Locating Embodied Effects: An Analytical Approach to the Reproducibility Crisis

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Abstract

Recent research has found that certain embodiment effects cannot be replicated, bringing an unprecedented reproducibility crisis to the field of psychology. Based on an analysis of the "conceptualization," "replacement," and "constitution" themes in embodied cognition, distinguishing four aspects of embodiment effects—their generative levels, strong/weak conditions, constructive direction, and task characteristics—enables more accurate "location" of these effects in experiments. Future research may be advanced through the separation and integration of embodiment effect levels, demarcation of strong/weak conditions, investigation of moderating or mediating mechanisms, and innovation of experimental paradigms.

Full Text

Preamble

Where to Find Embodiment Effects: An Analytical Approach to the Replication Crisis

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Abstract

Recent studies have found that certain embodiment effects cannot be replicated, bringing an unprecedented replication crisis to psychology. Based on an analysis of the three themes of embodied cognition– "conceptualization," "replacement," and "constitution" –this article proposes distinguishing four characteristics of embodiment effects: generating level, strength degree, constructing direction, and experimental task. Clarifying these four aspects can help more accurately "locate" embodiment effects in experiments. Future research could advance by

separating and synthesizing embodied generating levels, distinguishing conditions for embodied strength, exploring mediating or moderating mechanisms, and innovating experimental paradigms.

Keywords: embodied cognition; replication; generating level; strength degree; constructing direction; online-offline task
Classification: B841

"The body is in the world as the heart is in the organism···I can certainly think about my apartment, imagine it, or draw a floor plan on paper, but I cannot understand the unity of objects without bodily experience."
–Maurice Merleau-Ponty, *Phenomenology of Perception*

Embodied Cognition posits that human cognitive processing is rooted in the interaction between body and world (Wilson, 2002). Embodiment effects refer to the influence of bodily or environmental variables on human cognitive processing activities. In recent years, embodied cognition has produced many remarkable research findings (Andy, 2008; Bargh, Chen, & Burrows, 1996; Carney, Cuddy, & Yap, 2010; Zhong & Liljenquist, 2006). However, recent studies have found that many embodied cognition findings have failed to replicate, bringing an unprecedented replication crisis to cognitive science, particularly psychology (陈巍, 2014; 胡传鹏等, 2016).

For example, Bargh et al. (1996) found that when the stereotype of elderly people was primed, participants walked more slowly when leaving the laboratory, a phenomenon that was not observed in subsequent replication attempts (Doyen, Klein, Pichon, & Cleeremans, 2012). Similarly, Schnall, Benton, and Harvey (2008) found that priming the concept of cleanliness or engaging in handwashing after experiencing disgust led people to make less severe moral judgments. However, Johnson, Cheung, and Donnellan (2014) conducted a direct replication using the original authors' materials and failed to find a similar effect. Conversely, does irrelevant disgust amplify the severity of moral condemnation? Landy and Goodwin (2015) used meta-analysis to find modest evidence for disgust amplifying moral condemnation (d = 0.11), but this effect completely disappeared when publication bias was taken into account (d = -0.01). The inconsistent presence of embodiment effects has drawn heavy skepticism from the academic community.

Goldinger, Papesh, Barnhart, Hansen, and Hout (2016) argued that the basic principles of embodiment theory are either unacceptably vague (e.g., the theoretical premise that perception is influenced by the body) or offer nothing new (e.g., cognition evolves to maximize preservation, emotions influence cognition, etc.), and therefore have not advanced cognitive science.

So, do embodiment effects truly exist? Both theoretically and factually, there is no doubt that the body participates in human cognitive activities. Theoretically, early analyses distinguishing conscious from unconscious processes placed embodiment effects in the unconscious, serving as a fundamental and default mechanism in human daily cognitive activities. As Nosek, Hawkins, and Frazier

(2011) argued, most human cognition occurs outside conscious perception or control, with some implicit processes influencing social perception, judgment, and action. Factually, embodiment effects have been found in many domains, where changes in physical variables such as up/down, left/right, high/low, heavy/light, hard/soft, strong/weak, large/small, near/far, bright/dark, clean/dirty, sweet/bitter, fragrant/foul, warm/cold may correspond to psychological variables (彭凯平, 喻丰, 2012). However, the many non-replicable phenomena in empirical research have prompted continuous reflection in academia. Wu, Feng, and Chen (2011) noted that when conducting empirical research within the framework of embodiment theory in social cognition, attention should be paid to conditions such as bodily states and the social nature of dependent variables. Meier, Schnall, Schwarz, and Bargh (2012) pointed out that most embodiment research is descriptive rather than explanatory, and that phenomenologically-based methods are needed to identify boundary conditions and mediating variables of embodiment effects, explore measurements of action-related outcomes, and address individual differences. These studies have attempted to conduct more detailed classification and mechanism exploration of embodiment effects, providing references for future research. However, they have not touched upon the fundamental issues of embodied cognition. To further understand and resolve the replication crisis of embodiment effects, it is necessary to trace the origins of embodied philosophy, re-examine experimental embodiment effects, and thus find a suitable way forward.

Returning to embodied philosophy, researchers have distilled three major themes of embodied cognition (Shapiro, 2011; 陈巍, 郭本禹, 2014): (1) **Conceptualization**: The physiological properties of the body constrain or limit the concepts we acquire about organisms. The concepts humans construct about the world are influenced by the perspectives provided by their bodies. In addition, factors such as ethnic language, culture, customs, and environmental color also participate in cognitive processing. (2) **Replacement**: The interaction between the organism's body and environment replaces representational processes as the core of classical cognition. Cognition no longer relies on algorithmic processes based on symbolic representation. Its most important contribution is recognizing the body's crucial role in mental processing, understanding the constraints the body imposes on the mind, or grasping the coupled interactions that spontaneously emerge among brain, body, and world during cognitive activity. (3) **Constitution**: The body or world plays a constitutive role in cognitive processing, not merely a causal one. If the "constitution" thesis of traditional cognitive science holds, then the body should at least be one of the "constitutive" components, meaning the mind extends into the body. Overall, the body and environment are components of mental activity. As constitutive elements of cognitive processing, embodiment variables are organic components of cognitive activity and may influence cognitive processing as moderating or mediating variables, though not necessarily as independent variables.

Based on the "conceptualization" theme of embodied cognition, the process of humans "conceptualizing" the world through the body is inevitably influenced

by macro-level natural and cultural environments, meso-level torso and limbs, and micro-level sensory channels. Therefore, different embodiment effects may manifest at these three levels. However, current replication issues in embodiment effects have not effectively distinguished these levels. Thus, this does not prove that embodiment effects are non-replicable or non-existent. According to the "replacement" theme, the degree of coupling among brain, body, and world determines the strength of embodiment effects. Different degrees of coupling produce different effect strengths. Therefore, "locating" embodiment effects must also consider conditions that influence the coupling strength among brain, body, and world. According to the "constitution" theme, whether the body or world exists as the subject or object of cognition during the construction of cognitive activity objects determines different constructing directions of embodied cognition. This should also be considered in embodiment effect experiments to clearly "locate" the constructing direction of embodiment effects. Additionally, experimental operational tasks themselves differ between offline priming and online manipulation. Wilson (2002) proposed that behavioral observation belongs to online embodiment, while word priming belongs to offline embodiment. Su and Sun (2014) distinguished between online and offline tasks in their meta-analysis of moral embodiment effects, finding that online tasks showed stronger embodiment effects than offline tasks (effect size ratio: 0.234 vs. 0.149, not significant but still showing a clear difference). Therefore, task characteristics are also important factors influencing embodiment effects.

Based on this analysis, embodiment effects are real, but experimental research needs to make more detailed distinctions regarding four aspects: generating level, strength conditions, constructing direction, and task characteristics, thereby accurately "locating" embodiment effects and addressing issues of stability and replicability. This article will analyze embodiment effects from these four perspectives.

1. Generating Levels of Embodiment Effects

Traditional cognitive science has focused research on the core cognitive system—the brain—while neither body nor environment has been formally incorporated into its purview. Embodied cognition achieves its revolution against traditional disembodied cognition precisely in this sense. According to Shapiro' s summary of the three themes of embodied cognition, embodied cognitive processing differs across levels (Shapiro, 2011).

Whether as vehicle or subject, the body undoubtedly participates in the process of human cognition of the world and itself. As the "conceptualization" theme states, bodily participation in cognitive processes can be divided into at least three levels, as shown in Figure 1 [Figure 1: see original paper]: External environment participation in core cognition, including interaction with natural and socio-cultural environments, constitutes the macro level of embodied cognition; torso and limb participation in core cognition, including body posture, motor interaction, and expression systems, constitutes the meso level of embodied cog-

nition; and internal sensory channel participation in core cognition, including the five senses and proprioception, constitutes the micro level of embodied cognition. Cognition, body, and environment merge into one: cognition exists in the brain, the brain exists in the body, and the body exists in the environment (叶浩生, 2010, 2013).

Across these three levels, the stability of embodiment effects may decrease from macro to micro levels. The reason lies in the fact that during the development of embodied cognitive activity, macro-level natural and cultural environments change most slowly, possessing seasonal and regional stability; meso-level torso and limbs change at a moderate speed, showing immediate reactivity to current interaction objects; and micro-level sensory channels change fastest, showing instantaneous reactivity based on neural electrical and chemical transmission. Therefore, the macro level changes slowest and maintains the most stable effects; the meso level changes faster than the environment, resulting in slightly weaker effect stability; and the micro level changes fastest, resulting in the poorest effect stability. Consequently, it is necessary to effectively distinguish the level at which currently discovered embodiment effects occur, in order to understand why many embodiment effects cannot be replicated.

1.1 Natural and Cultural Environment Involvement in Core Cognition

This is the macro level of embodiment. Temporally, seasonal and phenological characteristics of natural environments may shape human cognitive activities. Spatially, external spatial environments such as the size of environmental space, width of visual field, and vertical/horizontal spatial features and occlusion relationships may also influence core cognitive activities. In human environments, participants' group identity, cultural values of their region, and traditional customs may all affect cognitive processing. Existing research, such as the relationship between awe and external spatial environment (Bai et al., 2017) and the correlation between regional temperature and geographical personality (Wei et al., 2017), provides important evidence for environmental influence on core cognition. Synthesizing the spatiotemporal characteristics of body-environment interaction, we can distinguish between body-small environment interaction, such as how family environments shape cognition, and body-large environment interaction, such as how natural environments and cultural backgrounds influence cognitive processing.

In body-small environment interaction, the most representative research involves immersive environments, such as using core disgust to prime moral disgust by having participants complete questionnaires next to foul-smelling trash cans, thereby making moral judgments more severe (Schnall, Haidt, Clore, & Jordan, 2008), or finding that individuals in fresh laboratory air environments show more reciprocity and trust (Liljenquist, Zhong, & Galinsky, 2010). These experiments immerse the body in a particular natural or laboratory environment. In body-large environment interaction, representative research includes correlations between embodied disgust and political attitudes (Inbar, Pizarro, &

Bloom, 2009), religious purity (Ritter & Preston, 2011), and other phenomena not advocated by culture, such as violations of mainstream humanistic values in interpersonal relationships like homosexuality (Inbar, Pizarro, Knobe, & Bloom, 2009; Rozin, Lowery, Imada, & Haidt, 1999). Other research has involved natural environmental factors such as landforms (Bai et al., 2017) and temperature (Wei et al., 2017) and their interaction with the body in shaping subjective cognition.

All human cognitive activities are immersed in certain natural and cultural environments and are thus shaped by their stable and enduring influence. Among the three levels, the macro environment changes slowest. This immersive characteristic and its most slowly sustained influence make embodiment effects at this level most stable. When replication study participants share homogeneous sampling backgrounds with original study participants in terms of natural and cultural environment, embodiment effects at this level should have the highest replicability. Conversely, if participants have different natural and cultural backgrounds, embodiment effects may show great variability. For example, Su and Sun' s (2014) meta-analysis of embodiment effects in morality—a domain highly related to cultural background—found that participant country of origin had a very significant moderating effect on moral embodiment effects ($Q = 79.454$, $df = 41$, $p < 0.001$, see Su & Sun, 2014 for details).

1.2 Torso and Limb Involvement in Core Cognition

This is the meso level of embodiment. At this level, we can further distinguish between torso and limbs, which influence core cognitive processing through direct interaction with the external environment. The torso refers to the entire torso's sensorimotor state, such as sitting, standing, walking postures, and states of body extension or contraction. Limbs refer to parts of the torso, primarily hands and feet that directly interact with the external world. When hands or feet are in states of disability, occupation, or action (e.g., reaching forward or retracting), cognitive activities and psychological processes may be affected.

Changes in overall body posture causing different patterns of cognitive activity represent embodiment phenomena where the whole torso participates in cognitive processing. For example, Carney et al.' s (2010) experiment enhanced individuals' sense of power and adaptability through body posture[1]; Fischer, Fischer, Englich, Aydin, and Frey (2011) found that high-power postures made people more confident in their decision-making effectiveness, systematically biasing them toward information consistent with their decision preferences; Rotella and Richeson (2013) found that different body postures directly affected individuals' guilt about behavioral transgressions and willingness to compensate. Li, Du, and Ye (2016) found bidirectional metaphorical effects between body contraction postures and social status in the context of Chinese ritual culture. These studies all involve how different states of the whole torso affect cognitive processing of humans and the external world during interaction. In research where partial torso or limbs participate in cognitive processing, the most exten-

sive and popular current topic is bodily cleansing behavior, such as Zhong and Liljenquist' s (2006) discovery of the "Macbeth effect," where guilt or immorality prompts thoughts or behaviors of cleansing oneself. Lee and Schwarz (2011) found that individuals experiencing guilt showed preferences for hand-cleaning behaviors, and Schnall, Benton, et al. (2008) found that after physical cleansing, moral judgment standards decreased. Similar findings have emerged in religious studies (Preston & Ritter, 2012; Yan, Ding, & Yan, 2011; 阎书昌, 2011), political attitude research (Helzer & Pizarro, 2011), and even in judgments about luck (Xu, Zwick, & Schwarz, 2012) and economic activities like handling money (Yang et al., 2013). These findings primarily demonstrate metaphorical relationships between limb cleanliness, especially hand cleanliness, and advanced cognitive concepts like moral purity and advanced emotions like moral disgust.

Torso and limb activities often accompany cognitive activities, with different torso and limb activities accompanying different cognitive activities. Therefore, certain torso and limb states may have functional links with certain cognitive activities, manifesting certain embodiment effects. Embodiment effects at this level are concomitant and variable, with embodiment manifestations changing as cognitive activities change. Compared with natural and cultural environments, this concomitant variability is more pronounced and faster, making embodiment effects at this level less stable than those of natural and cultural environments, and replicability consequently decreases.

1.3 Sensory Channel Involvement in Core Cognition

This is the micro level of embodiment. The micro level emphasizes internal sensory channels of the body, participating in core cognitive processing based on neural transmission. In addition to basic senses such as vision, touch, taste, smell, and hearing, proprioception may also influence advanced cognitive processing activities.

Visually, there are metaphorical correlations between moral/immoral and white/black (Sherman & Clore, 2009), bright/dark color patches (牛怡然, 鲁忠义, 2013), bright/dark characteristics of interaction partners' faces (Song, Vonasch, Meier, & Bargh, 2012), and bright/dark degrees of ambient light (Banerjee, Chatterjee, & Sinha, 2012). In touch, there are correlations between physical temperature and social temperature or "moral temperature" (Williams & Bargh, 2008; Kang, Williams, Clark, Gray, & Bargh, 2011; 黄茜羽, 李宏翰, 2013; 栾子烟, 2013), and tactile physical properties like heaviness, roughness/smoothness, and hardness/softness also influence judgments about unrelated people and events (Ackerman, Nocera, & Bargh, 2010).

In taste, consuming sweet foods leads to more prosocial behavior (Meier, Moeller, Riemer-Peltz, & Robinson, 2012), while conversely, gustatory disgust shares similar facial muscle reflexes with disgust toward immoral phenomena (Chapman, Kim, Susskind, & Anderson, 2009), and even taste perception can influence individuals' political attitudes (Eskine, Kacinik, & Prinz, 2011). In smell, fresh

scents can induce reciprocity and charity (Liljenquist et al., 2010), while foul odors can trigger feelings of disrespect and unfairness (Skarlicki, Hoegg, Aquino, & Nadisic, 2013) and feelings of exclusion (Homan et al., 2017). Research has also found a bidirectional metaphorical relationship between fishy smells and social suspicion (Lee & Schwarz, 2012). In hearing, background music reduces information recall, with positive music leading to reduced attention to immoral information and increased product acceptance (Ziv, Hoftman & Geyer, 2012). Seidel and Prinz (2013) found that music significantly influences moral judgment through emotion. Background music also affects consumers' cognitive performance in price discount calculations through executive attention (Kang & Lakshmanan, 2017). In proprioception, research has primarily examined the embodiment of subjective body weight and heaviness. For example, Day and Bobocel (2013) found that the immoral behavior group showed increased subjective weight judgments compared to the control group. He and Ding (2014) explored the mutual mapping relationship between weight and guilt. Han and Ye (2014) synthesized previous research, arguing that the metaphor of importance is built upon bodily experiences of weight. Recent research has found metaphorical associations between abstract moral concept words and weight (刘钊, 丁凤琴, 2016).

Sensory channel participation in cognitive processing is inherently difficult to measure because it occurs inside the body. Among the three levels, embodiment effects at this level are based on neural transmission, characterized by rapid change and adaptability, making them most difficult to capture, fastest to change, and consequently least stable and replicable.

Based on the theoretical background and ecological analysis of embodied cognition, generating levels of embodiment effects differ from macro to micro. However, in human cognitive activities and researchers' experimental studies, these three levels act comprehensively on human cognitive activity, not with only one level participating. The primary significance of dividing embodiment effect levels lies in clearly locating the key level at which embodiment effects are generated, thereby enabling more comprehensive and accurate discovery of new embodiment effects and controlled replication verification in experimental and replication studies.

2. Strength Conditions of Embodiment Effects

From the "replacement"theme of embodied cognition, we know that embodiment effects themselves differ in strength. In the perspective of embodied cognition, the core cognitive system (brain), body, and environment are all indispensable elements of cognitive activity. The stronger the coupled interaction among these three, the stronger the embodiment effect. From the perspectives of core cognition, body, and environment, all can affect the strength of this coupled interaction. In core cognitive activities, differences in the dominant processing system, the arousal degree of the body in cognitive activity, and the consistency between cognitive activity and environmental factors may all lead to different

coupling strengths, resulting in embodiment effects of varying strength. Temporally, embodiment effects may also vary in strength over short-term time courses and may preserve or develop certain embodiment effects that align with evolutionary trends over long-term evolutionary processes. Therefore, dominant processing system, embodiment arousal degree, consistency between cognitive activity and environmental factors, and time are four basic factors affecting embodiment effect strength.

First is the difference in dominant processing systems in cognitive tasks. According to current mainstream dual-process system division, when processing cognitive tasks, individuals' intuitive processing system and rational processing system have different operating processes. The intuitive system reacts quickly, is directly related to emotion, involves more unconscious components, while the rational system reacts relatively slowly, is related to cognitive deliberation, and involves more controlled components. This dual division is similar to Dijksterhuis and Nordgren' s (2006) "Unconscious Thought Theory" about human thinking, which distinguished unconscious and conscious thought modes, and also resembles recent divisions between intuitive and rational processing. In moral cognition, Greene et al., building on previous rational moral and social intuition models, made similar divisions in their proposed dual-process theory of moral judgment (Greene, 2007; Greene, Morelli, Lowenberg, Nystrom, & Cohen, 2008). Ferrin (2017), summarizing psychology and cognitive science, noted that the brain has two "systems" : one (System 1) described as fast, intuitive, sharp, and possibly more primitive, while the other (System 2) is described as slower, more deliberative, and responsible for higher-order cognition. Obviously, when discussing whether embodiment effects exist, these two cognitive systems should be effectively separated for examination. Schnall et al.' s (2008) finding that embodied disgust influences moral judgment supports the theory that moral judgment is driven by intuitive processing rather than cognitive reasoning. This somewhat proves that embodiment effects may exist more in the intuitive system. Recently, Zestcott, Stone, and Landau (2017) examined the influence of intentional attention in weight-importance embodiment effects, preliminarily finding that intentional attention eliminates embodiment effects, also proving that embodiment effects may exist in the intuitive system. However, other embodiment effect studies still require further testing.

Second is the difference in arousal degree of embodiment variables in cognitive tasks. Embodiment arousal degree refers to the extent to which embodiment variables participate in cognitive and behavioral tasks. For example, simple visual search tasks basically rely only on visual channels, requiring no participation from other sensory channels, resulting in low embodiment arousal degree. Taking disgust as an example, disgust itself has diffuse bodily effects, awakening holistic defensive mechanisms that drive the entire body and all sensory channels to escape the disgust source, resulting in high embodiment arousal degree. Besides disgust, pain has similar effects; for instance, Eisenberger, Lieberman, and Williams (2003) found that social exclusion pain shares similar brain mechanisms with physical pain. This embodiment of social pain has very high

embodiment arousal degree. Therefore, embodiment arousal degree may vary with cognitive tasks, making embodiment effects not cross-task consistent, and meta-analytic comparisons of embodiment effects across different cognitive tasks should be distinguished accordingly.

Third is the difference in consistency degree between cognitive activity and environmental factors. Environmental factors can be divided into natural and socio-cultural environmental factors. When a hypothesized embodiment effect is highly consistent with environmental factors, the likelihood of that embodiment effect occurring in that environment is higher; conversely, it is lower or even disappears. For example, in China' s hierarchical culture and differential social structure, traditional rituals include the cultural practice of kowtowing to high-power individuals, so individuals' obedience to social power leads to greater body contraction (黎晓丹等, 2016), but this phenomenon may not exist in egalitarian cultural backgrounds. In previous research, relatively little examination has been made of the consistency between embodiment effects and cultural background environments. Yan (2011) proposed that the cross-cultural consistency of the association between bodily cleanliness and morality remains an issue requiring in-depth discussion, and Yang and Guo (2016) also argued that cross-cultural verification of the stability and consistency of embodiment effects is necessary. The fact that current replication studies cannot replicate original embodiment effects or show smaller effect sizes is not unrelated to differences in the natural and human environments of participant groups. Su and Sun' s (2014) meta-analysis of moral embodiment effects also found significant moderating effects of participant country of origin.

Fourth is the change in embodiment effects over time. Most currently discovered embodiment effects have been found using priming paradigms, and priming effects often weaken over short-term time courses. For example, Zhang and Li (2012) found that holding a heavy bag (vs. a light bag) made participants judge matters as more important, but this relationship was mediated by the accessibility of weight-related concepts. As time passes, this accessibility gradually declines, causing embodiment effects to gradually weaken. This may be a motivation-independent embodiment process, while previous research has also found that in motivation-related processing, goal motivation strengthens over short-term time courses until the goal is achieved (Chartrand, Huber, Shiv, & Tanner, 2008), causing embodiment effects to show time-enhancing phenomena (Mukherjee, Kramer, & Kulow, 2017). In long-term temporal processes—evolutionary relevance—the degree of correlation between embodiment effects and three evolutionarily beneficial aspects: harm avoidance, approaching advantageous conditions, and signaling functions (薛灿灿 & 叶浩生, 2011), may also be important factors affecting embodiment effects. Time differences between replication studies and original studies, along with sociocultural changes and changes in metaphorical content, can also cause embodiment effect magnitude changes or non-replicability. Therefore, it is necessary to incorporate the time characteristics of embodiment effect enhancement or weakening into research design considerations.

Based on differences in coupled interactions among core cognition (brain), body, and environment, embodiment effects also differ in strength. The first three aspects analyze from a spatial cross-sectional perspective: strong embodiment effects may be primarily dominated by the intuitive system, characterized by high body arousal degree and high consistency with environmental factors; relatively speaking, weak embodiment effects are dominated by the rational system, characterized by low body arousal degree and low or inconsistent consistency with environmental factors. The fourth aspect, from a temporal longitudinal perspective, has received less research attention and has not yet reached consensus. The discovery of extremely weak or completely absent embodiment effects is likely due to inadequate manipulation of the first three aspects and failure to properly consider the fourth aspect.

3. Constructing Direction of Embodiment Effects

According to the "conceptualization" and "constitution" themes of embodied cognition, embodiment may exist as the subject or object of cognition in the process of humans constructing themselves and the world. Embodiment essentially manifests as a moderating effect, regulating the relationship between abstract and concrete concepts, as well as the relationship between intention and behavior. Regarding the constructing direction of embodiment effects, Su and Sun (2014) mainly discussed unidirectional or bidirectional metaphorical relationships between abstract and concrete concepts. In fact, the distinction of constructing direction in embodiment effects exists not only between abstract and concrete concepts but also across three aspects: cognition, emotion, and behavior. In cognition, the distinction mainly manifests as metaphorical construction relationships between abstract and concrete concepts (Gilead, Gal, Polak, & Cholow, 2015; IJzerman & Koole, 2011; Landau, Meier, & Keefer, 2010; Schaefer, Denke, Heinze, & Rotte, 2014; 杨继平, 郭秀梅, 王兴超, 2017; 殷融, 苏得权, 叶浩生, 2013). In emotion, it mainly discusses unidirectional or bidirectional construction relationships between embodied emotion variables and advanced emotion variables (Montoro, Jose Contreras, Rosa Elosua, & Marmolejo-Ramos, 2015; Niedenthal, 2007; Oosterwijk, Rotteveel, Fischer, & Hess, 2009; Price & Harmon-Jones, 2015; Sheikh, Botindari, & White, 2013; Wiswede, Muente, Kraemer, & Ruesseler, 2009). In behavior, it mainly discusses unidirectional or bidirectional construction relationships between embodied behavior variables and internal psychological variables (Schaefer, Rotte, Heinze, & Denke, 2015; Valdesolo, Ouyang, & DeSteno, 2010; 黎晓丹等, 2016; 阎书昌, 2011; 翟贤亮, 葛鲁嘉, 2017).

These phenomena and psychological mechanisms can be interpreted through conceptual metaphor theory, perceptual symbol theory, embodied emotion theory, and simulated sensorimotor metaphor theory (see 方溦, 葛列众, 甘甜, 2016 for details). From the perspective of embodiment variables, as important factors participating in cognitive processing, embodiment variables may have unidirectional or bidirectional constructiveness with cognitive variables, emotion

variables, and behavior variables. In previous research, some studies have still not distinguished the directionality of embodiment effects, which may be an important factor in why certain effects cannot be replicated.

At the cognitive level, embodiment effect research is already very rich, mainly manifested in conceptual metaphor research (Gilead et al., 2015; IJzerman & Koole, 2011; Landau et al., 2010; Schaefer, Denke, Heinze, & Rotte, 2014; 杨继平等, 2017). Yin et al. reviewed relevant research on conceptual metaphor (殷融, 曲方炳, 叶浩生, 2012; 殷融等, 2013), finding that these studies mainly involved spatial metaphor, temperature metaphor, cleanliness metaphor, and tactile metaphor, and pointed out that future research should explore factors shaping unidirectional and interactive metaphorical mapping. Recently, Yang et al. (2017) examined moral concept metaphorical representation from three dimensions: red-white color, left-right position, and upright-slanted font, finding that left-right position and upright-slanted font have certain metaphorical connections with moral concepts. These provide references for the metaphorical directionality of embodied cognition.

At the emotion level, current research mostly focuses on the influence of embodied emotion variables on advanced emotion variables. For example, in moral disgust research, core disgust is often used to arouse embodied disgust, and then the influence of this disgust on subsequent social judgments is observed (Giner-Sorolla & Chapman, 2017; Horberg, Oveis, Keltner, & Cohen, 2009; Schnall, 2017; Schnall, Haidt, et al., 2008). Discussion of reverse relationships is relatively rare, represented by Eskine, Kacinik, & Webster (2012), who found that reading about harmful behavior, moral or neutral events correspondingly primed participants' disgust, liking, or neutral tasting experiences. Banerjee et al. (2012) found that the immoral behavior priming group judged their environment as darker than the moral behavior priming group and preferred light-related items when choosing experimental gifts. Skarlicki et al. (2013) found that disgust emotion in turn influenced individuals' olfactory responses. Embodied emotion has extensive theoretical hypotheses and research evidence (刘亚, 王振宏, 孔凤, 2011), but exploration of embodiment directionality needs to continue.

At the behavior level, the constructing direction between embodied behavior variables and internal psychological variables can be distinguished as executive embodiment and shaping embodiment. Executive embodiment refers to embodied behavior variables being executive expressions of certain internal psychological variables. For example, Li et al. (2016) found that when participants called someone with higher social status (e.g., a principal) versus a same-status classmate, their body contraction degree was higher—this is an executive expression of the embodiment variable (body contraction degree) on the internal psychological variable (social power status obedience). Shaping embodiment refers to embodied behavior variables shaping or causing changes in internal psychological variables. For example, Valdesolo et al. (2010) found that synchronous swaying enhanced individuals' perceptual sensitivity to others' actions, thereby improving their success rate in subsequent joint action tasks, which required

dynamically discovering and appropriately responding to partners' actions—this is a shaping effect of the embodiment variable (synchronous swaying) on the internal psychological variable (others' action perception ability). Schaefer et al.' s (2015) channel-specific research on shaping embodiment found that after lying in a voicemail, participants' need for mouthwash products increased, while after writing a lie, their need for handwashing products increased, but whether executive embodiment has similar effects is currently unclear.

In embodiment effect replication research, on the one hand, it is necessary to note the constructing direction of embodiment effects in original studies and effectively control for direction in experimental operations, especially strictly controlling constructing directions at different levels of cognition, emotion, and behavior. Otherwise, 笼统地对具身效应进行元分析或者缺乏严格控制的重复实验, 并不能证明具身效应不可重复甚至不存在. On the other hand, for embodiment effect research as a whole, embodiment variables act as "elements" rather than simple "factors" in cognitive activity, and their more important significance lies in moderating or mediating relationships among traditional psychological variables. Across different constructing directions, there may be covariates of cognitive, emotional, and behavioral variables that have not been examined, and embodiment variables work by moderating or mediating relationships among these variables.

4. Task Characteristics of Embodiment Effects

Experiments designed with embodiment variables as independent variables most commonly use priming paradigms, STROOP paradigms, IAT paradigms, and situational manipulation paradigms (陈潇, 江琦, 侯敏, 朱梦音, 2014). Tasks in these paradigms typically have two types: offline tasks and online tasks. Offline embodiment tasks are often sequential, represented by priming paradigms that typically prime a psychological variable and then observe whether it affects embodiment performance, such as Bargh' s "elderly experiment" and "hot coffee" experiment (Bargh et al., 1996; Williams & Bargh, 2008). Effects of such offline tasks may be influenced by priming effectiveness itself and time decay issues. Additionally, embodiment variables affected by offline embodiment typically have no direct relationship with experimental tasks, representing an exploration of unconscious influence, which also 埋下隐患 for replication failure. Online embodiment tasks are often concomitant, represented by on-site situational manipulation paradigms where embodiment and participants' experimental tasks are integrated, with embodiment variables accompanying the experimental task process. In online embodiment, embodiment variables usually have some relationship with the variables under investigation. For example, when commenting on Chapman et al.' s (2009) work, Rozin, Haidt, and Fincher (2009) noted that bitterness directly triggers rejection and disgust, causing social emotions like unfairness—this is a typical representative of online embodiment.

In social cognitive neuroscience, the second-person method reflects the real-time interactive characteristics of online embodiment (Schilbach et al., 2013). Moore and Barresi (2017) noted that social understanding development in-

volves the integrated functioning of five types of second-person information: self-directedness, contingency, reciprocity, affective engagement, and shared intentions. This second-person paradigm has stronger real-time social interaction characteristics than third-person observation and speculation, allowing participants to be more immersed in experimental tasks and more likely to exhibit embodiment effects. A recent study using second-person methods to examine social contingency sensitivity in adults with high-functioning autism also found this method has good embodied interactive characteristics that help restore social function (Zapatafonseca, Froese, Schilbach, Vogeley, & Timmermans, 2018).

In embodiment effect research, online tasks have more important embodiment significance than offline tasks. Embodiment effects of online tasks are greater than those of offline tasks (Su & Sun, 2014). From the perspective of embodied cognition's revolution against the disembodied nature of traditional cognitive science, embodied cognition truly restores human cognitive activity to its occurring environment and vehicle (the body), making cognitive activity ecological. This ecological nature lies in the synchronous online nature of embodiment variables and core cognitive activity. Offline tasks actually use imaginative reproduction to achieve imagination-based embodiment-cognitive synchrony, which itself may cause embodiment effects to attenuate or even disappear.

Related to the distinction between offline and online embodiment tasks, the variable properties of embodiment variables in experimental tasks are also important. Theoretically, embodiment variables can appear in experimental research as independent variables, mediating variables, moderating variables, and dependent variables. From the theoretical origins of embodied cognition, the body carries and influences cognitive processing, so the most important role of embodiment variables should be moderating variables that regulate the relationship between humans' internal cognitive activities and external practical activities. For experimental logic, researchers often use embodiment variables as independent variables to observe their influence on dependent variables to prove their direct effects. This operationalization is logically sound experimentally but inconsistent with the constitution hypothesis of embodiment. The body or world plays a constitutive role in cognitive processing, not a simple causal role. Therefore, embodiment experimental operationalization tasks, especially in online experimental tasks, should more often operationalize embodiment variables as concomitant moderating variables, which is also an important factor affecting embodiment effects.

Distinguishing between offline and online experimental tasks and the properties of embodiment variables is crucial for clarifying embodiment effects and their replicability. Because in human daily cognitive activities, the significance of embodiment influence lies precisely in the synchronous online nature of embodiment variables and cognitive variables, thereby affecting human cognitive activity. For offline tasks, researchers actually use imaginative reproduction to achieve imagination-based embodiment-cognitive synchrony, which itself may reduce the influence of embodiment variables, further leading to statistical non-

significance. Embodiment variables appearing as moderating variables in experimental research designs require further verification.

Future Directions

Embodiment effects are difficult to replicate and appear inconsistent, partly because the academic community has not returned to the origins of embodied philosophy to make fine distinctions among embodiment effects. Based on the "conceptualization," "replacement," and "constitution" themes of embodied cognition and recent embodiment effect research, embodiment effects should be subdivided into four aspects: generating level, strength conditions, constructing direction, and task characteristics, thereby promoting research on the role and function of embodiment variables in human cognitive processing activities. Based on these distinctions, future research can proceed in four ways:

First, separation and synthesis of embodiment effect levels. In real life, the three levels of embodied environment, body, and senses are often interdependent and coexistent, and cannot be strictly separated. However, to clarify differences in embodiment effects across these three levels, it is necessary in strictly controlled laboratory experiments to focus on the separation and synthesis of these three levels, thereby more deeply and carefully identifying the key level at which embodiment effects occur and individual differences.

Second, distinguishing strength conditions of embodiment effects. Among currently discovered embodiment effects, dominant processing systems have not been distinguished, body arousal degrees vary, and consistency with background environments differs. These are all reasons that may cause strength differences from a cross-sectional perspective and need further distinction in future experimental research. From a temporal longitudinal perspective, existing research has found that embodiment effects have time-enhancing characteristics due to motivational processing over time and time-attenuating characteristics due to non-motivational processing (Mukherjee et al., 2017; Natanzon & Ferguson, 2012), which also requires further clarification of temporal strength patterns of embodiment effects.

Third, exploring moderating or mediating mechanisms of embodiment effects. Embodiment effects have directional differences between subject and object, internal construction and external execution in cognition, emotion, and behavior. Embodiment variables often play moderating or mediating roles between traditional disembodied cognitive variables and external behavioral variables. As Schnall (2017) proposed when reviewing research on bodily disgust and moral judgment, experimentally primed disgust and cleanliness influence moral judgment, but moderating variables and attribution processes need to be considered. Therefore, future research needs to explore moderating or mediating mechanisms of embodiment effects to clarify the "constitutive" role of embodiment variables.

Fourth, innovating embodiment experimental paradigms. Current embodied

cognition experimental paradigms mostly adapt or modify traditional basic cognition (especially perception) and social cognition (especially situational cognition) research paradigms. These paradigms mostly involve offline embodiment tasks, with few online embodiment tasks. The second-person technique used in social cognitive neuroscience can serve as a reference method for embodiment research; experiments should be designed based on real-time interaction that immerses participants. Currently, there are no specific paradigms for embodiment experiments based on online tasks. Therefore, future experimental research should further expand embodiment experimental paradigms, especially integrating new technologies and methods such as mobile internet technology, virtual reality technology, artificial intelligence wearable devices, and 3D motion capture technology to find unique experimental paradigms suitable for embodied cognition.

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References

陈巍. (2014). 可重复性: 盘旋在具身认知实验室上方的”幽灵”. 心理技术与应用, (1), 23–25.

陈巍, 郭本禹. (2014). 具身-生成的认知科学: 走出”战国时代”. 心理学探新, 34(2), 111–116.

陈潇, 江琦, 侯敏, 朱梦音. (2014). 具身道德: 道德心理学研究的新取向. 心理发展与教育, 30(6), 方溦, 葛列众, 甘甜. (2016). 道德具身认知的理论研究. 心理与行为研究, 14(6), 765–772.

韩冬, 叶浩生. (2014). 重中之”重”——具身视角下重的体验与表征. 心理科学进展, 22(6), 918–925.

何华容, 丁道群. (2014). 良心的重量: 基于具身视角的内疚情绪与重量感关系的实验研究. 第十七届全国心理学学术会议, 中国北京.

黄茜羽, 李宏翰. (2013). 冷暖体验对道德判断的影响. 心理学与创新能力提升——第十六届全国心理学学术会议, 中国南京.

胡传鹏, 王非, 过继成思, 宋梦迪, 隋洁, 彭凯平. (2016). 心理学研究中的可重复性问题: 从危机到契机. 心理科学进展, 24(9), 1504–1518.

黎晓丹, 杜建政, 叶浩生. (2016). 中国礼文化的具身隐喻效应: 蜷缩的身体使人更卑微. 心理学报, 48(6), 746–756.

刘亚, 王振宏, 孔凤. (2011). 情绪具身观: 情绪研究的新视角. 心理科学进展, 19(1), 50–59.

刘钊, 丁凤琴. (2016). 大学生道德概念的重量与洁净隐喻. 中国健康心理学杂志, 24(4), 533-536.

栾子烟. (2013). 道德温度: 身体冷暖与青少年道德决策 (硕士学位论文). 上海: 华东师范大学.

牛怡然, 鲁忠义. (2013). 道德概念的亮度隐喻表征及其对亮度知觉判断的影响. 心理学与创新能力提升——第十六届全国心理学学术会议, 中国南京.

彭凯平, 喻丰. (2012). 道德的心理物理学: 现象、机制与意义. 中国社会科学, (12), 28-45.

苏彦捷, 孙芳芳. (2014). 道德具身性的元分析研究. 华东师范大学学报 (教育科学版), 32(2), 88-96.

伍秋萍, 冯聪, 陈斌斌. (2011). 具身框架下的社会认知研究述评. 心理科学进展, 19(3), 336-345.

薛灿灿, 叶浩生. (2011). 具身社会认知: 认知心理学的生态学转向. 心理科学, 34(5), 1230-1235.

阎书昌. (2011). 身体洁净与道德. 心理科学进展, 19(8), 1242-1248.

杨继平, 郭秀梅. (2016). 具身视角下道德概念的隐喻研究. 心理学探新, 36(5), 387-391.

杨继平, 郭秀梅, 王兴超. (2017). 道德概念的隐喻表征——从红白颜色、左右位置和正斜字体的维度. 心理学报, 49(7), 875-885.

叶浩生. (2010). 具身认知: 认知心理学的新取向. 心理科学进展, 18(5), 705-710.

叶浩生. (2013). 认知与身体: 理论心理学的视角. 心理学报, 45(4), 481-488.

殷融, 曲方炳, 叶浩生. (2012). 具身概念表征的研究及理论述评. 心理科学进展, 20(9), 1372-1381.

殷融, 苏得权, 叶浩生. (2013). 具身认知视角下的概念隐喻理论. 心理科学进展, 21(2), 220-234.

翟贤亮, 葛鲁嘉. (2017). 从离身到具身: 具身管理学的可能. 心理科学, 40(1), 238-243.

Ackerman, J. M., Nocera, C. C., & Bargh, J. A. (2010). Incidental haptic sensations influence social judgments and decisions. *Science*, 328(5986), 1712-1715.

Andy, C. (2008). *Supersizing the mind: Embodiment, action, and cognitive extension*. New York: Oxford University Press.

Bai, Y., Maruskin, L. A., Chen, S., Gordon, A. M., Stellar, J. E., McNeil, G. D., ···Keltner, D. (2017). Awe, the diminished self, and collective engagement: Universals and cultural variations in the small self. *Journal of Personality and Social Psychology*, 113(2), 185-209.

Banerjee, P., Chatterjee, P., & Sinha, J. (2012). Is it light or dark? Recalling moral behavior changes perception of brightness. *Psychological Science*, 23(4), 407-409.

Bargh, J. A., Chen, M., & Burrows, L. (1996). Automaticity of social behavior: Direct effects of trait construct and stereotype-activation on action. *Journal of Personality and Social Psychology*, 71(2), 230–244.

Carney, D. R., Cuddy, A. J., & Yap, A. J. (2010). Power posing: brief nonverbal displays affect neuroendocrine levels and risk tolerance. *Psychological Science*, 21(10), 1363–1368.

Chapman, H. A., Kim, D. A., Susskind, J. M., & Anderson, A. K. (2009). In bad taste: evidence for the oral origins of moral disgust. *Science*, 323(5918), 1222–1226.

Chartrand, T. L., Huber, J., Shiv, B., & Tanner, R. J. (2008). Nonconscious goals and consumer choice. *Journal of Consumer Research*, 35(2), 189–201.

Day, M. V., & Bobocel, D. R. (2013). The weight of a guilty conscience: subjective body weight as an embodiment of guilt. *PLoS One*, 8(7), e69546.

Dijksterhuis, Ap, & Nordgren, Loran F. (2006). A theory of unconscious thought. *Perspectives on Psychological Science*, 1(2), 95–109.

Doyen, S., Klein, O., Pichon, C. L., & Cleeremans, A. (2012). Behavioral priming: It' s all in the mind, but whose mind? *Plos One*, 7(1), e29081.

Eisenberger, N. I., Lieberman, M. D., & Williams, K. D. (2003). Does rejection hurt? An fMRI study of social exclusion. *Science*, 302(5643), 290–292.

Eskine, K. J., Kacinik, N. A., & Prinz, J. J. (2011). A bad taste in the mouth: gustatory disgust influences moral judgment. *Psychological Science*, 22(3), 295–299.

Eskine, K. J., Kacinik, N. A., & Webster, G. D. (2012). The bitter truth about morality: virtue, not vice, makes a bland beverage taste nice. *PLoS One*, 7(7), e41159.

Ferrin, A. (2017). Good moral judgment and decision-making without deliberation. *Southern Journal of Philosophy*, 55(1), 68–95.

Fischer, J., Fischer, P., Englich, B., Aydin, N., & Frey, D. (2011). Empower my decisions: The effects of power gestures on confirmatory information processing. *Journal of Experimental Social Psychology*, 47(6), 1146–1154.

Garrison, K. E., Tang, D., & Schmeichel, B. J. (2016). Embodying power: A preregistered replication and extension of the power pose effect. *Social Psychological and Personality Science*, 7(7), 623–630.

Gilead, M., Gal, O., Polak, M., & Cholow, Y. (2015). The role of nature and nurture in conceptual metaphors: the case of gustatory priming. *Social Psychology*, 46(3), 167–173.

Giner-Sorolla, R., & Chapman, H. A. (2017). Beyond Purity. *Psychological Science*, 28(1), 80–91.

Goldinger, S. D., Papesh, M. H., Barnhart, A. S., Hansen, W. A., & Hout, M. C. (2016). The poverty of embodied cognition. *Psychonomic Bulletin & Review*, 23(4), 959–978.

Greene, J. D. (2007). Why are VMPFC patients more utilitarian? A dual-process theory of moral judgment explains. *Trends in Cognitive Sciences*, 11(8), 322–323.

Greene, J. D., Morelli, S. A., Lowenberg, K., Nystrom, L. E., & Cohen, J. D. (2008). Cognitive load selectively interferes with utilitarian moral judgment. *Cognition*, 107(3), 1144–1154.

Gronau, Q. F., Van Erp, S., Heck, D. W., Cesario, J., Jonas, K. J., & Wagenmakers, E.-J. (2017). A Bayesian model-averaged meta-analysis of the power pose effect with informed and default priors: The case of felt power. *Comprehensive Results in Social Psychology*, 2(1), 123–138.

Helzer, E. G., & Pizarro, D. A. (2011). Dirty liberals! reminders of physical cleanliness influence moral and political attitudes. *Psychological Science*, 22(4), 517–522.

Homan, P., Ely, B. A., Yuan, M., Brosch, T., Ng, J., Trope, Y., & Schiller, D. (2017). Aversive smell associations shape social judgment. *Neurobiology of Learning and Memory*, 144, 86–95.

Horberg, E. J., Oveis, C., Keltner, D., & Cohen, A. B. (2009). Disgust and the moralization of purity. *Journal of Personality and Social Psychology*, 97(6), 963–976.

IJzerman, H., & Koole, S. L. (2011). From perceptual rags to metaphoric riches —bodily, social, and cultural constraints on sociocognitive metaphors: Comment on Landau, Meier, and Keefer (2010). *Psychological Bulletin*, 137(2), 355–361.

Inbar, Y., Pizarro, D. A., & Bloom, P. (2009). Conservatives are more easily disgusted than liberals. *Cognition & Emotion*, 23(4), 714–725.

Inbar, Y., Pizarro, D. A., Knobe, J., & Bloom, P. (2009). Disgust sensitivity predicts intuitive disapproval of gays. *Emotion*, 9(3), 435–439.

Johnson, D. J., Cheung, F., & Donnellan, M. B. (2014). Does cleanliness influence moral judgments? A direct replication of Schnall, Benton, and Harvey (2008). *Social Psychology*, 45(3), 209–215.

Kang, E., & Lakshmanan, A. (2017). Role of executive attention in consumer learning with background music. *Journal of Consumer Psychology*, 27(1), 35–48.

Kang, Y., Williams, L. E., Clark, M. S., Gray, J. R., & Bargh, J. A. (2011). Physical temperature effects on trust behavior: the role of insula. *Social Cognitive and Affective Neuroscience*, 6(4), 507–515.

Landau, M. J., Meier, B. P., & Keefer, L. A. (2010). A metaphor-enriched social cognition. *Psychological Bulletin*, 136(6), 1045–1067.

Landy, J. F., & Goodwin, G. P. (2015). Does incidental disgust amplify moral judgment? a meta-analytic review of experimental evidence. *Perspectives on Psychological Science*, 10(4), 518–536.

Lee, S. W. S., & Schwarz, N. (2011). Wiping the slate clean: Psychological consequences of physical cleansing. *Current Directions in Psychological Science*, 20(5), 307–311.

Lee, S. W. S., & Schwarz, N. (2012). Bidirectionality, mediation, and moderation of metaphorical effects: the embodiment of social suspicion and fishy smells. *Journal of Personality and Social Psychology*, 103(5), 737–749.

Liljenquist, K., Zhong, C. B., & Galinsky, A. D. (2010). The smell of virtue: clean scents promote reciprocity and charity. *Psychological Science*, 21(3), 381–383.

Meier, B. P., Moeller, S. K., Riemer-Peltz, M., & Robinson, M. D. (2012). Sweet taste preferences and experiences predict prosocial inferences, personalities, and behaviors. *Journal of Personality and Social Psychology*, 102(1), 163–174.

Meier, B. P., Simone, S., Norbert, S., & Bargh, J. A. (2012). Embodiment in social psychology. *Topics in Cognitive Science*, 4(4), 705–716.

Montoro, P. R., Contreras, M. J., Elosúa, M. R., & Marmolejoramos, F. (2015). Cross-modal metaphorical mapping of spoken emotion words onto vertical space. *Frontiers in Psychology*, 6, 1205.

Moore, C., & Barresi, J. (2017). The role of second-person information in the development of social understanding. *Frontiers in Psychology*, 8, 1667.

Mukherjee, S., Kramer, T., & Kulow, K. (2017). The effect of spicy gustatory sensations on variety-seeking. *Psychology & Marketing*, 34(8), 786–794.

Natanzon, M., & Ferguson, M. J. (2012). Goal pursuit is grounded: The link between forward movement and achievement. *Journal of Experimental Social Psychology*, 48(1), 379–382.

Niedenthal, P. M. (2007). Embodying emotion. *Science*, 316(5827), 1002–1005.

Nosek, B. A., Hawkins, C. B., & Frazier, R. S. (2011). Implicit social cognition: from measures to mechanisms. *Trends in Cognitive Sciences*, 15(4), 152–159.

Oosterwijk, S., Rotteveel, M., Fischer, A. H., & Hess, U. (2009). Embodied emotion concepts: How generating words about pride and disappointment influences posture. *European Journal of Social Psychology*, 39(3), 457–466.

Preston, J. L., & Ritter, R. S. (2012). Cleanliness and godliness: Mutual association between two kinds of personal purity. *Journal of Experimental Social Psychology*, 48(6), 1365–1368.

Price, T. F., & Harmon-Jones, E. (2015). Embodied emotion: the influence of manipulated facial and bodily states on emotive responses. *Wiley Interdisciplinary Reviews-Cognitive Science*, 6(6), 461–473.

Ranehill, E., Dreber, A., Johannesson, M., Leiberg, S., Sul, S., & Weber, R. A. (2015). Assessing the robustness of power posing: No effect on hormones and risk tolerance in a large sample of men and women. *Psychological Science*, 26(5), 653–656.

Ritter, R. S., & Preston, J. L. (2011). Gross gods and icky atheism: Disgust responses to rejected religious beliefs. *Journal of Experimental Social Psychology*, 47(6), 1225–1230.

Rotella, K. N., & Richeson, J. A. (2013). Body of guilt: Using embodied cognition to mitigate backlash to reminders of personal & ingroup wrongdoing. *Journal of Experimental Social Psychology*, 49(4), 649–654.

Rozin, P., Haidt, J., & Fincher, K. (2009). Psychology. From oral to moral. *Science*, 323(5918), 1179–1180.

Rozin, P., Lowery, L., Imada, S., & Haidt, J. (1999). The CAD triad hypothesis: A mapping between three moral emotions (contempt, anger, disgust) and three moral codes (community, autonomy, divinity). *Journal of Personality and Social Psychology*, 76(4), 574–586.

Schaefer, M., Denke, C., Heinze, H. J., & Rotte, M. (2014). Rough primes and rough conversations: evidence for a modality-specific basis to mental metaphors. *Social Cognitive and Affective Neuroscience*, 9(11), 1653–1659.

Schaefer, M., Rotte, M., Heinze, H. J., & Denke, C. (2015). Dirty deeds and dirty bodies: embodiment of the macbeth effect is mapped topographically onto the somatosensory cortex. *Scientific Reports*, 5, 18093.

Schilbach, L., Timmermans, B., Reddy, V., Costall, A., Bente, G., Schlicht, T., & Vogeley, K. (2013). Toward a second-person neuroscience. *Behavioral and Brain Sciences*, 36(4), 393–462.

Schnall, S. (2017). Disgust as embodied loss aversion. *European Review of Social Psychology*, 28(1), 50–94.

Schnall, S., Benton, J., & Harvey, S. (2008). With a clean conscience: cleanliness reduces the severity of moral judgments. *Psychological Science*, 19(12), 1219–1222.

Schnall, S., Haidt, J., Clore, G. L., & Jordan, A. H. (2008). Disgust as embodied moral judgment. *Personality & Social Psychology Bulletin*, 34(8), 1096–1109.

Seidel, A., & Prinz, J. (2013). Sound morality: irritating and icky noises amplify judgments in divergent moral domains. *Cognition*, 127(1), 1–5.

Shapiro, L. (2011). *Embodied Cognition*. London and New York: Rutledge.

Sheikh, S., Botindari, L., & White, E. (2013). Embodied metaphors and emotions in the moralization of restrained eating practices. *Journal of Experimental Social Psychology*, 49(3), 509–513.

Sherman, G. D., & Clore, G. L. (2009). The color of sin: white and black are perceptual symbols of moral purity and pollution. *Psychological Science*, 20(8), 1019–1025.

Skarlicki, D. P., Hoegg, J., Aquino, K., & Nadisic, T. (2013). Does injustice affect your sense of taste and smell? The mediating role of moral disgust. *Journal of Experimental Social Psychology*, 49(5), 852–859.

Song, H. J., Vonasch, A. J., Meier, B. P., & Bargh, J. A. (2012). Brighten up: Smiles facilitate perceptual judgment of facial lightness. *Journal of Experimental Social Psychology*, 48(1), 450–452.

Valdesolo, P., Ouyang, J., & DeSteno, D. (2010). The rhythm of joint action: Synchrony promotes cooperative ability. *Journal of Experimental Social Psychology*, 46(4), 693–695.

Wei, W. Q., Lu, J. G., Galinsky, A. D., Wu, H., Gosling, S. D., Rentfrow, P. J., ···Wang, L. (2017). Regional ambient temperature is associated with human personality. *Nature Human Behaviour*, 1(12), 890–895.

Williams, L. E., & Bargh, J. A. (2008). Experiencing physical warmth promotes interpersonal warmth. *Science*, 322(5901), 606–607.

Wilson, M. (2002). Six views of embodied cognition. *Psychonomic Bulletin & Review*, 9(4), 625–636.

Wiswede, D., Münte, T. F., Krämer, U. M., & Rüsseler, J. (2009). Embodied emotion modulates neural signature of performance monitoring. *Plos One*, 4(6), e5754.

Xu, A. J., Zwick, R., & Schwarz, N. (2012). Washing away your (good or bad) luck: physical cleansing affects risk-taking behavior. *Journal of Experimental Psychology: General*, 141(1), 26–30.

Yan, Z. X., Ding, D. Q., & Yan, L. S. (2011). To wash your body, or purify your soul: Physical cleansing would strengthen the sense of high moral character. *Psychology*, 2(9), 992–997.

Yang, Q., Wu, X. C., Zhou, X. Y., Mead, N. L., Vohs, K. D., & Baumeister, R. F. (2013). Diverging effects of clean versus dirty money on attitudes, values, and interpersonal behavior. *Journal of Personality and Social Psychology*, 104(3), 473–489.

Zapatafonseca, L., Froese, T., Schilbach, L., Vogeley, K., & Timmermans, B. (2018). Sensitivity to social contingency in adults with high-functioning autism during computer-mediated embodied interaction. *Behavioral Science*, 8, 22.

Zestcott, C. A., Stone, J., & Landau, M. J. (2017). The role of conscious attention in how weight serves as an embodiment of importance. *Personality & Social Psychology Bulletin*, 43(12), 1712–1723.

Zhang, M., & Li, X. P. (2012). From physical weight to psychological significance: The contribution of semantic activations. *Journal of Consumer Research*, 38(6), 1063–1075.

Zhong, C. B., & Liljenquist, K. (2006). Washing away your sins: threatened morality and physical cleansing. *Science*, 313(5792), 1451–1452.

Ziv, N., Hoftman, M., & Geyer, M. (2012). Music and moral judgment: The effect of background music on the evaluation of ads promoting unethical behavior. *Psychology of Music*, 40(6), 738–760.

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[1] Regarding whether this effect exists, controversy has been ongoing. Ranehill et al. (2015) found power pose effects on participants' self-reported sense of power in replication studies, but found no corresponding effects on testosterone, cortisol, or risk behavior. Garrison, Tang, and Schmeichel (2016) conducted a preregistered replication and extension of power posing and found no risk-seeking behavior resulting from power poses, nor even any effect on self-reported sense of power. Gronau et al. (2017) conducted a Bayesian model-averaged meta-analysis of relevant research and found strong evidence for the effect' s existence, but after excluding the influence of participants' familiarity with the effect, found only moderate evidence for the effect.

Note: Figure translations are in progress. See original paper for figures.