A Century of Imagery Research: Reflections on Cheves Perky's Contribution to Our Understanding of Mental Imagery

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We review contemporary scientific research on the relationship between visual perception and visual mental imagery in the context of Cheves Perky's (1910) landmark article on imagery and imagination. This body of research has firmly established a strong connection between the psychology of imagery and perception and has contributed a strong voice to the imagery debate. We then use the concept of embodiment to discuss additional avenues of inquiry at which Perky's work hinted. These include a more thorough examination of the relationship between imagery and emotion, the creative, active aspects of imagery and imagination, and the methods we can bring to bear on understanding imagery and imagination as a human experience.

It has been more than one hundred years since Cheves Perky published "An Experimental Study of Imagination" in the *American Journal of Psychology* (Perky, 1910). Although a significant body of research on imagery and imagination preceded it (e.g., Külpe, 1902; Scripture, 1896), Perky's work was especially creative and generative, and her article is an early milestone in the scientific understanding of mental images and their relationship to perception and memory. The connection between perception and imagery continues to be investigated and debated by today's cognitive scientists, and Perky's work is still cited as foundational to these efforts. But Perky's article presaged other modern scholarly developments in our understanding of imagery and imagination and contained insights that have yet to be fully appreciated or developed by mainstream psychological science. In this article, to recognize the contribution and impact of Perky's article, we review and evaluate the state of scientific research on mental imagery. By the end, we will have discussed directions that Perky's work could have taken nearly as much as we will have discussed the path that it has. Before examining these ideas, though, it is worth reflecting on the role of the image in the philosophy of mind and the intellectual milieu from which Perky's contribution arose, for even in 1910, psychological investigation of imagery was not without context and history.

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Philosophers since at least Aristotle have invoked the concept of an *image* in a variety of ways to develop conceptions of human thought and behavior. For example, Aristotle (1907) stated that behavior occurs when an appetitive–avoidant judgment is applied to an image (derived from the senses), but he distinguished this from pure imagination, which does not involve such judgments (book 3, chapters 7–8). In the context of describing what he considered to be a more natural account of human emotions, Spinoza (1677/1883) observed that images can affect emotions just as much as percepts (part 3, prop. XVIII). Kant (1781/1922) maintained that concepts are represented as rules for producing images of those concepts and that the process of producing images is facilitated by mentally reproducing objects of experience (division 1, book 1, chapter 2, section 2). After the Enlightenment and the early successes of physics, chemistry, and biology, philosophers generally became increasingly interested in the findings and analytic approaches of science, to the practical neglect of the more aesthetic, humanistic, and deliberately a-rational perspectives that had been common among earlier philosophers and theologians. In combination with the epistemological topics that have always been an important part of philosophical discourse, this development set the stage for the interdisciplinary marriage that gave birth to the modern field of psychology. As the child of science and philosophy, psychology was in a unique position to bring both modern technology and ancient wisdom to bear on the most fundamental questions about human nature, including the nature of imagination. (However, contemporary psychology seems to have identified much more strongly with only one of its parents!)

As the field of psychology began to examine human experience as an empirical science, the notion of the image figured centrally in the discipline. For Wundt and Titchener, for example, determining whether thought could occur without images was a major aspect of an empirical approach to psychology (see Woodworth, 1915, for a review of the "imageless thought" debate). Precursors to Perky had already illustrated a potentially close tie between perception and imagery. In an article titled "Measuring Hallucinations," Scripture (1896) reported an experiment in which, after being trained for several trials to detect a barely supraliminal stimulus, participants subsequently reported it to be present, even when it was not there (see also Külpe, 1902). Although the evidentiary value of Scripture's experiments today may be questionable, it is nevertheless clear that by the end of the 19th century, the field of psychology had adopted imagery as a phenomenon that was suitable for scientific investigation.

Relationship Between Imagery and Perception

Perky's efforts to explore imagery scientifically were multifaceted, but perhaps her most innovative contribution involved reversing Scripture's demonstration of the relationship between imagery and perception. Rather than showing that a mental image can be mistaken for a percept, Perky showed that a percept can be mistaken for an image. To do this, she developed an elaborate projection system involving her lab room and an adjacent darkroom that was separated from the lab by a wall with a large window. By covering the window with a cardboard screen and projecting colors through a stencil onto the screen from the darkroom, Perky could produce differently shaped patches of six different colors on the wall of the lab without an apparent projection system. Pilot testing of luminance enabled Perky and her assistants to project these colors at a dim but perceptible level on the wall of the lab room. Individual participants were subsequently brought to the lab and asked to form and describe mental images of several common objects (e.g., tomato, banana, leaf, or orange) while the corresponding shape and color of the imaged object was projected onto the wall before them—initially at a subliminal luminance but gradually increasing until it was well above threshold. Without exception, the 24 participants in Perky's main experiment did not consciously perceive the color patches but rather mistook them for their own imagination. Perky wrote, "At the end of the series, after all the introspections had been recorded, the observer was asked whether he was 'quite sure that he had imagined all these things.' The question almost always aroused surprise, and at times indignation" (p. 431).

These provocative results may run counter to our experience: Except in very unusual or contrived situations, people are easily able to distinguish a percept (derived from immediate afferent sensory information) from an image (derived from internal or stored information). Yet the fact that highly degraded, nearly

subliminal sensory information can be mistaken for a mental image seems to suggest that perception and imagery draw on the same mental systems, processes, or resources. Perhaps because of this, contemporary researchers have linked imagery and perception very closely—indeed, commonly using the word *perception* in their definition of *imagery*. Thus, for Wraga and Kosslyn (2003), an image is "an internal representation that produces the experience of perception in the absence of the appropriate sensory input" (p. 466). Ishai and Sagi (1995) defined visual imagery as "the invention or recreation of a perceptual experience in the absence of retinal input" (p. 1772). Similarly, Finke (1989) defined imagery as "the mental invention or recreation of an experience that in at least some respects resembles the experience of actually perceiving . . . either in conjunction with, or in the absence of, direct sensory stimulation" (p. 2). We reflect later in this article on the implications of defining imagery as an experience, as these and other examples illustrate. For present purposes, it is sufficient to notice that for many contemporary psychologists, imagery—by definition—shares a close bond with perception. Understanding the strength, nature, and limits of this bond has occupied much of the contemporary research on mental imagery.

During the era of behaviorism in the first half of the 20th century, there was almost no follow-up work on Perky's demonstration (but see Penfield & Jasper, 1954, or Short, 1953, for relevant research on imagery in the 1950s). By the 1960s, psychologists had begun to apply scientific methods to the study of imagery, and several began to reexamine Perky's ideas and their implications. Seminal work on imagery in this era came from Allan Paivio (1971), Donald Hebb (1968), and Roger Shepard (e.g., Shepard & Chipman, 1970), who collectively restored imagery as a topic of psychological inquiry (for a contemporaneous account of the return of *image* to psychology, see Holt, 1964; for retrospective accounts, see also Paivio, 1971; Shepard & Cooper, 1982). More pointedly, Segal essentially replicated Perky's main finding using signal detection techniques to show that the detection threshold for visual stimuli was higher during a concurrent imaging task (Segal & Fusella, 1969, 1970; Segal & Gordon, 1969). Particularly impressive evidence came from Segal and Fusella (1970), who showed that visual and auditory imagery have selective effects on the detection of a modality-consistent percept and not the cross-modal percept (see also Reeves, 1981, for analogous findings with visual discrimination). Based largely on this work, Perky's original insight has become identified primarily with the idea that perceptual detection or discrimination is interfered with by concurrent imagery tasks, a finding that is now called the Perky effect.

Consideration of the Perky effect as interference between imagery and perception has led to a substantial body of research examining the processing characteristics of imagery and perception and, furthermore, where in the processing stream (e.g., optics, sensation, perception, attention, response) these phenomena may overlap. However, even if one grants that there are close ties between perception and imagery, it is not clear a priori whether one would expect the Perky effect. By some accounts (e.g., Finke, 1980; Kosslyn, 1980), if perception and imagery share a common representational medium, then imagery may be able to *facilitate* perception by activating or priming this common medium. In fact, and in seeming contradiction to the findings cited earlier, such facilitation effects have been demonstrated by Farah (1985, 1989), whose participants were asked to imagine the letter *T* or *H* in the same location where these letters (or other stimuli) were subsequently presented. Farah's participants correctly recognized these stimuli more efficiently when they were also imagined (see also Ishai & Sagi, 1995, 1997b; Pearson, Clifford, & Tong, 2008). In related research, it has been shown that imagining the context of an object or event can facilitate its perception (Peterson & Graham, 1974) and that imagery can effectively prime word or picture recognition (Michelon & Koenig, 2002; Pilotti, Gallo, & Roediger, 2000).

Yet an important body of empirical work involving concurrent perception and imagery tasks has also demonstrated a strong interference effect between the two processes. In addition to Segal and colleagues' work cited earlier, Craver-Lemley and Reeves have repeatedly shown that concurrent imagery tasks can reduce performance on perceptual tasks. This robust interference effect occurs despite manipulations of the complexity of the imagined figure (Reeves, 1981, but see Craver-Lemley & Arterberry, 2001), the optical characteristics of the perceived stimuli (Craver-Lemley & Reeves, 1987), and the delay between imag-

ing and perceiving (Craver-Lemley & Reeves, 1987). This work has also helped rule out an account of the Perky effect as involving solely attentional changes imposed on perception by imagery (Craver-Lemley & Reeves, 1992; Thompson, Hsiao, & Kosslyn, 2011). This interference between perception and imagery has been interpreted as reflecting the fact that the two psychological functions draw on the same low-level sensory processes. In these cases, imagery is thought to reduce the sensitivity of the visual system by lowering the available energy of perceptual stimuli (Craver-Lemley & Reeves, 1992) and to align with perception at the level of visual processing in which visual features are combined (Craver-Lemley, Arterberry, & Reeves, 1999).

In reconciling the findings on the effect of imagery tasks on concurrent perception, Ishai and Sagi (1997a) suggested that interference is more likely when imagery is drawing on long-term memory, and facilitation is more likely when imagery draws on short-term working memory; however, the relationship is probably more complicated than this. The direction of influence also appears to depend on the similarities between the content of the image and the percept (Rebotier, Kirsh, & McDonough, 2003), their relative spatial location and orientation (Craver-Lemley & Arterberry, 2001), and the nature of the perception task (i.e., detection vs. identification, see Finke, 1986).

In addition to investigating commonalities between perception and imagery in terms of their processing demands, a great deal of research has illustrated structural similarities between the *contents* of both perception and imagery. Research on mental scanning, for example, shows that the time to make judgments about pairs of imagined objects exhibits a linear relationship to the corresponding perceived or physical distances between them (Borst & Kosslyn, 2008; Denis & Cocude, 1997; Kosslyn, Ball, & Reiser, 1978). Similar effects also occur when one imagines changes in orientation—the well-known phenomenon of mental rotation (Shepard & Metzler, 1971). Similarities between the content of images and perception also emerge from findings on aftereffects (Finke, 1979; Finke & Schmidt, 1977), acuity (Finke & Kosslyn, 1980), vividness (Giusberti, Cornoldi, de Beni, & Massironi, 1992), and recovery of implicit information (Thompson, Kosslyn, Hoffman, & ven der Kooij, 2008). Collectively, these studies provide a compelling case for the idea that the contents of an image affect the way it is processed and that these ways correspond closely to the processing of percepts.

Central to more recent efforts to understand the relationship between perception and imagery has been the application of neuroscientific methods to imagery tasks. As with the behavioral work reviewed earlier, much of this research aims to determine the extent to which imagery and perception engage identical, overlapping, or independent mental structures or processes, which are now measured with respect to areas of cortical activation. Research with lesioned individuals (Shuttleworth, Syring, & Allen, 1982), normal individuals under transcranial magnetic stimulation (Sparing et al., 2002), and patients with neglect (Bisiach & Luzzatti, 1978; Bourlon, Pradat-Diehl, Duret, Azouvi, & Bartolomeo, 2008; but see Bartolomeo, 2002) has demonstrated that deficits in perception (e.g., face recognition) are typically accompanied by deficits in the ability to form corresponding images. Brain imaging techniques such as event-related potential (Farah, Péronnet, Gonon, & Giard, 1988; Farah, Weisberg, Monheit, & Péronnet, 1989), positron emission tomography (Kosslyn et al., 1993; Roland & Friberg, 1985), and functional magnetic resonance imaging (Ganis, Thompson, & Kosslyn, 2004) have also converged on showing that occipital, temporal, and parietal cortical areas that are active in visual perception are also active in visual mental imagery tasks. The large body of neuroscientific research on imagery is reviewed by Guillot and Collet (2010; see also Kosslyn, Ganis, & Thompson, 2001).

Another noteworthy development of contemporary research on imagery has been the extension of findings on visual imagery to nonvisual modalities. Most of this research is consistent with the notion that imagery shares modality-specific resources with perception. For example, auditory images can either facilitate (Hubbard & Stoeckig, 1988) or interfere with (Okada & Matsuoka, 1992) auditory perception (see Hubbard, 2010, for a review), and auditory imagery appears to draw on the same cortical areas as auditory perception (Halpern, Zatorre, Bouffard, & Johnson, 2004). Imagery in other external senses such as olfaction (Carrasco & Ridout, 1993; Djordjevic, Zatorre, Petrides, & Jones-Gotman, 2004; Stevenson & Case, 2005) and touch (Klatzky, Lederman,

& Matula, 1991) also shares close association with perception. A particularly vigorous body of research has also examined imagery of internal senses such as kinesthesia and proprioception (Decety, 1996; Guillot & Collet, 2010; Jeannerod, 1995; Parsons et al., 1995). This research on motor imagery is extensive and has shown—as we discuss later in this article—that motor processing may underlie dynamic transformations of visual imagery, such as imagining the rotations of objects (Wraga, Thompson, Alpert, & Kosslyn, 2003) or the visual consequences of one's own movement (Decety & Jeannerod, 1995).

As an important complement to the large literature on the similarities between perception and imagery, a much smaller body of work has also shown how they are psychologically and anatomically distinct. Subjective experience indicates that images can be purposefully produced in ways that percepts cannot and that as a result, images may be more effortful than percepts to generate and maintain. Behavioral evidence has shown that images are less effective than percepts as primes (McDermott & Roediger, 1994; Michelon & Zacks, 2003). The majority of the limited research on differences between imagery and perception comes from neuroscience, which has exhibited a double dissociation between imagery and perception. Thus, brain lesions that lead to impairments in imagery do not necessarily lead to corresponding perceptual deficits (Farah, 1984), and deficits in perception are not necessarily matched by analogous deficits in imagery (Behrmann, Winocur, & Moscovitch, 1992; Jankowiak, Kinsbourne, Shalev, & Bachman, 1992). A review of these dissociations is provided by Bartolomeo (2002). Research has also shown differences between perception and imagery from event-related potential data (Ganis & Schendan, 2008) and patients with neglect (Guariglia, Padovani, Pantano, & Pizzamiglio, 1993).

As a result of this body of research, probably the most widely accepted current scientific conceptualization of imagery is that it engages many of the psychological structures and processes used in perception; however, imagery is thought to instigate these processes through top-down instead of bottom-up pathways. Kosslyn's (1994; see also Kosslyn & Thompson, 2000) influential model of imagery and visual processing captures this notion, with imagery involving the activation of a visual buffer (by way of information lookup and attentional subsystems), through signals initiating from associative memory. Perception, on the other hand, activates the same visual buffer by means of incoming sensory information. In this view, because imagery engages the selfsame psychological processes as perception, the two functions are intimately related. However, because the instigation of these processes derives from internal sources in imagery and external sources in perception, the two phenomena are dissociable.

This view of imagery, and much of the research that has investigated the connections between perception and imagery, has constituted an important piece of the imagery debate that has dominated much of cognitive psychology's treatment of imagery for nearly four decades (see Kosslyn, 1994; Kosslyn & Pomerantz, 1977; Pylyshyn, 1973, 2002). At the core of this debate is a question about the nature of the representation used in imagery. By one account (Kosslyn, 1994), images are analog and depictive representations of other entities. Thus, for example, it makes sense to consider spatial properties of an image and to ask how they correspond to the represented spatial properties. In contrast, a propositional account (Pylyshyn, 2002) holds that, although they may subjectively seem to be picture-like, such mental images are epiphenomena of underlying computations on symbolic expressions. Inasmuch as perceptual representations are generally considered to be analog, a close tie between imagery and perception has been used in the literature to provide evidence for the analog and depictive nature of imagery.

What Is Left?

To this point, we have examined the place of Perky's (1910) seminal article in the history of science's understanding of the relationship between imagery and perception. We have seen that in recent years, this understanding has culminated in neuroscientific approaches to imagery and a strong voice in the imagery debate on representational format. Although it is impressive how much research effort has been devoted to imagery in the past few decades, it is also clear that the majority of these efforts have been directed toward addressing only a handful of basic, albeit important questions. These questions include, How are images mentally represented? What common processes are shared by perception and imagery?

How do we imagine our own and others' motor movements? The literature also addresses a handful of applied issues, including the use of imagery to improve performance (see Martin, Moritz, & Hall, 1999, for a review) or in therapeutic settings (Singer, 2006). In the remainder of this article, we hope to point out fruitful areas in which to raise additional fundamental questions about imagery, questions that have been relatively neglected by psychological inquiry. As before, we note and develop insights offered by Perky's (1910) work to examine possible avenues of furthering our understanding of the power of image. We have noted that Perky's finding about the confusability of perception with imagery represented only a piece of her broader efforts. Subsequent experiments in her article examined kinesthetic and affective elements of images and the relationship between "images of memory" and "images of imagination," three topics that we develop in more detail in this article. We close with some reflections on the methods used to research imagery.

Embodiment of Imagery

In the past decade, a growing number of cognitive scientists have pursued the idea that "high-level" cognitive functions such as memory, categorization, language, and decision making are founded on—and indeed ultimately consists of no more than—the mental structures and processes involved with perception and action. Whereas some approaches to cognitive psychology (e.g., those based on the work of Simon, Chomsky, or Fodor) may regard the representational code used by higher-level cognition as symbolic and arbitrary (and hence reproducible by artificial intelligence in, say, binary format), this "embodied cognition" approach to mental phenomena seeks to ground such cognition in modal, nonarbitrary interactions with the world, interactions that are governed by perception and action systems (see Shapiro, 2010, for an overview of the embodied cognition approach). As a movement in cognitive science, embodied cognition owes its conceptual foundations to aspects of the phenomenological philosophies of Husserl, Heidegger, and Merleau-Ponty, who focused attention on the importance of prereflective and preanalytical aspects of day-to-day experience.

As we describe shortly, the psychological literature on imagery has already had an important voice in the formulation and development of theories of embodied cognition, and the seeds for such an influence can arguably be seen in Perky's (1910) article. Perky's insight into the relationship between bodily and imaginal processes involved examining the diagnosticity of eye movements for discriminating between imagery based on memory and imagery based on imagination. We develop the relevance of the imagery–imagination distinction for contemporary psychological inquiry in a later section. For present purposes, it is sufficient to note that for Perky, "images of memory" were associated with particular episodic content (e.g., an image of one's pet cat), whereas "images of imagination" were general, abstract, or lacking personal reference (e.g., an image of a running cheetah). Using a clever technique for measuring deviations of participants' gaze from a fixation point, Perky showed that images of memory tended to be associated with more eye movements than images of imagination. Indeed, when images of imagination were associated with eye movements, such images tended to be dynamic, or of "greater extension than could be compassed by the resting eye" (p. 438). Although these particular findings generally have not been pursued by contemporary psychologists (but see Bourlon, Oliviero, Wattiez, Pouget, & Bartolomeo, 2011), it is interesting to note Perky's prescience in examining mental images in terms of fine motor movements and her idea to relate imagery and kinesthetic senses. When Perky discusses gazing across images with a wider-than-normal field of view, a reader so inclined may even read the hints of an embodied approach to image properties such as their field of view (Finke & Kurtzman, 1981) or how they are scanned (Kosslyn, Ball, & Reiser, 1978).

Despite the relative neglect of this aspect of Perky's article, the ties between imagery and embodied cognition are clear in today's literature. Certainly, in the renaissance of imagery research at the end of the 20th century, Shepard and Metzler's (1971) research on mental rotation provided a groundbreaking demonstration of the analog nature of mental processing. The finding that people need increasing amounts of time to match objects with increasingly discrepant orientations is not one that would be expected if mental operations—like computer algorithms—used arbitrary symbolic codes. Instead, this effect is typically interpreted as a demonstration that the mental

transformations needed for recognizing stimuli are nonarbitrary and are analogous to the physical operations one might use to effect such transformations in the world. Subsequent research on embodiment and mental rotation has substantiated and deepened such conclusions by showing the influence of the motor system in visuospatial thinking. For example, Wohlschläger and Wohlschläger (1998) showed that concurrent manual movements in the same direction as a mental rotation item facilitate performance on mental rotation. Conversely, manual movements in the opposite direction interfere with mental rotation (see also Wexler, Kosslyn, & Berthoz, 1998). Grush (2004) synthesized these and similar findings to develop an emulation theory of mental representation, which stresses the influence of motor systems on, among other phenomena, visual imagery. According to this theory, the visual imagery involved in mental rotation engages motor commands that would be used to perform the analogous transformations in the world.

Barsalou (1999, 2009) has put forth a detailed theory of how abstract conceptual knowledge can be grounded in modal perceptual symbol systems. Central to this theory are the following ideas: During perception, brain systems create perceptual symbols by capturing some aspects of the information available about perceived events in the environment and perceived body states; related symbols are organized by a simulator that enables subsequent simulation of an event in its absence; and such simulations constitute conceptual knowledge. When conceived as an analog simulation of perceptual experience, mental imagery provides one of the clearest demonstrations of how Barsalou's theory of perceptual symbol systems can be used to understand high-level cognitive functions. Indeed, the body of research on imagery in the literature may be the most investigated and best understood example of how conceptual knowledge relies on and is supported by perceptual systems. Therefore, we expect research on mental imagery to provide continued support for an embodied approach to human cognition.

Imagery and Emotion

One of the implications of the embodied approach to understanding higher-level cognition is a heightened appreciation of the importance of emotion as both a wellspring of "high-level cognition" and a system in which conceptual knowledge (and meaning) is grounded. Many influential cognitive (e.g., Anderson, 1976; Landauer, 2007; McClelland, Rumelhart, & Hinton, 1986) and philosophical (e.g., Fodor, 1977; Frege, 1892) theories of meaning have little to say about the formative role of emotional experience in constituting cognition or creating meaning. And indeed, although contemporary theories of embodied cognition (e.g., Barsalou, 2008; Glenberg, 1997; Grush, 2004; Lakoff & Johnson, 1980, 1999) recognize the fundamental role of perceptual symbols, metaphor, and motor systems in constituting cognition, these theories too are largely silent on the ways in which visceral functioning may underlie cognition. Yet significant lines of contemporary thought hold that it is the emotional component of bodily experience that enables thought to be imbued with meaning (Damasio, 1999; Johnson, 2007; see also Niedenthal, 2007). For example, drawing heavily from John Dewey and William James, Johnson wrote,

> The long-standing prejudice in Western philosophy against granting cognitive meaning to emotional experience is due primarily to the widespread belief that emotions are not conceptual. However, once we stop thinking of concepts as abstract, disembodied entities and see them rather as bodily processes of discrimination and relation, we can recognize the crucial role of emotion in the meaning of situations, persons, objects, and events. (Johnson, 2007, p. 68)

As with the other aspects of imagery that we have so far discussed, the connection between image and emotion was also touched on by Perky (1910), who examined differences between images of memory and images of imagination on their attendant emotions. Based on introspective reports from two observers, Perky concluded that images of memory tended to be associated with emotions of familiarity, whereas images of imagination were more likely to be associated with surprise or novelty. Although the evidentiary value of this study may not be as strong as that of some of Perky's other work, the idea of connecting images with emotion was an insightful direction to point her research.

Today, imagery research may be particularly well poised to uncover the relationships between emotion

and cognition. Although several authors have emphasized the close ties between emotion and imagery, the direction of influence between imagery and emotion is currently more a matter of theoretical speculation than empirical support. An embodied approach to imagery and cognition such as that described earlier may be likely to regard emotional systems as an underlying *source* of imagery. By this view, imagery is constituted and made meaningful by the emotions that give rise to it. To quote Johnson (2007) again, "Before there is abstract thinking, before there is reasoning, before there is speech, there is emotion" (p. 52). Alternatively, emotion and images may have bidirectional, reciprocal, and mutually reinforcing relationships (see Damasio, 1994, 1999, 2003).

A small body of empirical research has examined the links between imagery and emotion by considering emotion as a consequence—not an antecedent—of imagery, concentrating on the potentially profound emotions that images are able to engender. As an analogy, consider Filo's iconic image of the 1970 Kent State shootings. Such a physical image is much more able to convey emotion (and to have a more lasting impact) than its prose description. In a similar way, mental images may be especially likely to evoke emotions and may thus be an important tool in understanding and treating emotional disorders. Holmes and Mathews (2005) have shown that instructing people to imagine a description of an aversive event is more likely to engender negative emotions than instructions to focus on the linguistic meaning of the description. They speculate that the especially close tie between imagery and emotion may have evolutionary origins—because both imagery and emotion, as ways of experiencing the world, developed phylogenetically before language (see also Holmes & Mathews, 2010). If this is true, imagery may provide a viable framework for conceptualizing the nature of thought and may provide insights into the processes that underlie cognition in organisms that do not think propositionally (i.e., in terms of language).

Active Imagery and Imagination

Another implication of embodiment as a framework for understanding human cognition is an increased appreciation of agency in perceptual systems. Although most approaches to human perception and cognition recognize the importance of active information gathering, the embodied approach is one of the strongest in rejecting the notion of perception as a passive filter through which information is collected from the environment and subsequently internally processed to create a representation of that environment. The ideas of active perception and information pickup that have arisen within the ecological approach to perception (Gibson, 1979) stress the tight connection and mutuality between perception and action and are thus common themes in the literature on embodied cognition. For example, O'Regan and Noë (2001) wrote, "Instead of assuming that vision consists in the creation of an internal representation of the outside world whose activation somehow generates visual experience, we propose to treat vision as an *exploratory activity*" (p. 940). In the context of imagery research, recognition of the close complementarity between perception and action raises an important question: If (as illustrated in much of the science we reviewed earlier) there are strong ties between perception and imagery, and if, as many hold, perception is a participatory activity, can we gain theoretical traction by considering imagery as a participatory activity?

We suggest that a useful means of considering the active nature of imagery may be through the historically checkered concept of imagination. Among ancient, modern, and postmodern thinkers, claims about the epistemological status of imagination have tended to incite both antinomy and ambivalence (see Harpur, 2002; Kearney, 1988). Perhaps the most overarching and perennial point of contention around this concept is whether imagination is autonomous and originary or rather is derivative of other psychological processes and hence ordinary. At the turn of the 20th century, intellectuals may have been generally sympathetic with a concept of imagination as being autonomous. By distinguishing images of memory from images of imagination, for example, Perky (1910) was able to confer to imagination a degree of theoretical independence. Yet today, in the contemporary scientific literature on mental imagery, imagination is seldom considered to be originary; it is more often framed as derivative of prior interactions with one's physical environment. For example, Denis and Borst (2006) wrote,

> Images are thought to include features that are derived from previous perceptual episodes.

> In fact, this situation limits the investigation of image scanning to "reproductive imagery," and therefore overlooks many forms of imagery, such as the creation of novel images that are not directly traceable to immediate or recent sensory experience. Pioneer research has highlighted the distinction between the so-called "memory images" and "imagination images" (Holt, 1964; Vinacke, 1952), but the creative facet of mental imagery has been (and still is) largely ignored by contemporary research on imagery. (pp. 51–52)

Indeed, images in contemporary investigations tend to be singular, static, and devoid of context; experimental participants may be induced to imagine in isolation a banana (Perky, 1910), an elephant (Kosslyn, 1975), or a letter of the alphabet (Farah, 1985). In research to date, the spontaneous working of the imagination is rarely if ever the focus. Yet phenomena of imagery also routinely derive from rich, dynamic, and active internal worlds, and it may be worthwhile to explore the idea that images are actively created from and within these worlds, in addition to being derivative memories of the physical world.

It is instructive to note in O'Regan and Noë's (2001) quotation that the notion of active perception facilitates a conception of mental phenomena as not necessarily involving internal representations. Indeed, the idea that active dynamic probing of the physical environment can function as a viable alternative to the construction of an internal model of it has gained increasing support in the past few decades (see Brooks, 1999). Thus, if one is to regard imagination as an active, dynamic probing of a mental environment, it becomes natural to reexamine the representationalist assumptions of mainstream cognitive research on imagery. As we mentioned earlier, the past several decades of research on imagery have been dominated by the question of *how* images are internally represented. Yet questions about how images are represented should follow only from a thorough consideration of *whether* and *when* imagery is best considered as a representation. Nonrepresentational approaches to imagination (e.g., perceptual activity theory; see Thomas, 1999) may provide a vehicle for understanding perception, imagery, and imagination as a participatory, exploratory, and interrogative activity with respect to physical and mental environments. In this view, images are not things or representations in the brain; rather, they are patterns of ongoing activity involved in purposeful exploration of the possibilities that are latent in one's physical or mental environment. Moreover, inasmuch as the faculty of imagination consists in going beyond habitualized ways of perceiving, we may regard its kind of imagery as presentational (not representational), such that its surpassing of reality proffers new ways of seeing.

In this regard, Hunt's (1989, 1995) inquiry into consciousness is especially noteworthy, because it is quite sympathetic to a nonrepresentationalist view of imagery, and is at the same time broad enough to conceptualize and organize multiple forms of imagery. For Hunt, for example, the distinction between reproductive and productive imagery and imagination is encompassed by a broader framework defined by two orthogonal dimensions of imagery: concrete mimetic–geometric abstract and representational–presentational. Where the concrete mimetic–representational quadrant accommodates the simple reproductive imagery largely pursued by contemporary science, the geometric abstract–presentational quadrant accounts for seemingly spontaneous, productive, and polysemous imagery found in mystical experiences, bizarre, archetypal dreams, and other frames of experience connected to imaginative imagery.

Broadening current scientific research on imagery to include presentational as well as representational imagery phenomena would be a valuable addition to our understanding of human psychology. Of course, putting forth this notion as an ideal is much easier than understanding how to actualize it through scientific methods. How could one go about developing a science of spontaneous imagination, given a presumed lack of control, lack of replicability, and a seemingly necessary reliance on introspection? For example, Casey (1976) provided a thorough and trenchant introspective analysis of imagery and imagination, much of which concluded by emphasizing inherent differences between imagery and perception. Determining how to square such conclusions with the wealth of scientific evidence reviewed earlier on the similarities between imagery and perception is daunting and causes one to reflect on the role of introspection in imagery research—a topic we take up next.

In tracing the history of psychological inquiry into imagery, it is difficult not to recognize a several-decade gap between roughly the time of Perky's article and the 1960s. The dearth of research into imagery during these years is commonly attributed to the rise of behaviorism. Thus in 1913, as Watson published "Psychology as the Behaviorist Views It" and behaviorism began to dominate the field of psychology, the topics of imagery and imagination lost their viability as appropriate areas of investigation for an empirical science. Inasmuch as science is constrained to deal with observable phenomena, psychological constructs such as memory, thought, and imagery were regarded as no more suitable than the concepts of demon, spirit, or god as topics of scientific inquiry.

But it was probably the methodological prohibitions of behaviorism that were more immediately responsible for the absence of research on imagery throughout the first half of the 20th century. Indeed, it takes only two sentences into his landmark article for Watson (1913) to make his methodological proclamation that, for behaviorism, "Introspection forms no essential part of its methods, nor is the scientific value of its data dependent upon the readiness with which they lend themselves to interpretation in terms of consciousness" (p. 158). Moreover, with respect to imagery research, the naturalistic methods on which many psychologists had come to rely were also regarded as having committed the error of taking consciousness as part of the physical world and as obeying the laws of physical nature (Jennings, 1992).

Although the cognitive revolution of the 1960s helped relegitimize the study of "mentalistic" phenomena, the subjectively based methods of the "old era" (i.e., introspectionism) were not subject to a similar renaissance and to a large degree are today still presumed to lack adequate validity, control, and reliability. But it is possible that the abandonment and lack of development of such methods constitute an instance of throwing out the baby with the bathwater. For example, Haber (1979) stated,

> Psychologists in general, and perceptual researchers in particular, have invested enormous energy in developing methodologies in which we never have to trust what the subject says. . . . But when we believe we can discover and understand all the rules of perception by treating the subject as a null indicator, then we must fail. The study of visual imagery is perhaps the clearest case of this failure. (p. 594)

We will argue that a complete account of mental imagery and human imagination must include and take seriously the experience of the person in the world. To this end, we will briefly distinguish introspectionist from phenomenological approaches and explicate how phenomenological analysis may be more germane to cognitive science than is commonly believed. After all, if contemporary science defines imagery as a type of experience, then research methods that aim to describe and understand experience more generally cannot be entirely irrelevant.

Gallagher and Sorensen (2006) pointed out the utility of distinguishing between two forms of introspection. The first (weaker) form consists in procedures that entail a report of experience in the service of ascertaining something of which the participant is not aware, such as the use of button presses in response to a visual stimulus to measure reaction time. In its stronger form, introspection involves a report of direct experience of which the participant is aware, such as a description of a voluntarily formed image. Whereas the weaker form uses experience indirectly to indicate a variable of interest, the stronger form is concerned with experience itself. Although the weak form of introspection is commonly used in contemporary psychological science, the lack of replicability across observers commonly renders the external validity of the stronger form suspect.

But it is worth differentiating introspection in general from a more rigorous phenomenological approach because, indeed, the two methods are often conflated (Dennett, 1991). In contrast to the subjective experience of mental contents circumscribed by the introspectionist operation, the phenomenological method instead concerns itself with "intersubjectively accessible modes of appearance" (Zahavi, 2003, p. 54) or the recurrent and self-organizing structures that indicate the conditions of a common phenomenological situation across individuals. Contrary to expectation, Husserl conceptualized phenomenology as a rigorous science whose aim consisted in an analysis of the essential structures of experience. Recognizing

that prior suppositions and assumptions can obfuscate our apprehension of these (eidetic) structures, Husserl posed the exclamatory dictum, "Back to the things themselves!" (Husserl, 1913/1982, p. 35). In what comprises the essence of phenomenological method, the phenomenological reduction involves "bracketing" the natural attitude (of investigators and participants alike), which means to "strip the world of the multitude of implicit presumptions about its existence as 'real,' thereby allowing aspects of the world to recur as 'pure phenomena' for consciousness" (Jennings, 1992, p. 299). Moreover, as alluded to earlier, phenomenological data per se do not consist in subjective contents but rather the "typical character of consciousness in meaning-conferring acts" (Jennings, 1992, p. 300) whereby typicality is established by comparing the descriptions of one participant with the descriptions of other participants with respect to a particular meaning-conferring act (Gallagher & Sorensen, 2006).

Contemporary developments of such a phenomenological method (e.g., interpretive phenomenological analysis; see Smith, Flowers, & Larkin, 2009) hold promise for gaining increased understanding of imagery and imagination, especially as they manifest in situated, intersubjective, and participatory processes of meaning making. Inasmuch as these methods can provide a rich account of what circumscribed experiences (e.g., somatic hallucinations) mean to specified people (e.g., psychiatric patients) in particular contexts (e.g., a hospital setting), they may be uniquely suited to informing questions posed by embodied approaches to cognitive science. Beyond the scope of phenomenological methods, we suggest that the principle of describing and understanding experience qua experience may be generative, if not essential, to the practice of cognitive science, particularly in the area of imagery, whose conceptual boundaries have historically been perpetually indeterminate and ever-shifting.

Conclusion

Despite its brief history, the psychological investigation of mental imagery has developed an impressive body of literature on the neurological, anatomic, and cognitive underpinnings of this phenomenon. In 1910, when Cheves Perky published her investigations of imagery and imagination, an elaborate two-room projection system was a state-of-the-art means of illustrating the close association between perception and imagery. Today, the brain imaging methods of neuroscience have enabled us to see exactly how perception and imagery draw on overlapping neural systems.

Yet in a historical context, this body of research also illustrates how inquiry can be swayed as much by academic hegemony and fashion as by openness and understanding of alternative conceptualizations. Perky's largely untapped contributions may also have been to recognize the roles of embodiment and emotion in imagery, as well as to consider the role of presentational in addition to representational ways of thinking about imagery and imagination. And although Perky's introspective methods have fallen into disregard, when developed by contemporary phenomenological approaches, they may yet have contributions to make to our understanding of imagery and imagination. Given the perennial interplay between philosophical frameworks that regard imagery as either ordinary or originary, we would do well to recognize that both the topics of imagery and imagination, as well as the methods by which we seek answers to our questions about these experiences, are undergirded by tacit ontological, epistemological, and ethical assumptions. Recognizing, reflecting on, and questioning these assumptions are critical to developing a full appreciation of imagery and imagination and should be de rigueur for an academic discipline that is born of philosophy.

NOTES

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