effect on cognitive processing on the output side. As a matter of fact, the present review identified only two articles that considered both cognition and affect in their studies (i.e., Joy & Sherry, 2003; Risen & Critcher, 2011). As a result, we propose a conceptual framework—somatic marker theory—that bridges the role of cognition and affect in embodiment and offers a theoretical explanation for the differential effects of distinct body movements on downstream judgment and choice.

Somatic Marker Theory: A Possible Unifying Framework

The observation that damage to one specific brain region—the ventromedial prefrontal cortex—often leads to profound alterations in the ability to make advantageous decisions in personal, social, and financial domains has led Antonio R. Damasio to develop somatic marker theory, also known as the somatic marker hypothesis (Damasio, 1994; Damasio, Everitt, & Bishop, 1996; Damasio, Tranel, & Damasio, 1991). One of its central features is that emotion-related signals (i.e., somatic markers, also sometimes called bodily markers), which are indexed changes in the visceral state such as changes in heart rate, blood pressure, gut motility, and glandular secretion, assist cognitive processes in implementing decisions. Changes in the visceral state may be considered as a form of anticipation of the impact of objects and events in the world on the body. Visceral responses to biologically relevant stimuli (e.g., threats or rewards) allow an organism to maximize the survival value of situations that may impact the state of the internal milieu. These stimuli include events that promote homeostasis, such as an opportunity to feed or engage in social interaction, as well as events that disrupt homeostasis, such as a physical threat or a signal of social rejection. Furthermore, these visceral responses are only one component of a broader emotional response system that also includes changes in the endocrine and skeletomotor systems, as well as changes within the brain that alter the perceptual processing of biologically relevant stimuli (Damasio, 1994; Reimann & Bechara, 2010). This notion can be traced back to William James, who argued that a broad range of bodily states, including visceral changes, facial expressions, and muscle action, can cause the brain to interpret emotions (James, 1884, 1894). We argue that this grounding of somatic markers within the skeletomotor system may explain the effects of body movement on cognition. This argument is supported by another hallmark of somatic marker theory, which claims that somatic markers can be nonconscious and, thus, bias behavior even when a person may not be aware of them (Damasio, 1994).

Body Movement as a Secondary Inducer of Emotional States

Several neuroanatomical structures have been shown to be key components of the neural circuitry underlying somatic state activation. The amygdala as well as the medial orbitofrontal cortex/ventromedial prefrontal cortex region are critical structures for triggering somatic states, but the amygdala seems to be implicated in triggering somatic states from emotional events that occur in the environment (i.e., primary inducers), while the medial orbitofrontal cortex/ventromedial prefrontal cortex region seems to be implicated in triggering somatic states from memories, knowledge, and cognition (i.e., secondary inducers) (Bechara & Damasio, 2005). Reviewing the studies included in the present literature review, we find that most studies manipulate secondary inducers. For example, studies have asked participants to flex or extend their arms which, the authors argued, triggers an approach or avoidance behavior (e.g., Cacioppo, Priester, & Berntson, 1993; Neumann & Strack, 2000). Interpreting this finding from the standpoint of somatic marker theory, it could be argued that flexing or extending one's arm could have induced avoidance or approach behaviors

because these bodily movements triggered emotional memories (i.e., secondary inducer) of situations when one was under tension to avoid something or relaxed and open to approach new experiences. Moreover, the study by Hung and Labroo (2011) suggested that firming muscles leads to an increase in self-control. Again, emotional memories could have been triggered by the request to firm muscles, brought up knowledge of situations when tense discipline was required to control oneself, and therefore led participants to be more self-controlled.

From Body Movement via Emotional States to Valuating Decisions

Decision-making is a complex process that relies on the integrity of at least two sets of brain systems: (a) one set is important for working memory (e.g., the dorsolateral prefrontal cortex) and memory integration (e.g., the medial temporal lobe) in order to bring online knowledge and information used during the deliberation of a decision; and (b) the other set is vital for triggering emotional responses. This second set includes effector structures such as the hypothalamus and autonomic brainstem nuclei that produce changes in the internal milieu and visceral structures along with other effector structures such as the ventral striatum, periacqueductal gray, and other brainstem nuclei, which produce changes in facial expression and specific approach or withdrawal behaviors. It further includes cortical structures that receive afferent input from the viscera and the internal milieu, such as the insular cortex and the posterior cingulate gyrus, retrosplenial cortex, and cuneus region (i.e., medial area of the parietal cortex; Damasio, 1994; Bechara & Damasio, 2005; Reimann & Bechara, 2010).

During the process of valuating decisions, the immediate prospects of an option may be driven by more subcortical mechanisms (e.g., via the amygdala) that do not require the prefrontal cortex. However, weighing future consequences requires the prefrontal cortex for triggering somatic responses (i.e., secondary inducers) about possible future consequences. In particular, when pondering a decision, the immediate and future prospects of an option may trigger numerous positive and negative somatic responses that conflict with each other, followed by an overall positive or negative signal: a "go" or "no-go" signal (Bechara et al., 1997; Damasio, 1994; Bechara & Damasio, 2005; Reimann & Bechara, 2010).

General Discussion

The present literature review shows that body movement is the most frequently applied manipulation in embodiment research, with profound effects on downstream judgment and choice across a wide variety of domains. Yet, prior research is unclear about the underlying psychological and physiological processes that may explain these effects. Long ago, William James argued that visceral changes, facial expressions, and muscle action can cause the brain to interpret emotions (James, 1884, 1894). More recently, Antonio Damasio proposed and Antoine Bechara empirically showed how emotions grounded in bodily perceptions impact judgment and choice (Bechara et al., 1997; Damasio, 1994). As such, somatic marker theory conceptually integrates both affect and cognition in embodiment and provides explanations for bodily effects on downstream judgment and choice found in psychology and consumer research.

While this article has attempted to answer a number of questions, more questions were generated, which in turn provide avenues for future research. A roundtable meeting at the 2011 Association for Consumer Research Annual Conference in St. Louis, Missouri, identified the following issues for further investigation.

Origins of Embodiment

While the above discussion clearly highlights that bodily movements influence cognitive and affective output, it is less clear how these connections are formed to begin with. We need to understand the origin of the relationship, linking embodiment to cognitive and emotional output. Are these relationships learned or are they innate or perhaps both? For example, crying makes us sad because crying is usually a reaction to sad situations and is akin to a hardwired reaction. Similarly, nodding indicates agreement and this translates to the results we have seen in existing research where a simple act of nodding enhances agreement. While nodding almost universally signifies "yes," consider the

effect of this gesture for cultures in which it signifies "no" (e.g., Bulgaria where a single nod signifies "no") or "go on" (e.g., Japan). Will embodiment of this gesture unintentionally lower agreement for these populations? It seems reasonable to suggest that this will be the case. If yes, then the effect of embodiment is learned as well as innate. Exploration of this and related questions provide a fruitful avenue for future research in this emerging domain.

Nonconsciousness and Embodiment

Research by Labroo and her colleagues illustrates two ways in which this bidirectional mind-body feedback link can serve as a nonconscious resource that guides people's actions and helps them accomplish their goals. First, demonstrating the impact of the body on the mind, Labroo and Nielsen (2010) show that associating a physical or psychological approach sensation to an otherwise aversive outcome can reduce a person's aversion to the outcome. The idea is that consciously committing to approach an outcome in space or time alters a person's self-perception for his actions; thus, bodily actions serve as feedback to the individual that the outcome must be liked: Why else would the individual be trying to physically or psychologically approach the outcome? Next, Hung and Labroo (2011), show that firming muscles helps to recruit the correct type of thoughts that engage willpower, provided an individual wishes to engage in self-control. Again, these findings highlight the body-mind feedback link by showing that when the mind signals that willpower resources might be running low, the body can provide additional willpower resources by serving as a nonconscious cue that helps in the redirecting of thoughts toward actions that facilitate goal accomplishment. Future research should investigate other ways in which the mind-body link can provide resources that help people regulate their actions. Future research should also investigate conditions under which somehow misinterpreting or misattributing the meaning of these bodily signals might reverse these observed findings.

Mental Simulations and Embodiment

One topic that warrants further investigation is mental simulation as a means of affecting judgment and choice through somatic markers. For example, Niedenthal et al. (2009) has argued that actual bodily states as well as simulations of experiences are involved with processing of abstract concepts. To what extent does mental simulation play a role in embodied cognition, and if so, how? One question relates to whether, and under what conditions, mental simulations may be able to replace bodily movements as sufficient secondary inducers in somatic marker theory? To the extent that bodily movements simulate previous experiences and trigger or simulate memories of somatic markers, can mental simulation of these same bodily movements trigger these same memories and thus, equally influence judgments and decisions?

Recent research is focusing on the impact of mental simulation of embodiment on behavioral responses. For example, Elder and Krishna (in press) show that the way a product is visually portrayed can facilitate mental simulation, with significant behavioral outcomes. In several studies these authors show that visual product depictions within advertisements, such as a small manipulation of orienting a product toward a participant's dominant hand facilitate mental simulation that increases motor responses (behavioral intentions). Thus, visual depiction leads to imagined behaviors not necessarily altering perceptions through an affective route. A potential interesting avenue for future research could be to examine how mental simulation, or the reenactment of experiences, can be another way in which cognition can be grounded. How can different types of sensory experiences be simulated through embodied imagery? How do different types of embodied imagery alter the perceptual experience and actual behavior?

Sensory Perception and Embodiment

As noted previously, the bulk of research to date on embodied cognition that explores sensory-motor effects on human cognitive and affective responses has focused on *motor*-driven rather than *sensory*-driven processes. Therefore, there would appear to be considerable opportunity to investigate the impact of visual, auditory, olfactory, haptic, and gustatory effects on cognitive, affective, and behavioral response. A deeper understanding of how our earliest con-

crete sensory experiences are used as foundations for later learning of abstract concepts is needed (Williams, Huang, & Bargh, 2009). Thus, further investigation of how individuals associate their concrete sensory experiences of temperature, light, color, sound, odor, pain, taste, and so forth with higher-level abstract concepts such as social connectedness, morality, safety, power, and so forth, offers considerable opportunity to develop deeper insight into understanding human responses to environmental stimuli. Particularly interesting would be investigations of multimodal sensory effects on behavioral response.

Cognitive Appraisals and Embodiment

Recent research examined the understudied emotion of hope (MacInnis & de Mello, 2005) and proposed two distinct hope constructs: Hot hope, which reflects yearning for an uncertain outcome and cold hope, which reflects the certainty with which a yearned outcome is assessed (Nenkov, MacInnis, Morrin, & Reimann, 2011). Although both types of hope contain the essential appraisal characteristics linked to hope (i.e., outcomes are yearned for/goal-congruent and uncertain/future-focused), they emphasize different appraisal dimensions (desirability vs. uncertainty). Thus, while closely related, it is possible that these two emotions are experienced in a different manner. Hot hope, which anchors on the desirability appraisal dimension, might be associated with immediate and automatic "hot" bodily perceptions of desire and pleasantness, whereas cold hope, which anchors on the certainty appraisal dimension, might be associated with "cold" cognitive appraisals of likelihood.

Metaphors and Embodiment

One of the key questions in embodiment research is how bodily experiences figure into motivational and conceptual systems. Damasio (1994) demonstrates the importance of bodily movement and sensations in motivating and biasing preferences in decision-making. Lakoff's cognitive metaphor theory explains how concrete bodily experiences become the basis for understanding abstract concepts (Lakoff & Johnson, 1999). Lakoff postulates that humans first acquire concrete knowledge about the physical world through direct experience (e.g., up vs. down, close vs. far). At this lower-level, more concrete knowledge then becomes a building block through which we make sense of higher-level, more abstract constructs. For instance, time is often understood in terms of physical spatial relations (e.g., "I look *forward* to seeing you"; Thibodeau & Boroditsky, 2011) and concepts such as morality or dissonance are seen through the lens of physical purity (e.g., Lee & Schwarz, 2010b; Schnall, Haidt, Clore, & Jordan, 2008; Zhong & Liljenquist, 2006). Future research should attempt to integrate linguistic theories of metaphor into embodiment research.

Scaffolding the Body and Mind

A number of models of embodied processing exist. One dimension on which these models are distinguished involves their applicability to Tinbergen's (1963) classic four questions (also see Aristotle's four causes; Killeen, 2001). For instance, somatic marker theory appears to primarily address the question of mechanism (Aristotle's material cause) by delineating connections between neural and somatosensory states. Another, "dual process" approach—scaffolding—addresses two different questions, those involving the phylogeny and ontogeny of embodiment (Ackerman, Huang, & Bargh, in press; Williams, Huang, & Bargh, 2009). Phylogenetic scaffolding refers to the species-level evolutionary adaptation of primitive, preexisting physical processing systems for the processing of more abstract, psychological information. Ontogenetic scaffolding refers to the development of connections between physical and abstract processing systems over the course of an individual's life span. Empirical work supports a scaffolding perspective (e.g., Ackerman, Nocera, & Bargh, 2010; Williams, Huang, & Bargh, 2009), but only by addressing the full range of explanatory questions and causes will embodiment become a fully mature theoretical framework.

Field Advancement and Maturity

There is no doubt that research on the influence of embodied cognition on judgment and choice processes has been fruitful and is expanding at an accelerating rate. In addition, progress to date gives strong evidence of this

being an area that is maturing in both scope and rigor. Unifying theories (e.g., Barsalou, 1999; Damasio, 1994), extensive and multifocal programs of study (e.g., the influence of gesturing), and the synthesis and codification of research as done here are all indicators of maturity. Moreover, early in the field's development, researchers on a project may have drawn on theories from clinical psychology (e.g., Secord & Jourard, 1953), cognitive linguistics (e.g., Lakoff, 1987), cognition (e.g., Barsalou, 1999), and neuropsychology (e.g., Damasio, 1994), and studies were often ecumenical in the methodologies applied and the effects being investigated. More recently, as illustrated by this integrative review, the scope within research programs has narrowed and intensified, and the effects being studied are more complex and nuanced within individual theory domains. Advances in methodological capabilities in consumer research and decision research (e.g., fMRI, cf. Kable, 2011; Reimann, Schilke, Weber, Neuhaus, & Zaichkowsky, 2011) and depth of knowledge within domains (e.g., neural pathways and areas of brain activity), and significant growth in the number of accomplished scholars working in the area have made this narrowing possible, and the knowledge contribution that comes from it is highly desirable.

Such maturing is also beneficial in that it more clearly defines additional opportunities for research into the broader influence of embodied cognition outside the domain of judgment and choice. Somatic marker theory makes allowances for somatic states being engendered by activity in the ventromedial prefrontal cortex, which can help explain why some people choose to avoid environments (e.g., enclosed spaces, crowded passageways) on account of "feeling crowded" when in effect they are objectively capable of negotiating the situation. Such flawed choices are likely caused by a person's body schema generating a false sense of body proportions at a somatic level (see Rosa and Malter (2003) for a discussion of such effects in the context of e-commerce). Extreme cases of the ventromedial prefrontal cortex giving rise to somatic states that are simply not possible occur in phantom limb syndrome, in which persons "feel" parts of their bodies that are no longer physically present (e.g., arms, breasts), and experience pain when the absence of the limb is made salient. Likewise, the phenomenon of field independence, where an individual maintains a clear sense of body position in fast changing environments (e.g., a body harness rotating on three axes) is one in which a somatic state is maintained against the influence of intense and fast-changing sensory information (e.g., visual and proprioceptive inputs). Maintaining that state is mentally taxing and not something that all people do equally well, but the fact remains that flow through the ventromedial prefrontal cortex can be bidirectional, and that in some instances the processes involved are highly complex and only partially understood. Phenomena such as phantom limb syndrome, mistaken projections of body size, and field independence point to the richness of influences and consequences that remain to be explored in the quest to understand the role of embodied cognition in human behavior beyond judgment and choice environments. The rate at which the field is maturing suggests that it will not be long before many such questions are addressed.

Future Challenges

In sum, over the past 20 years, the embodied approach has become more widely acknowledged and accepted in basic and applied cognitive and social psychology. A succession of dominant paradigms from behaviorism to information processing led to a disembodied view of cognition, but recent advances in neuroscience have helped to restore the notion that the human mind and body work together as one integrated system. The role of the body in emotion has long been recognized, but now scholars seek to understand the mechanism that links cognition and affect, and their combination to downstream behaviors. Embodied cognition and embodied emotion continue to be investigated as largely separate phenomena, but neuroscience offers new possibilities for integrating studies of cognition and affect.

Consumer research is one domain that shows the increasing acceptance of the embodied framework and offers rich grounds for testing the effects of embodied cognition and embodied emotion on judgment and decision-making. Since the mid-1990s, studies of embodied effects have progressed from an occasional topic at national meetings to a regular presence in the leading journals and conferences in the field.

Challenges remain to apply embodied theories to a broader range of behaviors, and to show that past findings are consistent with new embodied approaches.

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Correction to Reimann et al. (2012)

In the article "Embodiment in Judgment and Choice," by Martin Reimann, Wilko Feye, Alan J. Malter, Joshua M. Ackerman, Raquel Castaño, Nitika Garg, Robert Kreuzbauer, Aparna A. Labroo, Angela Y. Lee, Maureen Morrin, Gergana Y. Nenkov, Jesper H. Nielsen, Maria Perez, Gratiana Pol, José Antonio Rosa, Carolyn Yoon, and Chen-Bo Zhong (*Journal of Neuroscience, Psychology, and Economics*, Advance online publication. doi:10.1037/a0026855), author Josh Ackerman should have been listed as Joshua M. Ackerman. All versions of this article have been corrected.

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