Chapter 1
Introduction to Embodied Psychology: Thinking, Feeling, and Acting

Michael D. Robinson and Laura E. Thomas

Abstract Psychological phenomena are embodied to the extent that bodily processes (whether perceptual, expressive, or action-oriented) contribute to them. A great deal of research, most of which has occurred in the past several decades, has revealed that embodied influences are seemingly ubiquitous and findings of this type have led to the suggestion that embodiment is foundational to the manner in which individuals think, feel, and act. In the present introductory chapter, phenomena of this type are initially reviewed in outlining the scope of enquiry. Subsequently, five major theoretical perspectives on embodiment are summarized as well as briefly compared and contrasted with each other. After a discussion of key questions and directions for research, the chapter introduces the content of the book, which consists of four sections related to Theoretical Foundations, Cognitive and Neuroscience Perspectives, Social and Personality Perspectives, and Current Issues and Future Directions. Although the book concentrates on the areas of cognitive and social psychology, it does so in broad terms, such that some of the chapters approach their content from ecological, philosophical, developmental, clinical, or evolutionary viewpoints. Thus, the volume is comprehensive and should appeal to multiple audiences.

Keywords Embodiment · Psychology · Cognition · Emotion · Behavior

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Consider the following empirical results. Pecher et al. (2003) found that it took longer to verify that nouns had certain qualities (e.g., being loud) if the previous trial had suggested a different sense-modality, even if no objects were actually sensed. Topolinski and Boecker (2016) found that potential food products were rated more favorably if articulating their nonsense names would involve backward (e.g., PASOKI), relative to forward (e.g., KASOPI), movements of the mouth and tongue,

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M. D. Robinson and L. E. Thomas (eds.), *Handbook of Embodied Psychology*,
https://doi.org/10.1007/978-3-030-78471-3_1

consistent with eating something. Meier et al. (2012) found that nicer, more agreeable people liked sweet foods to a greater extent and others who claimed to like sweet foods were viewed as friendlier too. Finally, and consistent with a long line of research (starting with Dehaene et al., 1993), Pinhas et al. (2014) found that participants tended to point to the right when solving addition problems, but point to the left when solving subtraction problems.

What all of the above findings have in common is the fact that they all involve bodily representation processes in one way or another. For example, Pecher et al. (2003) suggested that people simulate the sensory qualities of text they read, resulting in difficulties when the text shifts from one modality (e.g., hearing) to another (e.g., taste). Meier et al. (2012) pointed out that metaphors for affect and personality frequently reference sweet tastes (e.g., a sweet person). Owing to associations of this type, nicer people are drawn to sweet foods and thinking about sweet foods activates thoughts about friendliness. In broader terms, all of the above-referenced findings are consistent with *embodiment*—the idea that our thoughts, feelings, and actions are shaped by the types of bodies we have and the types of experiences they enable (Adams, 2010). Or, stated a different way, embodiment occurs because the way we think is tied, in intimate yet subtle ways, to the ways that we perceive and act (Pecher et al., 2011).

Embodiment represents a challenge to traditional ideas about thinking, which posit that the cognitive system works with abstract amodal representational units, like a computer (Adams, 2010; Barsalou, 1999; Fodor, 1983). In contrast to such suggestions, embodied perspectives contend that there are no sharp dividing lines between perceiving, thinking, or doing, and thinking would be very difficult if we could not borrow from more concrete representations, like those involved in perception or action (Foglia & Wilson, 2013). One can consider embodied psychology a relatively new field in that much of this work has followed from publications in the late 1990s and early 2000s (Barsalou, 1999; Meier & Robinson, 2004; Wilson, 2002). Nonetheless, related ideas can be found in much earlier suggestions, such as those of Gibson, Skinner, or James (Morgan, 2018; Schubert & Semin, 2009). Outside of psychology, too, there are many precedents for embodiment, including in robotics and philosophy (Shapiro, 2007).

Indeed, embodiment may be unique in its capacity to integrate different areas of psychology as well as neighboring disciplines. Along these lines, Glenberg (2010) reviewed the evidence for embodiment within many sub-disciplines of psychology, such as those concerned with language comprehension, memory, neuroscience, cognitive and social development, social psychology, clinical psychology, and education. In all cases, key findings (e.g., concerning gesture) had suggested that individuals ground their thoughts and feelings in perception or action, pointing to the possibility of a meta-psychology based on embodiment principles. Similarly, Schubert and Semin (2009) traced the manner in which ideas about embodiment could be found within both classic (e.g., James, 1890) and modern (Niedenthal et al., 2005) ideas about personality, social behavior, and culture. Neighboring disciplines include those focused on phenomenology, cognitive science, and sociology or anthropology (Adams, 2010; Tirado et al., 2018).

The present volume, titled "Embodied Psychology: Thinking, Feeling, and Acting", seeks to facilitate these integration efforts. Because many of the developments in embodied psychology have emerged from its cognitive area, this area features prominently in the book. Because implications for emotion and social behavior have primarily occurred within social psychology, this area also features prominently in the book. Some of the cognitive topics overlap with neuroscience and some of the social topics overlap with personality and clinical psychology, thus extending the reach of the volume. In addition, topical chapters are linked to core theoretical perspectives, including theory-based chapters on interoception, grounded cognition, and conceptual metaphor. Finally, the book has a suitable concluding section dealing with critical issues such as replication concerns, alternative interpretations, and future directions.

Major Theoretical Perspectives

Embodiment can be approached from several directions and at least five theoretical perspectives can be identified. In part building on the theoretical work of James (1884), researchers in the area of interoceptive processing study the manner in which individuals use signals from the body as inputs to emotion and decision-making (Herbert & Pollatos, 2012). These researchers have devised tasks, such as the heartbeat detection task (Critchley & Garfinkel, 2017), to measure individuals' capacities to monitor and report on bodily processes. Individual differences are the rule rather than the exception in such tasks and some individuals, more so than others, are much more capable of reporting on the activity of their bodies (Herbert & Pollatos, 2012). Individuals displaying higher levels of interoceptive accuracy tend to experience more intense emotions (Pollatos et al., 2007) and are more empathetic (Terasawa et al., 2014). Also, the somatic marker hypothesis (Ohira, 2010) suggests that greater interoceptive awareness should support better decision-making and, consistent with this hypothesis, lower levels of interoceptive accuracy have been linked to lower levels of emotional intelligence (Murphy et al., 2018). In the present volume, Schulz and Vögele review this area of research while calling for greater precision in conceptualizing and measuring interoception-related constructs.

A resource-based theory, building in part on Gibson's (1979) ideas concerning the role of action and ecology in visual perception, instead contends that perceptions of the environment reflect and track our abilities to act within it (Proffitt, 2006). When resources are taxed or the body has limitations, perceptions are altered such that they discourage actions that might be difficult to perform (e.g., climbing a hill). When resources are plentiful or the body is particularly fit, perceptions are more supportive of exploratory actions, including those that might require vigorous efforts (Schnall et al., 2008). This theory has been extended to a consideration of emotional influences (Stefanucci et al., 2011) and to the influence of sensorimotor skills on the actions that one might perform in any particular context (Witt, 2011). Although a variety of inputs have been highlighted in this work, dependent measures have tended to focus

on perceptual judgments, in particular (Witt, 2011). In the present volume, Clore, Proffitt, and Zadra integrate the resource-based theory of perception with influences from affect and emotion and Stefanucci, Saxon, and Whitaker extend the theory to data obtained in a variety of settings, including within virtual reality paradigms.

Barsalou's (1999) Perceptual Symbol Systems Theory and Barsalou's (2008) expanded theory of Grounded Cognition can be considered theories of knowledge representation and its use. In contrast to theories of representation that emphasized the mental manipulation of arbitrary and non-perceptual symbols (Fodor, 1983), Barsalou (1999, 2008) has proposed that representations consist of simulations that preserve features of perception and action. And in contrast to theories of representation that emphasized static elements, Barsalou (1999, 2008) has proposed that representational processes are dynamic in mode and operation. A variety of sources of evidence support these theories. Under certain conditions, for example, action-related words activate regions of the premotor and motor cortex that would be involved in the actual performance of those actions (Hauk et al., 2004). And behavioral studies that suggest that particular sensory modalities (seeing, hearing, touching) appear to be recruited when processing text of a given type (Pecher et al., 2003) support simulation-based views of language processing. Although theories of this type were once considered "outlandish", they now occupy a central place in work on representational processes and language processing (Ostarek & Huettig, 2019). A number of chapters in the present volume review research that has followed from this tradition (e.g., Borghi, Fini, & Tumolini; Davis, Coulson, Arnold, & Winkielman; Fischer, Felsatti, Kulkova, Menda, & Miklashevsky).

James (1890) argued in favor of an action-oriented view of cognition and a variety of lines of research have pursued links of this type. According to the facial feedback hypothesis, for example, posing particular facial expressions (e.g., smiling versus frowning) should activate thoughts and feelings consistent with one's momentary expression (for a recent meta-analysis, see Coles et al., 2019). Bodily postures too, such as laying down versus leaning forward, have been linked to thoughts and feelings consistent with the current comportment of one's body (Price & Harmon-Jones, 2015). In cognitive psychology, in particular, Glenberg (e.g., Glenberg & Gallese, 2012) has advanced views of this type by arguing that actions give rise to corresponding perceptions, cognitions, and behavioral effects. Much of this evidence has concerned language processing or memory (e.g., Glenberg & Kaschak, 2002), but related evidence has been amassed in social psychology, clinical psychology, and educational settings (Glenberg, 2010). Action-oriented inputs to both cognition and social behavior are discussed throughout the present volume (e.g., Congdon & Goldin-Meadow; Reed & Hartley; Riskind, Schrader, & Loya).

Abstract thoughts pose a particular challenge for embodiment (Dove, 2016) and one theory has been especially generative in this context. According to conceptual metaphor theory (Gibbs, 2011; Lakoff & Johnson, 1999), we can understand abstract concepts (e.g., those related to personality or moral value) by drawing from our knowledge of more concrete bodily and perceptual experiences (e.g., related to visual perception or taste). In social psychology, conceptual metaphor theory has contributed to new insights into the causes of social behavior, which can be affected

Table 1.1 Major theoretical perspectives and domains of application

Theory	Key citation	Independent variable	Dependent variable (s)
Interoception	Critchley and Garfinkel (2017)	Interoception-related processes	Emotion, decision-making
Resource theory	Proffitt (2006)	Bodily & environmental Affordances	Perceptual judgments
Grounded cognition	Barsalou (2008)	Perceptual symbols, Simulations	Language processing, Knowledge representations
Action-oriented perspectives	Glenberg (2010)	Manipulated actions	Language processing, Performance, social behavior
Conceptual metaphor theory	Lakoff and Johnson (1999)	Perceptual experience	Metaphor-linked representations or behavior

by manipulating perceptual experiences consistent with a given class of metaphors (Landau et al., 2014). Cognitive psychology has also explored predictions derived from conceptual metaphor theory (Pecher et al., 2011) and research of this type is reviewed in several chapters of the present volume (Gibbs; Landau; Robinson, Fetterman, Meier, Persich, & Waters).

As Anderson (2008) notes, theories in embodiment ought to make different predictions (see Landau, present volume) and yet such theoretical differences are rarely highlighted. Accordingly, Anderson (2008) further suggests that the vast majority of research on embodiment probably contrasts predictions made from a generic embodiment perspective with predictions derived from a non-embodiment perspective and critical tests pitting embodiment theories against each other are rare (for an exception, see Schneider et al., 2011). Yet, it would seem that each theoretical perspective has domains of application that are non-overlapping to some extent, as suggested by Table 1.1. At the present time, therefore, it seems best to recognize that there are families of embodiment theories rather than just one theory.

Key Questions and Directions in Embodiment Research

One issue within embodiment research concerns how abstract concepts, which are entities that have no direct physical manifestations, could be grounded (Dove, this volume). Borghi et al. (present volume) suggest that such concepts are grounded in a metacognitive way: When one encounters such a concept, it does not trigger a great deal of specificity in motor planning or self-regulation and there is a search for meaning. This search for meaning makes use of the mouth movement system in the form of inner speech or by asking competent others what is being referred to. Borghi et al. (present volume) offer several sources of support for this perspective.

In another interesting analysis, Jamrozik et al. (2016) suggest that each abstract concept (e.g., love, truth) is metaphorically conceptualized in different, even mutually incompatible ways (e.g., using metaphors for space, taste, and touch). Eventually, the abstract concept loses its capacity to evoke any particular sort of sensorimotor detail and the concept gains independence from sensorimotor representational processes. As the result of such developments, people can think abstractly without the use of sensorimotor metaphors or grounding processes, which accords with other sources of data (Mahon & Caramazza, 2008).

Considerations of the latter type suggest that representational processes do not *always* need to be grounded and, under certain task conditions or with certain materials, they would not be. If so, this creates a challenge to identify the conditions or materials that do versus do not engage sensorimotor processing, as discussed within several chapters in the present volume (Davis, Coulson, Arnold, & Winkielman; Gianelli & Kühne; Kaschak & Madden). Furthermore, that sensorimotor grounding does not always occur (e.g., when the task only promotes superficial processing: Barsalou, 1999) means that, ultimately, cognitive processing could occur in either a grounded or non-grounded manner and such considerations are consistent with a weaker rather than stronger version of embodied cognition (Tirado et al., 2018). Even in this context, though, it is possible that grounding was necessary for concept acquisition despite some independence from grounding as expertise develops (e.g., see Congdon & Goldin-Meadow, present volume).

Another solution is to recognize that people differ—e.g., in terms of their tendencies toward interoceptive processing (Schulz & Vögele, present volume) or in their use of conceptual metaphors (Robinson, Fetterman, Meier, Persich, & Waters, present volume)—and such differences are likely to matter in tasks that could be approached in embodied or non-embodied manners. Consistent with this idea, Fetterman et al. (2016) found that a perceptual manipulation (light versus dark font color) influenced word evaluations among individuals who tended to use metaphors in their daily life, but did not matter among more literal thinkers. Individual differences can be utilized in other ways as well. For example, research has indicated that tall males, relative to short males, are more likely to be selected for leadership positions (Judge & Cable, 2004) and adolescents with larger bodily sizes are more prone to antisocial behavior (Ishikawa et al., 2001). In realms of this type and others, Casasanto (2011) presented the body specificity hypothesis: People with different types of bodies should think, feel, and act differently and influences of this type are consistent with the embodiment thesis (also see Keehner & Fischer, 2012). Even within the individual, differences in context in terms of action affordances (Reed et al., 2010; Thomas, 2015) and experience (Thomas, 2017), the availability of energy resources (e.g., Schnall et al., 2010) and task priorities (Garza et al., 2013), and matters of design (Kaschak & Madden, this volume) may shape the manner and extent to which embodied phenomena occur.

There are also questions about cultural differences in embodiment. Although human bodies are similar in different cultures, cultures can select and amplify certain particular bodily actions (e.g., whether smiling is encouraged) and cultural influences of this type are likely to matter for the sorts of experiences that people have (Bettinsoli, Suitner, & Maass, this volume). Relatedly, analyses of conceptual metaphors

(e.g., power is up) across cultures suggest that there is some degree of universality to the conceptual metaphors that people use, but there are also important differences (Kövecses, 2005). A very interesting study of this type was conducted by Gilead et al. (2015), who found that sweet taste experiences, which prime prosociality among American participants (Meier et al., 2012), primed judgments of inauthenticity among Israeli participants, who view interpersonal "sweetness" in more skeptical terms. Cultural differences in embodiment, then, deserve more extensive analyses (Bettinsoli et al., present volume; Cohen & Leung, 2009).

In sum, although embodiment research has made considerable progress since its initial appearances, future directions remain (Glenberg, 2010). There needs to be more integration of disparate theories (Anderson, 2008) and we need a better understanding of how mechanisms related to embodiment translate into particular patterns of cognition, emotion, and behavior (Gianelli & Kühne, this volume; Ostarek & Huettig, 2019). The challenges of abstract concepts (Dove, this volume) need to be resolved (Borghi et al., this volume) and questions concerning individual, situational, and cultural differences should receive greater attention. Regardless, we have learned a great deal, as the chapters of the present volume will attest to.

Overview of Contributions

Theoretical Foundations

Although all definitions of embodiment emphasize the relevance of body-based (e.g., sensory or motoric) processes to some extent, there is actually a diversity of relevant theoretical perspectives (Anderson, 2008). The first major section of the volume gathers some of these perspectives into a single place as a basis for understanding the chapters in the other sections of the volume. The relevant chapters cover several major theoretical perspectives, which include grounded cognition and simulation (Barsalou, 2008), bodily resources and perception (Proffitt, 2006), interoception (Craig, 2003), and conceptual metaphor (Lakoff & Johnson, 1999).

- Chapter 2: Dynamic Grounding of Concepts: Implications for Emotion and Social Cognition. Josh Davis, Seana Coulson, Andrew J. Arnold, and Piotr Winkielman present a general case for grounded cognition and then apply it to the processing of affect and emotion concepts. The presentation of emotional stimuli has led to changes in facial musculature that match the valence of the stimulus (e.g., smiling in the case of pleasant stimuli or frowning in the case of unpleasant stimuli). Disorders related to movement (e.g., Parkinson's disease) can interfere with conceptual processing and interfering with emotionally expressive behavior can also change the manner in which one processes emotional concepts. These effects are flexible, however, and they seem to depend on attending to "hot" or experiential qualities of the materials that one is processing. Behavioral and brain-related dependent measures can also exhibit dissociations. In total, there are

multiple ways in which emotion processing can be grounded, but such relations appear flexible rather than mandatory.

- Chapter 3: Feeling, Seeing, and Liking: How Bodily Resources Inform Perception and Emotion. Gerald L. Clore, Dennis R. Proffitt, and Jonathan R. Zadra integrate resource-based views of perception with the effects of emotional and mood states. In both cases, individuals must decide whether to pursue a given course of action or navigate the environment in a particular way. Perceptions of the environment (e.g., in relation to the steepness of hills or the distance to an object) play an important role in deciding which actions to take and factors related to available energy as well as the emotional state that one is feeling are influential. For example, a hill looks steeper when one is stressed, fatigued, or atop it in a fearful state. Collectively, this research supports an embodied view of perception that is dependent on both energy-related and emotional states in a manner sensitive to resources as well as information concerning social relationships and their supportiveness.
- Chapter 4: Interoceptive Approaches to Embodiment Research. André Schulz and Claus Vögele review different approaches to interoception, which is thought to play an important role in representations of bodily states and courses of action that might follow from them. This research is broadly focused on perceptions of signals from inside the body and considers questions related to how such signals are perceived, whether they are perceived accurately, and how such sources of information impact consciousness and behavior. Progress in this area depends on making distinctions, such as distinctions between interoceptive accuracy, sensibility, sensitivity, and awareness. Relevant indices can also be measured through the use of self-reports, behavioral tasks, or neurophysiological assessments. Given the important role that interoceptive processes play in emotion and decision-making, attention to issues of measurement can result in precise models concerning individual differences in emotionality as well as the sorts of clinical conditions (such as alexithymia or eating disorders) that implicate disturbances in interoceptive processing and its evaluation.
- Chapter 5: Metaphorical Embodiment. Raymond W. Gibbs notes that people often use body-based metaphors in describing abstract features of their lives or in understanding concepts. Usually, in such analyses, the body is viewed in concrete and non-symbolic terms. However, individuals also appear to use metaphors in describing their bodily experiences. For example, chronic fatigue can be likened to having been run over by a cement truck or experiences of pain are described using adjectives (e.g., cutting, stabbing, flickering) that are highly metaphoric in nature. The chapter amasses evidence of this type, which clearly makes the case that bodily experience is often conceptualized in metaphoric terms. Furthermore, there is some emerging evidence for the idea that thinking about bodily experiences using different metaphoric frames can change the nature of that experience, such as within psychotherapy contexts. At this point, more experimental evidence is needed, but the mechanism of metaphor appears to be a bidirectional one in linking bodily states to abstract concepts (the traditional focus of conceptual metaphor theory) and in conceptualizing the types of bodily experiences that one is having.

- Chapter 6: The Extended Mind Thesis and Its Applications. Mirko Farina and Sergei Levin review lines of thinking that have crystallized into the Extended Mind Thesis, which contends that many mental activities extend beyond the nervous system to include features of the body, the environment, or technological sources of information. Contributors to the extended mind thesis include philosophers who have challenged Cartesian dualism. They also include psychologists and neuroscientists who have documented extended inputs to traditional cognitive domains such as spatial cognition, planning, or autobiographical memory. In many cases, relevant research seems to make the case that thinking is an extended activity that encompasses environmental sources of information as well as the achievements of the brain, narrowly considered. For example, individuals with memory problems are frequently observed to use notebooks to guide their behaviors in a goal-directed and purposeful manner. Gestures, too, are often used in a way that suggests that they contribute to information processing rather than merely following from it. Extended mind principles cannot be used to understand all mental activities, but they can be used to understand many of them.

Cognitive and Neuroscience Perspectives

Many of the key developments in embodiment have occurred within cognitive psychology and within the allied area of cognitive neuroscience (Barsalou, 2008; Glenberg, 2010). Section 2 gathers together both cognitive and neuroscience approaches to embodiment in the areas of attention, language processing, thought, and mathematical processing, among other areas. The chapters also tackle key questions concerning how it is that human beings can use their bodily experiences to ground abstract concepts, the role of bodily experiences in evaluations of the environment, and the manner in which intentions, goals, and tasks become coordinated with what we see and do as bodily beings.

- Chapter 7: Measuring the Mathematical Mind: Evidence from Motor Resonance, Negative Numbers, Calculation Biases, and Emotional Priming. Martin H. Fischer, Arianna Felisatti, Elena Kulkova, Melinda A. Mende, and Alex Miklashevsky review an impressive body of evidence for the idea that individuals use spatial and bodily codes to represent numbers and operations concerning them. A well-replicated effect of this type is the Mental Number Line, whereby the processing of small numbers is facilitated by leftward responses and the processing of large numbers is facilitated by rightward responses. Other embodiment effects follow from an innate mechanism that assumes cross-modal associations between magnitude qualities (e.g., faster entities are big and strong rather than small and weak). Following from ideas of this type, it has been shown that larger numbers facilitate more powerful grips involving the hands than smaller numbers do. Magnitude comparisons are also facilitated when numbers are further apart (e.g.,

2 vs. 5), relative to closer together (e.g., 4 vs. 5). In total, this research has discovered many interesting phenomena that all point to the idea that mathematical processing is embodied rather than purely symbolic.

- Chapter 8: The Challenges of Abstract Concepts. Guy Dove elucidates the challenges that have emerged in attempting to characterize abstract concepts as well as their grounding in experiential systems. There is a growing recognition that concepts can be abstract in different ways, for example with reference to aesthetic qualities (e.g., freedom), emotional tones (e.g., gratitude), sociocultural ideas (e.g., celebrity), or mathematical and scientific concepts (e.g., infinity). Different explanatory frameworks may be necessary in accounting for this diversity. Relevant attempts to understand abstract concepts have either emphasized concreteness, imageability, or emotion, but these qualities are not isomorphic with each other and may play different roles in the representation of different concepts. Neurological advances have also been made, but how the relevant brain structures and their associated connections facilitate abstract concept processing is a work in progress. Ultimately, we need to answer some fundamental questions about abstractness in order to provide a convincing account of how it is that individuals can represent concepts that they cannot see, hear, or touch.
- Chapter 9: Abstract Concepts and Metacognition: Searching for Meaning in Self and Others. Anna M. Borghi, Chiara Fini, and Luca Tummolini contend that abstract concepts are more challenging to understand and their understanding is reliant, to a greater degree than concrete concepts, on metacognitive searching and monitoring processes. Abstract words lead to greater activation in the left inferior frontal regions of the brain, which are involved in searching for meaning. In understanding abstract concepts, individuals use the mouth motor system to a greater extent. For example, they engage in inner speech or they ask competent individuals how to assign meaning to complex and abstract concepts. Relevant experimental studies of this type have shown that interfering with mouth movements affects the processing of abstract concepts to a greater extent and interfering with hand movements interferes with the processing of concrete concepts to a greater extent. Word rating studies also suggest that metacognitive processes—both social and non-social—play a larger role in comprehension as abstractness increases. Various metacognitive processes thus play important roles in grounding abstract concepts.
- Chapter 10: Phonemes Convey Embodied Emotion. Christine S. P. Yu, Michael K. McBeath, and Arthur M. Glenberg outline traditional views in linguistics, which have treated phonemes as arbitrary symbols that are somewhat bereft of connotation or meaning. In contradistinction to such accounts, several lines of research have indicated that phonemes convey meaning. For example, sounds such as “bouba” implicate rounder and perhaps larger objects, whereas sounds such as “kiki” implicate sharper, spiked objects (the bouba-kiki effect). Recent research has sought to understand the emotional connotations of sounds, which are thought to arise from emotion-related facial expressions that also play a role in generating the relevant phonemes. Just as emotions, in general, can be mapped into a two-dimensional space anchored by valence and arousal, phonemes, too, appear to occupy a similar space. The valence dimension can be represented by

distinctions among sounds such as gleam (positive) versus glum (negative) and the arousal dimension is implicated in distinctions among sounds such as wham (high arousal) versus womb (low arousal). Phonemes convey evaluative meaning and can be linked to the sorts of facial actions that occur during emotional experiences.

- Chapter 11: Location, Timing, and Magnitude of Embodied Language Processing: Methods and Results. Claudia Gianelli and Katharina Kühne review embodiment effects and processes in the language processing domain. Behavioral results have indicated that actions can facilitate or interfere with language processing, depending on whether the actions are consistent or inconsistent with the movements suggested by the sentences. Verbs implicating different motor effectors (e.g., face vs. arm or leg) have also been shown to give rise to brain activation patterns consistent with the given effector. However, findings in a number of paradigms have been inconsistent and there are important questions concerning location, timing, and magnitude in understanding the relevant effects. Although neural activation patterns have consistently implicated motor and premotor areas, questions concerning timing and magnitude remain. To address these questions, researchers must use different methodologies. In addition, it may be necessary to pay increased attention to matters of task context, which appear to affect matters of timing and magnitude, if not location. As a final contribution, the chapter considers questions related to whether materials are presented in participants' first or second languages.
- Chapter 12: Embodied Attention: Integrating the Body and Senses to Act in the World. Catherine L. Reed and Alan A. Hartley contend that spatial attention should prioritize locations relevant to the actions that one intends to, or might, perform in a particular situation. This functional view of spatial attention has been supported by findings demonstrating that placing one's hand near a particular region of space tends to facilitate processing for events that occur in that proximal region. Other results, using non-human primate models, have similarly documented ways in which physical actions and spatial attention processes appear to use similar neural circuitry. More recent research has also indicated that the manner in which one extends one's hand, whether to support larger motor actions or more precise grasping behaviors, alters attention in a manner consistent with the actions implicated by the hand's orientation. These effects appear to involve several neural processes, some of which are more sensory in nature and some of which are more cognitive. This research highlights multiple ways in which spatial attention responds to the actions that oneself or others might perform in the near future.
- Chapter 13: The Role of Motor Action in Long-Term Memory for Objects. Diane Pecher, Fabian Wolters, and René Zeelenberg build on the idea that motor actions are used to simulate representations for objects that can be manipulated. Evidence, however, suggests that people can encode objects in a variety of ways that involve perception, emotion, introspection, and abstraction in addition to motor actions that might be performed. If this is the case, then possible motor actions need not be simulated in representing objects. In a present study, participants attempted to encode manipulable and nonmanipulable objects for a later memory test. At

retrieval, a manipulation of motor interference did not differentially affect recall for objects that could, versus could not, be manipulated. Hence, the simulation of motor actions may not be necessary in remembering objects, whether manipulable or not. The results constrain embodiment theories and suggest that objects can be encoded in a variety of ways, only some of which involve action simulations. Simulations are probably made in a flexible manner and motor simulations may occur particularly when people intend to act.

- Chapter 14: Embodied Perception and Action in Real and Virtual Environments. Jeanine K. Stefanucci, Morgan Saxon, and Miranda Whitaker argue that perceptions of the body figure prominently in perceptions of the environment and actions that might be performed in it. People scale their environmental perceptions to their action capacities and in accordance with the emotional states that they are experiencing. For example, fearful individuals, more so than non-fearful individuals, overestimate the distance to the ground when placed in elevated settings. Tool use can also alter perceptions of distance when reachable objects are involved. Many of the factors that influence perception can be manipulated in virtual settings and the authors review research in this area. Virtual hands that are larger or arms that are longer quickly shift environmental perceptions in a manner consistent with one's new (virtual) action capacities. Emotional factors, too, can be manipulated in virtual environments and they also shift judgments in manners consistent with theorizing. Environmental perceptions are, therefore, malleable and they accord with perceptions of the body and actions or outcomes suggested by one's emotional state. These perceptions, in turn, guide self-regulation efforts in both real and virtual environments.

Social and Personality Perspectives

Like cognitive psychology, social psychology has been responsible for some of the key evidence supporting bodily perspectives on thinking, feeling, and acting (Glenberg, 2010; Niedenthal et al., 2005). Accordingly, Sect. 3 focuses on social-personality approaches to embodiment. The authors detail the ways in which embodied influences affect social cognition, relationship dynamics, personality traits, and clinical symptoms. Additionally, the chapters call for new ways of thinking about such dynamics, both within and across cultures.

- Chapter 15: Towards Theory Formulization in (Social) Embodiment: A Tutorial. Anna Szabelska, Olivier Dujols, Thorsten M. Erle, Alessandro Sparacio, and Hans IJzerman use the theory of social thermoregulation to offer a tutorial on how to improve embodiment science. Thermoregulation posits that people use social relationships in an effort to regulate core body temperature, particularly when it drops (i.e., one is colder than ideal). Research inspired by this framework has evidentiary value, despite some small sample sizes, but there are many ways in which this research could be improved so that it is capable of making precise predictions. The measures that are used in some studies were ad hoc in nature or they were not

designed to tap the processes of interest. We, therefore, need to pay attention to measurement and we need to develop new measures that have better psychometric properties as well as capacities to capture the construct of interest in multiple cultural settings. At the same time, we need to move past proto-theories toward formal theories, which are capable of making precise (mathematical) predictions concerning manipulation effects and moderating conditions. Work of this type has begun and the results of these efforts should be of value to other researchers who seek greater reproducibility in their embodied cognition research programs.

- Chapter 16: The 4 Es and the 4 As (Affect, Agency, Affordance, Autonomy) in the Meshed Architecture of Social Cognition. Shaun Gallagher considers social interaction, especially among individuals who know each other well, to involve skilled performance akin to members of a sports team or an orchestra performance. In states of engaged social interaction, one can analyze behavior in both vertical and horizontal ways. A vertical dimension integrates matters of reflection and intention with automatized action schemas. A horizontal dimension then links individuals to their social, environmental, and cultural circumstances. When both vertical and horizontal dimensions are functioning effectively, skilled performance can result. Such dynamics are first applied to interactions between mother and child, which display considerable coordination in vocalization, affect, and action patterns. Among close friends or relationship partners, too, the same mechanisms seem to support dyadic interaction patterns that are highly skilled. The analysis explains how it is that we are able to fully commit to social interactions to encompass dyadic phenomena and beyond (e.g., effective group decision-making).
- Chapter 17: Forms and Functions of Affective Synchrony. Adrienne Wood, Jennie Lipson, Olivia Zhao, and Paula Niedenthal begin with the observation that mimicry and embodiment processes are involved in perceiving another's emotional state. Beyond imitation and perception, interacting individuals can also synchronize their physiological states in a manner that supports affective synchrony—a state in which two partners achieve a mutual sort of oneness. Affective synchrony can support more efficient information processing, mutual emotion regulation, and it can build or reinforce relationship closeness. Mothers and their infants have been shown to achieve states of affective synchrony, which can be assessed in terms of coupled cardiac rhythms and other forms of physiological responding and affect. Affective synchrony also occurs in romantic couples, though synchrony with respect to positive emotional states is far more useful to the relationship than synchrony with respect to negative emotional states. Accordingly, it has been shown that dyads synchronize themselves to a greater extent when positive emotional feelings are involved. Although affective synchrony is not always adaptive (e.g., in the case of an argument), it is nonetheless a key mechanism that supports pair bonding.
- Chapter 18: Joint Action Enhances Subsequent Social Learning by Strengthening a Mirror Mechanism. Tamer Soliman, A. K. Munion, Brenna Goodwin, Benjamin Gelbart, Chris Blais, and Arthur M. Glenberg study the effects of joint action, which occur when two individuals perform a task in a coordinated manner. Joint action episodes have been shown to increase affiliation and bonding between

members of the dyad. However, the effects of engaging in joint action could also extend beyond the initial episode to influence one's capacity to imitate a second person in a different joint action task. The chapter reports evidence consistent with this account. Compared to participants who engaged in a solo action, those engaged in joint action were better able to synchronize their left-hand movements to approximate those of the experimenter. An analysis of brain activity suggested that joint action recruits the mirror neuron system, though findings were not fully consistent with this account. Nonetheless, behavioral and affective variables consistently pointed to the benefits of engaging in joint action. Such benefits can be used in applied and educational realms and it does appear that good preschool teachers create joint action activities as a way of promoting better learning in the classroom setting.

- Chapter 19: Take a Walk on the Cultural Side: A Journey into Embodied Social Cognition. Maria Laura Bettinsoli, Caterina Suitner, and Anne Maass examine manners in which culture can shape embodied influences on cognition and social cognition. Individuals from diverse cultures have similar bodies, but cultures can encourage or discourage particular bodily gestures as a way of reinforcing cultural prescriptions. Physical features of the environment can also be influential in how individuals live their lives. For example, individuals living in densely populated regions tend to delay reproduction until later in life. Cultures can also encourage or discourage certain bodily expressions and there are some societies in which smiling is seen to mark lower levels of social intelligence. Language scripts can also shape social cognition, a phenomenon known as the Spatial Agency Bias (i.e., agency is attributed to leftward elements in left-to-right languages and rightward elements in right-to-left languages). Although many conceptual metaphors appear to be universal, cultural differences are also observed. In total, the chapter considers ways in which cultural conventions can reinforce, create, or discourage actions that the culture values, which will, in turn, shape social cognition patterns in ways that accord with cultural ideals.
- Chapter 20: Comparing Metaphor Theory and Embodiment in Research on Social Cognition. Mark J. Landau compares two prominent theories in embodiment research and finds that, in many cases, the relevant mechanisms are not likely to be equivalent to each other. Conceptual metaphor theory suggests that individuals use bodily states to conceptualize more abstract concepts, but many metaphors are not embodied. We can liken an argument to war, for example, with no direct bodily experience with wars or battles. Other metaphors liken theories and relationships to buildings and metaphors of this type involve using one conceptual scheme to represent another, somewhat independent of bodily experiences. There are also many embodiment effects that do not involve metaphor. Included among these would be influences of bodily arousal on processing or stereotype use and the use of perceptual simulations to represent concrete objects or actions. There are also cases, however, that are ambiguous with respect to embodiment and metaphoricity. Clarity concerning different forms of embodiment and/or metaphor will allow us to make distinctions in our research, which will support a better understanding of mechanism and process.

- Chapter 21: Embodied Perspectives on Personality. Michael D. Robinson, Adam K. Fetterman, Brian P. Meier, Michelle R. Persich, and Micheal R. Waters suggest that individual differences in embodiment could be the rule rather than the exception. Individuals have different types of bodies (large, small, tall, short) and such differences appear to matter for personality. Especially small infants, for example, are treated in ways that encourage lifelong dependence and vulnerability. Within adolescence, individuals (especially males) who have larger body sizes tend to be more prone to antisocial behavior even when controlling for other influences. Among adults, perceivers often use height as a cue to status and taller individuals in fact achieve larger salaries and more leadership positions. In another portion of the chapter, it is suggested that embodiment itself may be an individual difference. Individuals differ profoundly with respect to their sensitivity to bodily states, for example, and such individual differences in sensitivity contribute to different emotional and social lives. Theories of embodiment can, therefore, be leveraged to understand differences between people as well as similarities among them. Personality-based models can also be used to demonstrate that embodiment effects possess external validity.
- Chapter 22: Embodiment in Clinical Disorders and Treatment. John H. Riskind, Shannon W. Schrader, and Jennifer M. Loya note that standard theories in clinical psychology emphasize disordered cognitions rather than bodily states. However, bodily factors have been implicated in several disorders. Schizophrenia appears to involve disembodiment (alienation from the body) and depression has been linked to hyper-embodiment. In the latter connection, depressed individuals typically present with slumped bodily postures and slower gaits. Clinicians have started to attend to the body in their treatment approaches and theories, but more research is necessary. Regardless, body-based techniques have proven to be effective for anxiety disorders and body awareness has been emphasized in empirically supported treatments for depression. Changing bodily patterns and postures can be effective in altering perceptions and emotions and such techniques should be considered when attempting to treat psychopathological symptoms and experiences. Interventions of this type will be more effective when they align themselves with both the non-clinical and clinical empirical literature.

Current Issues and Future Directions

The field of embodiment is one in which we seek to know which effects are reliable and which are not (Meier et al., 2015). In addition, we should work toward integrating the different theories of embodiment that exist (Glenberg et al., 2013), but in the context of recognizing important distinctions (Landau et al., 2010). Insights would also occur to the extent that we attend to developmental processes and evolutionary considerations while promoting interdisciplinary work. The final chapters of the book tackle some of these issues and questions, thereby providing a broader context for the earlier material.

- Chapter 23: Mechanisms of Embodied Learning through Gestures and Actions: Lessons from Development. Eliza L. Congdon and Susan Goldin-Meadow examine the role of gesture and other demonstration actions in child development. Gestures appear to play a unique role in learning and can be observed prior to the articulation of the child's first words. Motor experiences, such as in the sticky mittens paradigm, can also facilitate the child's ability to understand goal-directed actions. Gestures seem particularly valuable in learning abstract concepts and gestures appear to have multiple functions related to directing attention, reducing working memory load, and supporting concept flexibility. Gestural influences on learning have been demonstrated in a variety of types of studies, but appear to be particularly useful when the child is cognitively ready for the new conceptual achievement. This work generally supports action-oriented approaches to learning, such as those advocated by John Dewey and Maria Montessori.
- Chapter 24: An Evolutionary Perspective on Embodiment. Paul Cisek presents an evolutionary perspective on embodiment and cognition. Evolutionary forces shaped actions, not cognitions, and embodiment is key to action control. The vast majority of actions, if not all of them, can be conceptualized in terms of control loops that involve the brain, the body, and changes to the environment. From this perspective, cognition should not be separated from perception and action, but rather is a subcomponent of the larger system concerned with the organism's control of the environment. Cognitions must typically be embodied, though certain developments (e.g., the use of mental maps) did permit cognitions that were divorced from concurrent sensorimotor input. Regardless, and generally speaking, cognition is an aspect of embodiment rather than vice versa. This model extends to social communications as these, too, typically support action control. An evolutionary perspective on animate life reinforces the centrality of embodiment to the manner in which we think, feel, and act.
- Chapter 25: Experiencing Embodied Cognition from the Outside. Robert W. Proctor and Isis Chong question the idea that cognitive psychologists have neglected perception and action. Within studies of human performance, perception, action, and cognition have long been studied in combination with each other and influences from perception to cognition or action to cognition have been demonstrated. Thus, there needs to be a better integration of the human performance literature with embodied cognition theory and hypotheses. There are certain lines of embodied theory and research, it is true, that are radical in their neglect of mental processes, but such lines of research are not part of the mainstream, either in cognitive psychology or in embodied cognition research. Among those who endorse simpler and less radical views of embodied cognition, more integration with standard cognitive theory is warranted.
- Chapter 26: The Future of Embodiment Research: Conceptual Themes, Theoretical Tools, and Remaining Challenges. Bernhard Hommel suggests that the embodied cognition movement is a loose collective that is more defined in terms of its rejection of certain conceptual frameworks (e.g., those following from artificial intelligence) than a unified area of enquiry. Different theorists or investigators have reacted to different assumptions and this has resulted in a fragmented literature.

Characterizations of the existing literature outside of embodiment may also not be entirely correct. Investigations of embodied cognition would do well to adopt some common theories or paradigms and one relevant theory is the theory of event coding (TEC). This theory allows for interactions among perception and action in stimulus–response compatibility effects, response-stimulus compatibility effects, and in relations between planning and intention as well as action imitation. Actors consistently link their actions to their effects and to the sensorimotor states that result from them. Adopting a theory such as TEC could permit researchers to make more specific predictions concerning the mechanisms involved in embodied cognition.

- Chapter 27: Embodiment in the Lab: Theory, Measurement, and Reproducibility. Michael P. Kaschak and Julie Madden note that the initial studies on embodiment in language processing were largely exploratory in nature. Because this was true, key questions about how the effects work were left underspecified. These include how motor-processing priming effects work, at what cognitive stage they work, and how long such effects should (theoretically) last. It appears that answering some of these critical questions may be necessary for understanding whether embodied effects on cognitive processing should be observed and under what circumstances. Greater attention to task characteristics and to subject experiences of them will likely suggest alterations in task procedures that matter. For example, comprehension questions can motivate participants to devote more than superficial efforts to what they are being asked to do. At this point in the field's development, more specificity concerning theory and mechanism should give rise to higher levels of scientific reproducibility.

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