

The Importance of a Consideration of Qualia to Imagery and Cognition

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Experiences of qualia, subjective sensory-like aspects of stimuli, are central to imagistic representation. Following Raffman (1993), qualia are considered to reflect experiential knowledge distinct from descriptive, abstract, and propositional knowledge; following Jackendoff (1987), objective neural activity is distinguished from subjective experience. It is argued that descriptive physical knowledge does not provide an adequate accounting of qualia, and philosophical scenarios such as the Turing test and the Chinese Room are adapted to demonstrate inadequacies of accounts of cognition that ignore subjective experience. Arguments by Dennett and others that qualia do not exist or that qualia do not provide additional explanatory power are addressed, and it is suggested that consideration of qualia is necessary in order to explain (and not just predict) objective behavior. The hypotheses of functional equivalence, second-order isomorphism, and psychophysical complementarity between imagery and perception are discussed, and the ability of analog and schematic models of imagery to account for qualia is examined. © 1996 Academic Press, Inc.

Fundamental to the experience of mental imagery is the recreation of sensory experience. Consider the following examples: the striking reds and oranges of the Grand Canyon or the deep blue of Crater Lake, the sound of a loved one's voice or the first pounding chords of Beethoven's Fifth Symphony, the feel of sandpaper or silk, the salty smell of the pounding surf or the special perfume of a lover, the taste and texture of a rich ice cream sundae smothered in chocolate sauce. . . . Indeed, examples of the sensory aspects of the phenomenological experience of imagery could be endlessly multiplied. Such sensory-like aspects of phenomenological experience have often been referred to as *qualia* (singular *quale*), and even though qualia are an important component of the experience of imagery (if not causally, at least epiphenomenally), none of the existing approaches to imagery within cognitive psychology adequately addresses the issue of qualia. More specifically, the apparent importance of qualia in our experience is not reflected in the importance of qualia in cognitive theory, and it will be argued here that what makes an image an image, that is, the qualia, is essentially missing from our models of imagery.

Historically qualia have been equated with "accidental" or "secondary" properties because qualia were thought to be idiosyncratic and not to reflect the true objective nature of a stimulus, and more recently qualia have been equated with "phenomenological" properties because a consideration of qualia was thought to focus on how a stimulus appeared (i.e., the phenomenon) rather than on how a stimulus actually was (i.e., the noumenon). In our discussion here we consider qualia to be *sensory*–

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perceptual or *experiential* knowledge; in other words, qualia correspond to sensations and the qualitative aspects of experience. This definition of qualia does not presume the truth or validity of the philosophical theories in which the idea of qualia was first elucidated, but it does preserve the essential notion that sensation or experience offers a way of knowing a stimulus that is fundamentally different from more abstract or propositional knowledge of that stimulus. For example, the frequency of the second note of *Somewhere Over the Rainbow* is approximately twice the frequency of the first note, but knowledge of this type is different from “hearing” what that octave interval sounds like. Similarly, milk chocolate is sweet and contains sugar, but that knowledge is different from “remembering the taste” of chocolate.

Although our primary concern is with the absence of qualia from contemporary models and theories of mental imagery, qualia and subjective experience are not limited to imagery. Part I contains a general examination of philosophical arguments supporting or denying the importance of qualia to cognitive processes. Although most of the historical arguments concerning qualia address the qualia of perception, extension of these arguments to address the qualia of imagery may be easily made. Part I concludes that qualia do indeed have a place in psychological theories and that a complete understanding of cognition and behavior is not possible unless qualia are considered. Part II examines the ideas of depiction and description, and it is suggested that any apparent ambiguities in depiction do not require images to be completely schematic or descriptive, and thus a place for qualia in imagery is preserved. The ability of spatial analog models to account for qualia is examined; although spatial analog models may account for qualia associated with spatial properties or spatial manipulations, it is not clear how either spatial analog or schematic models may account for nonspatial qualia. Part II arrives at the somewhat ironic conclusion that much of what makes an image an image, that is, the subjective sensory–perceptual experience, is missing from our theories of mental imagery.

PART I: A DEFENSE OF QUALIA AND SUBJECTIVE EXPERIENCE

The experience of mental imagery recreates sensory–perceptual experience (although not necessarily with perfect fidelity), and the experience of mental imagery is therefore of the concrete and specific rather than of the abstract and general. Many other types of mental representation such as schemata (e.g., Bransford, Barclay, & Franks, 1972), scripts (e.g., Bower, Black, & Turner, 1979; Schank & Abelson, 1977), production systems (e.g., Newell, 1990), propositional networks (e.g., Anderson & Bower, 1973; Collins & Loftus, 1975), or connectionist networks (e.g., Rumelhart & McClelland, 1986; McClelland & Rumelhart, 1986) all assume at least some abstraction of a stimulus beyond mere “sensory experience” and are thus more descriptive than experiential. The question of whether activation of a single node or a pattern of activation across nodes in a network also corresponds to the experience of having an image (with all the qualia inherent in an image) has rarely been addressed, and so we begin our examination of qualia with a comparison of description and experience.

Description and Qualia

If imagery involves a recreation of sensory experience, then it initially seems that it would not be possible to image something that has not been perceived. We are,

however, capable of imaging things we have never seen. Even though an entire imaged “scene” may not have been previously perceived, it is possible that many of the elements that make up that scene may have been perceived (albeit in different and separate contexts). For example, although no one has ever (accurately) perceived a unicorn jumping over the Washington monument, many people have seen drawings of unicorns and pictures of the Washington monument and could combine those separate elements into a single visual image. The elements combined to form such a visual image could be holistic sorts of objects such as a unicorn or the Washington monument, or they might be smaller and more basic feature-level shapes such as lines or angles. Although the total scene has not been previously experienced, the separate elements have been, and so these elements can be rearranged into a novel image much as the elements in a kaleidoscope can be rearranged to form novel patterns. Similarly, a composer may never have perceived a particular melodic sequence, but he or she would still be able to image that melody by combining pitches and intervals which have been previously perceived (albeit in different and separate contexts). In the case where none of the elements have been previously perceived, though, no image should be possible, although a description (of sorts) might be possible.

Objective Description and Subjective Experience

An example of a task in which a description might be possible but an image is not possible, and which also highlights the differences between a description and an image, can be found in Nagel’s (1974) essay on “What is it like to be a bat?” Nagel suggests that even though a human might possess a complete understanding (i.e., belief) of how bat sonar works, he or she would still be unable to imagine the experience (i.e., qualia) of being a bat (we can, however, imagine the experience of what it would be like for a *human* to pretend to be a bat, even though we cannot imagine what it is like for a *bat* to be a bat). Failure to address this difference between description and image is commonplace in experimental psychology; Pylyshyn (1984, p. 45) points out that information-processing types of theories have “set aside questions about what constitutes qualia, or ‘raw feels’—dealing only with some of their more reliable functional and semantic correlates (for example, the *belief* that one is in pain, as opposed to the *experience* of the pain).” However, even though we may possess some understanding or beliefs concerning a stimulus, the mere possession of such understanding or beliefs is not equivalent to an experience of that stimulus. In other words, an objective description is different from a subjective experience. Given that an image (in part) recreates subjective experience, a description must therefore also be different from an image.

Jackson (1982) presents two cases purportedly demonstrating that knowledge or understanding must be different from experience. For example, consider the case of Fred, an hypothetical individual who makes distinctions among two shades of red that otherwise look identical to the rest of us. To Fred, red₁ and red₂ appear as different as red and green appear to us, yet we see no distinction between what Fred calls red₁ and red₂. What type of experience does Fred have when he sees red₁ and what type of experience does Fred have when he sees red₂? Furthermore, how does his experience of red₁ differ from his experience of red₂? Jackson suggests that no amount of physical information about Fred’s brain or optical system can answer this question

for us. We may find out that Fred's cones respond differently than ours, but this information will tell us nothing about his subjective color experience. Even though we have all the physical information, we still would not know everything about his subjective experience because we would not know what it is like for Fred to see red₁ versus what it is like for Fred to see red₂.

In a similar example, Jackson (1982) describes the case of Mary, an hypothetical individual who has from birth been locked inside a room in which everything (including her body) is painted black or white. Mary can receive visual information about the outside world, but only over a black-and-white monitor. Thus, Mary has never seen (i.e., she has no experience with) spectral colors. Let Mary nonetheless learn all the optical, anatomical, and physiological information that can be known about color and color vision. Can Mary know what the experience of seeing color is like? If she escaped from her black-and-white cell, would she learn anything new about, for example, red, the first time she actually saw a red object? Our intuitions suggest that even if Mary were to have all the information about color and color vision prior to her escape from the black-and-white room, she still would not know what the experience of a specific spectral color is like. Thus, when she escaped and saw color for the first time, she would learn something new.

Dennett (1991) suggests our intuitions about Mary have force only if Jackson's thought experiment is incorrectly imagined; specifically, Dennett claims that it is not easy to imagine that Mary has *all* the physical information, and so most people do not imagine Mary having all the information. If we were to imagine Mary having all the information, then she should know exactly what impression an object of any color would have on her nervous system. Mary should be able to know, in advance of seeing any color, exactly what response it would create in her nervous system. However, Dennett's argument ignores the distinction between description (i.e., belief) and qualia (i.e., experience). If we can successfully imagine Mary with all of the physical information, then a portion of that information would have to be information about the subjective experience produced by seeing a red object. If Mary knew this, then she could know what the experience of seeing a red object is like. But because in her black-and-white world this pattern of stimulation would never have been available, Mary could not know this pattern through perception (experience of the pattern), nor could she image it anymore than she could image being Nagel's bat. Therefore, within the black-and-white room Mary could not possess all of the information about color and color vision, and so she could indeed learn something new the first time she actually saw red.²

² In an analogous example, Hubbard and Stoeckig (1992) discuss these aspects of description and qualia within the context of musical imagery and consider Mary not as a visual scientist but as an auditory scientist; specifically, Mary is a sophisticated, dedicated, highly educated cognitive neuroscientist who, poor child, was deprived of the experience of hearing music for all of her life. Despite such a cruel fate, poor Mary courageously studied cognitive psychology, neuroscience, and music theory and learned everything there is to know about the representation and processing of music. While we may certainly grant that Mary may have all the appropriate *beliefs* about music representation, are we justified in equating the possession of these beliefs with the *experience* of music? Even if Dennett's (1991) objection to Jackson's black-and-white Mary is correct and applicable to the musically deprived Mary, it does stretch credulity to suggest that all physical knowledge could be had in the absence of experience with the actual stimuli, especially in light of claims that experience with tonal systems is necessary in order

Two Types of Knowledge

Our confidence in the inability of a description to capture all of the qualia in an experience and our confidence in the distinction between objective and subjective responding are both strengthened by Raffman's (1993) argument that we can have knowledge of the ineffable aspects of music and that this knowledge of the ineffable is not available to linguistic processing or description. Indeed, Raffman maintains that "musical knowledge cannot be entirely learned by description but must be experienced; specifically musical knowledge . . . is *sensory-perceptual* or *experiential* or *felt* knowledge; as such, it cannot be communicated by language" (p. 40). Given that such types of ineffable knowledge may not be communicated by language, the only hope for communication lies with ostention. Such ostention would require the person we are trying to communicate with to have the same sensory-perceptual experience, that is, experience the same qualia, that we do. Even so, ostention may not suffice if different perceivers differ too greatly in their sensory-perceptual capabilities or background knowledge.

Building upon Cavell's (1967) ideas, Raffman distinguishes between knowledge_{sp} (*sensory-perceptual* or *experiential* knowledge) and knowledge_d (*descriptive* or *propositional* knowledge). Knowledge_{sp} involves knowledge of the perceivable or experiential aspects of a stimulus and knowledge_d involves abstract or linguistic knowledge of a stimulus. Raffman suggests that possessing knowledge_d is not sufficient for complete knowledge of a musical piece and that the experience of hearing the nuances of the music (i.e., acquiring knowledge_{sp}) can provide additional knowledge not contained within knowledge_d. Knowledge_{sp} can provide additional information beyond that contained within knowledge_d because our perception contains information too fine-grained to be preserved in the broader categories of schematic memory. In essence, our schemata do not include sufficiently precise categories to make all the distinctions we can make perceptually, and so there may be perceptual distinctions and perceptual knowledge that cannot be accounted for within a linguistic or descriptive scheme.³ Such an idea is also consistent with the claim that visual images exhibit implicit encoding of features that might not otherwise be explicitly (i.e., verbally) encoded (Finke, 1989).

Knowledge_{sp} and knowledge_d are thus different types of knowledge. Without both extensive knowledge_{sp} and extensive knowledge_d of a stimulus, a person could not be said to have complete knowledge of that stimulus.⁴ Thus, if Mary the black-and-

to exhibit tacit knowledge of (and the subsequent expectancies that result from) musical harmony (e.g., Bharucha, 1987; Krumhansl, 1990).

³ A similar inability to communicate aspects of a stimulus is suggested by Freyd's (1983, 1990) notions of "shareability." Freyd suggests that some stimuli may initially be encoded in a more continuous format, but if a person then needs to communicate about the stimulus, the representation will be recoded into a more discrete format. The discrete categories would collapse across neighboring values of stimulus intensity, and so although a person might be able to initially perceive fine discriminations between stimuli, he or she would not be able to verbally communicate that information.

⁴ Raffman admits, however, that if a person already possesses extensive knowledge_{sp} of a domain, then that person may use that knowledge_{sp} in conjunction with knowledge_d to obtain more complete knowledge of a stimulus. For example, Beethoven was deaf when he composed his Ninth Symphony, and so he could not obtain knowledge_{sp} of it by hearing the symphony performed. Beethoven could draw on his extensive previous knowledge_{sp} of timbres, chords, harmonies, and so forth used in the Ninth

white visual neuroscientist had read all the treatises on vision (i.e., possessed all possible knowledge_d), she still would not know what it was like to see red (i.e., would not possess knowledge_{sp}). More generally, if a person had complete descriptive knowledge (possessed all possible knowledge_d) of any domain (e.g., music, fine wines, aerobic exercise), he or she still would not know what it was like to experience that domain (would not possess knowledge_{sp}) until he or she had actually experienced that domain. Raffman's arguments for the ineffability of musical knowledge thus also provide suggestions for an analogous demonstration of the wider role of qualia and experience in knowledge. Just as some aspects of musical experience cannot be captured by verbal processes and so remain "ineffable," so too might other aspects of qualia remain untapped by more descriptive representations.

The Inverted Spectrum Argument

The differences between objective description and subjective experience are also highlighted by the philosophical notion of the inverted spectrum (see Lycan, 1973; Shoemaker, 1982). The inverted spectrum argument postulates the existence of a person whose apparent optical functioning is identical to a normal person's, but who nonetheless sees the colors of the spectrum in reverse order. Thus, while a normal person might see a given object as appearing-as-blue, a person with an inverted spectrum might see that same object as appearing-as-yellow. In such a case, there would be no differences in the verbal responses (i.e., in the external objective functioning) between a person with a normal spectrum and a person with an inverted spectrum (e.g., both say "blue" when presented with the same object), but there would be clear differences in the internal subjective experience, the qualia, upon which those verbal responses are based. A similar but more extreme version of this type of argument postulates an absent qualia (e.g., as might be found in an intelligent-appearing machine); again, there would be no differences in external functioning (objective responses) between an organism possessing qualia and an organism not possessing qualia, but there would be clear differences in internal experience (subjective responses).

The inverted spectrum and absent qualia arguments have been raised as objections against functionalism, the theoretical orientation upon which much of the computer simulation and modeling of cognition is based (Bechtel, 1988; readings in Block 1980a; Goldman, 1993; Lycan, 1990; Rosenthal, 1991), and to the extent that the inverted spectrum and absent qualia arguments are successful, then a portion of the human cognitive response (i.e., qualia) would remain unaccounted for within a functionalist approach.⁵ Indeed, Jackendoff (1987, p. 18) has noted that "computational

Symphony, however, to supplement the knowledge_d obtained from the score to give him more complete musical knowledge of the piece. Without such extensive background knowledge_{sp}, though, Beethoven's deafness would have prevented him from obtaining complete musical knowledge of the Ninth Symphony.

⁵ There is a wide diversity of opinion on this issue within the philosophical community. For example, Block and Fodor (1980; see also Block, 1980b) suggest that functional states cannot account for qualia, while Shoemaker (1980) suggests that qualia may be characterized only in so far as they cause beliefs, and Churchland and Churchland (1981; Churchland, 1986) have argued that only functional criteria are important and that cases of inverted qualia could not arise. The issue of qualia remains a troubling one, as there subjectively seems to be some aspect of experience beyond that which can be captured in purely mechanistic models of the mind (Bechtel, 1988; however, see Dennett, 1978). Indeed, Penrose (1990)

accounts may provide the right distinctions—they may, as it were, give the phenomenological mind the cue to produce experiences of blue at the right times and experiences of red at the right times. But that is not the same as producing the experiences themselves.” By analogy, although functionalist schematic or connectionist approaches could perhaps provide the cues for the experience of qualia, those cues would not be the same things as the experiences, and thus the nature of the qualia itself would remain unaccounted for.⁶ According to this line of thought, functionalist approaches may model important aspects of the computational mind, but they do not model important aspects of the phenomenological mind. In essence, functionalist approaches cannot account for qualia (see also Block, 1980b).

The inverted spectrum and absent qualia arguments appear to assume that differences in subjective experience (or lack of subjective experience) of the qualia are important. However, it may be objected that because such differences may not be observable in the behavior of an organism (e.g., drivers of two different automobiles both stop at a red light even though one sees the red-as-red and a second sees the red-as-violet), then any differences in subjective experience are irrelevant to the adaptive functioning of the organism. Both behavioral and cognitive theories explaining the stopping behavior claim that the drivers stopped because they saw a light possessing a wavelength of approximately 700 nanometers, and the nature of any inner experience of that particular wavelength of light would not be addressed. Neither behavioral nor cognitive theories would appeal to qualia in explaining the stopping of a driver because the behavioral level appears sufficient and no additional explanatory power would be provided by such an appeal. In the absence of additional explanatory power and with the impossibility (with current technology) of objectively measuring or specifying qualia, the qualia simply have not been included in our theories.

Inadequacies of Behavioral Tests of Qualia

The objections given to the inverted and absent spectrum arguments focus on the apparent lack of additional predictive power provided by qualia. Behavioral criteria are used to allegedly demonstrate that qualia do not appear to have any apparent necessary role in objective responding, and so Occam’s razor is used to trim qualia

goes so far as to claim that some mental processes (e.g., consciousness) are neither algorithmic nor computable!

⁶ A different interpretation of the nature of qualia is found in philosophers who argue for an eliminative materialist approach (e.g., Churchland, 1988; see also Stich, 1983), an approach in which the common-sense vocabulary of “folk psychology” is eliminated in favor of a precise, scientific vocabulary. The eliminative materialist approach suggests that folk psychological theories are simply incorrect and that no further understanding of cognitive activity will be possible unless folk psychological terms (e.g., beliefs, desire, fear, sensation, pain, joy, etc.) are eliminated. The eliminative approach seems unduly harsh and may end up throwing the phenomenological baby out with the folk psychological bathwater. While it is possible that our experiences of qualia may be completely inaccurate and that a psychologist with a fully developed perceptual psychology might one day say his nerves are firing at *X* frequency or in a *Y* pattern (instead of saying “I see blue” or “I hear a flute”), it seems more reasonable to begin with the supposition that our subjective experiences, including qualia, may have at least some validity and usefulness and are therefore worthy of explanation. Even if in the unlikely case qualia are not at all useful (and it is not clear why we would have evolved them if they were not useful), psychology would still face the task of explaining this element of human experience. Simple denial will not suffice.

away. Such a strictly behavioral approach to evaluating the subjective elements of mental experience has a clear precedent in the cognitive literature: the debate whether computers can be said to think and understand in the same way that humans can be said to think and understand. Some theorists consider that a computer running the appropriate program understands in the same way a human understands (Schank & Abelson, 1977) and has cognitive states (e.g., beliefs) in the same way a human has cognitive states (Newell & Simon, 1972), whereas other theorists (e.g., Dreyfus, 1993; Searle, 1980; Weizenbaum, 1976) disagree with such a strong identification of mental states with the syntactical execution of a computer program. Given that qualia are, if anything, mental states, we may be able to evaluate the importance of qualia by using tasks that were originally designed to evaluate whether computers think or have mental states.

Qualia and the Turing Test

One criterion that has been proposed for use in evaluation of whether a computer has mental states, understands, and is intelligent in the same way that a human has mental states, understands, and is intelligent is the Turing test. This test involves placing two people and a computer in three separate rooms. These three participants are allowed to communicate with each other via keyboards and printers. One human asks questions of the other two participants and must determine, based solely on the answers, which of the other participants is the other human and which is the computer. If the questioner cannot distinguish between the answers given by the other human and the computer, then the computer is said to have passed the Turing test. The logic of the Turing test requires that if the behavior (i.e., answers) of the computer is not distinguishable from the behavior of a human, then we are not justified in distinguishing between the computer and a human. We must then attribute to the computer all the mental states, experiences, and capabilities we would have attributed to the other human.

Using a Turing test to assess qualia would not reveal any differences between someone with a normal spectrum and someone with an inverted or absent spectrum because both individuals would respond with the same color name for any stimulus. The Turing test, therefore, fails to distinguish between individuals with different subjective experiences, and to make this type of failure more vivid, consider a slight modification of the Turing test such that the responses of Mary in the black-and-white room need to be distinguished from the responses of Jane, a normal individual with a history of seeing color. The inputs to both Mary and Jane are pictures presented on black-and-white video monitors, and Mary and Jane could be asked about the natural color of the objects in the pictures. If they are shown an apple, both might answer that the color of the apple was red, but for Mary the experience of saying "red" while looking at a shade of gray might correspond to the customary experience of red, but for Jane the experience of saying "red" while looking at a shade of gray would not correspond to the customary experience of red. Similarly, even though Fred might perceptually distinguish between red₁ and red₂, he might also just respond "red" to the picture of the apple, and although this verbal response would be identical

to Jane's or Mary's, the subjective experiences of Fred, Jane, and Mary would all be quite different.

Qualia in the Chinese Room

Critics of the Turing test (most notably Searle, 1980, 1993) have pointed out that the purely syntactic procedures used in computer programming may not capture critical aspects of the semantics or meaning in a cognitive process or experience. Searle's (1980) rebuttal of the Turing test, referred to as the Chinese Room, posits an individual locked within a room. In the room are numerous sheets of paper, and each paper contains some squiggles whose meaning, if any, is unknown to the person in the room. There are slots in one of the walls of the room, and pieces of paper containing apparently meaningless squiggles occasionally come in through one of the slots. When a piece of paper does come in, the person in the room consults a book which tells him, based on the pattern of squiggles on the newly arrived paper, which other piece of paper to select and pass out through one of the slots. Searle then explains that the squiggles are actually Chinese characters, but that the person in the room doesn't read or speak Chinese; all he has is a book (in his native language) which tells him which pieces of paper to select and pass out in response to any given pattern of input. Searle then supposes the person in the room gets a lot of practice and becomes very fluent in this task, so fluent, in fact, that from a perspective outside of the Chinese Room the responses (i.e., the speed and content of output) are indistinguishable from those of a native Chinese speaker.

The question then asked is: Does the person in the room understand Chinese? Searle's intuition is that the person in the room does not understand Chinese, at least, not in the way that a native speaker of Chinese could be said to understand Chinese. Importantly, this failure to understand Chinese occurs despite the person in the room appearing to pass the Turing test. Although the person in the Chinese Room clearly has mastered the syntax of matching particular patterns of squiggles with other patterns of squiggles, he does not have knowledge of the semantics of the squiggles; in other words, he knows how to manipulate the patterns and sequences of symbols, but he does not know or understand the meaning of the symbols. By analogy, Searle argues that a computer does not think or understand in the same way that a human thinks or understands; much like the person in the Chinese Room, all that a computer can do is manipulate the patterns and sequences of symbols, but a computer cannot know or understand the meaning or content of the symbols. One implication of this is that a strictly behavioral criterion such as the Turing test is not appropriate in evaluating the existence of mental states. For our purposes, we would note the subjective experience of matching sets of squiggles whose meaning, if any, is unknown would be very different from the subjective experience of conversing in Chinese.

The question of whether the person in the Chinese room understands Chinese in the same way that a native Chinese speaker outside of the room would understand Chinese is directly analogous to the question of whether Mary in the black-and-white room understands "red" in the same way that a person with normal color vision and outside of the black-and-white room would understand "red." Just as a person in

the Chinese Room may know to match one pattern of input squiggles to a particular pattern of output squiggles, so too, Mary in the black-and-white room may know that the word "red" should be applied when the light that enters her eye has a wavelength of approximately 700 nanometers. Even though Mary might know the correct word, and the objective descriptions of the correct situations in which to apply the word, she need not know the meaning of the word in the sense that she understands "red" in the same way a person outside the black-and-white room would understand "red." Mary in the black-and-white room might know the syntax of using spectral terms (i.e., could possess knowledge_d), but she would not know the subjective content, that is, the experiential meaning or the qualia, of spectral terms (i.e., could not possess knowledge_{sp}).

A similar tale may be told if we consider differences between red₁ and red₂. Although with Fred's help we might understand that the word "red₁" should be applied to light of wavelength *X* and the word "red₂" should be applied to light of wavelength *Y*, we still could not experience or understand the difference between red₁ and red₂ in the same way that Fred experiences or understands this difference because our knowledge of red₁ and red₂ would be like black-and-white Mary's knowledge of red: we know that light of wavelength *X* should be called red₁ and light of wavelength *Y* should be called red₂. We would know the correct words, and the correct situations in which to apply the words (assuming we had an objective measure of the wavelength of the light), but we would not know the experiential meaning or qualia of red₁ or red₂ in the sense that we would understand red₁ and red₂ the same way that Fred would. Just as the person inside a black-and-white room might have knowledge_d of spectral names but cannot have knowledge_{sp} about the experience of particular spectral color, we might have knowledge_d about the differences between red₁ and red₂ but we cannot have knowledge_{sp} about the differences between red₁ and red₂; this difference is analogous to a person in the Chinese Room possessing knowledge about the syntax of when to output a particular squiggle (akin to knowledge_d) but not possessing knowledge about the semantics or meaning of that particular squiggle (akin to knowledge_{sp}).

Much as the original Chinese Room argument purports to demonstrate that computers do not understand or have mental states in the same way in which humans can be said to understand or have mental states because computer programs focus on the syntax and syntactical manipulation and ignore the semantics (i.e., focus on manipulating symbols and ignore the meaning of the symbols), it will be suggested here that contemporary theories of imagery focus on the syntax of imagery and ignore the semantics. In the case of imagery, the syntax of imagery corresponds to how the image is used or transformed and the semantics of imagery corresponds to the content, that is, the qualia of the image. The consideration of both the Turing test and the Chinese Room scenario also suggests that methods of assessment which rely on behavioral measures can easily miss detection of differences in experience. At a gross level of prediction or control these omissions may not be important, but if the goal is to understand not just the objective behavioral response but also the subjective experience that may generate or determine that objective behavioral response, then arguments that considerations of qualia are not important or that qualia do not exist because they are not detected by behavioral measures are simply incorrect.

Whither Qualia?

The discussion of the Turing test and the Chinese Room scenarios demonstrates that many objective behavioral measures may be insensitive to the nuances of qualia and differences in subjective experience. Even so, in many cases prediction and control at a gross level do not seem to be influenced by this lack of sensitivity (e.g., both a person with a normal spectrum and a person with an inverted spectrum would produce the same color name in response to the same chromatic stimulus), and so one might then wonder whether anything might be gained by broadening psychological models to consider or include more qualia. It is not clear if current models of imagery (or models of other cognitive or behavioral processes, for that matter) make predictions at odds with predictions that might be made from models which consider or include more aspects of qualia; at the very least, however, increasing our understanding of qualia within images would certainly provide a better understanding of imagery and mental representation, even if the image (and by extension, the qualia inherent in the image) is merely epiphenomenal and thus not deserving of a causal role in models of cognition (cf. Kosslyn & Pomerantz, 1977). Before we consider arguments demonstrating the importance of qualia, it would be useful to respond to some of the more common criticisms and arguments against qualia.

Responses to Previous Objections to Qualia

Dennett (1990, 1991) argues that qualia do not in fact exist, and he considers several “intuition pumps” that he suggests highlight fatal flaws in our conception of qualia. One alleged flaw is the intuition that we can isolate the qualia from everything else and a second alleged flaw is the intuition that we can conceive of qualia as some residual of “the way things are” independent of how individuals are stimulated or affected and independent of how those individuals are disposed to believe or behave. These alleged flaws are based on properties traditionally attributed to qualia such as a person having direct apprehension of or access to his or her own qualia, the intrinsic nature of qualia to experience, the private nature of qualia, and the general ineffability of qualia. Dennett (1990, 1991) argues that in various instances qualia may be shown to not possess these traditional characteristics, and even though he is quite correct in pointing out that qualia need not be the ineffable, intrinsic, private, or immediately apprehensible and infallible experiences they are often considered to be, Dennett subsequently overstates his case when he then concludes that there are thus no qualia at all.

In an example based on an intrapersonal inverted spectrum, Dennett posits a case in which a person wakes up one morning to find his qualia experiences are different (e.g., the sky looks yellow, the grass looks red, etc.). Dennett suggests two possible interpretations for such an apparent shift in qualia: changes in which photoreceptor is stimulated by a given wavelength of light and changes in which memories are activated by which color words. The former interpretation suggests a change in qualia per se, whereas the latter interpretation suggests apparent qualia may be changed without changing the receptor or qualia per se but by merely manipulating the memory links associated with different experiences. Dennett takes this latter possibility as a refutation of the claim that a person has direct and immediate apprehension of

his or her qualia, thus allegedly invalidating the qualia notion. Although Dennett is quite correct in pointing out that the source of a subjective experience may be unknown, he overstates his case by arguing that the experience itself does not therefore exist. To make this point even more strongly, we can consider the notion of displaced pain [i.e., pain manifested in an area away from the actual area of damage or malfunction (e.g., a heart problem may be felt as pain or numbness in the arm or shoulder)]. Even though the origin of displaced pain may be uncertain or incorrectly attributed, that uncertainty or incorrect attribution does not negate the existence of the pain. Therefore, even if a person is confused concerning the origin of his or her qualia, it need not follow that those qualia do not therefore exist.

In another example, Dennett points out the difficulties of separating the effects of qualia from the effects of a person's attitudes regarding qualia. For example, in a person whose taste preferences have changed over the course of time (e.g., acquiring a preference for the taste of beer when such a preference did not initially exist), is the change due to changes in the qualia (substances actually taste differently than they used to), the attitude toward the substances involved (perhaps different standards for an unchanged taste), or some combination of qualia and attitude? In many cases the precise role of each possible contributing factor might be impossible to determine, and Dennett uses this to suggest that qualia are logical constructs rather than immediately given experiences. However, even if attitude did not contribute to qualia, it would still be possible (even likely) that qualia experiences involve some logical construction, as what often seems to be immediately given in awareness is usually the result of a great deal of cognitive processing. The true cause of a given quale may not be known, and we might not be able to remove all possible modulating factors (such as attitudes), but this should not invalidate the existence of the experience in itself. In support of this, it should be noted that the common observation that qualia can be "educated," as in ear training in a musician or palate training in a wine taster, does not invalidate the fact that there is some phenomenological experience, regardless of the level of sophistication, training, or knowledge of the individual.

The existence of perceptual qualia has also been rejected by Tye (1991), who also denies that visual images and percepts have any intrinsic, nonintentional features in virtue of which those images and percepts have their contents. Tye quite correctly points out that the subjective nature of an image need not tell us anything about the format of the image or about the way that information is encoded (see also Anderson, 1978; Marschark, Richman, Yuille, & Hunt, 1987); however, Tye seems to suggest that the format rather than the content of our representations is what is most critical to our experience and our qualia. Despite his rejection of qualia, Tye allows that images and percepts may have subjective, introspective aspects and he suggests that what makes a visual (or perceptual) experience a visual (or perceptual) experience is determined not by the presence of qualia but rather by the functional role of the experience. Indeed, Tye states that "What makes my experience visual is not, I maintain, its having certain qualia . . . the property of being a visual experience is not itself classifiable as a visual quale . . ." (p. 124). Given that Tye admits images and percepts may have subjective and introspective elements, however, it is not clear

how his objections against qualia apply to our use of the term as denoting subjective sensory–perceptual experience.

The Appearance of Qualia Must Still Be Explained

Even if qualia are ultimately rejected by a mature cognitive science as mere figments of a hopelessly deluded folk psychology, and such an outcome is by no means certain, it still remains for us to account for why such experiences or delusions arise in the first place. One type of explanation involves reducing the range of our sensations for any given sensory qualia and modality down to specific values along a limited number of dimensions and then determining the neurological underpinnings of those dimensions. Qualia clearly are created and represented within the brain and nervous system and both brain imaging (e.g., Kosslyn, Alpert, Thompson, Maljkovic, Weise, Chabris, Hamilton, Rauch, & Buonanno; 1993; Zatorre, Halpern, Perry, Meyer, & Evans, 1996) and clinical (e.g., Trojano & Grossi, 1994) studies suggest particular types of sensory-like experiences result from neural activity in particular brain regions. Presumably, changes in qualia (e.g., an inversion of spectrum) would also be accompanied by either structural or functional changes in the brain.

A strong version of neurological reduction attempts to explain (or, perhaps more precisely, explain away or eliminate) qualia by making qualia identical to neural activity. For example, color seems to be coded at the retinal level by three different types of cones which code for short, medium, and long wavelengths, and Churchland (1990) suggests that the visual sensation (i.e., qualia) of any given color is literally identical with a specific triplet of spiking frequencies in the retinal system. Even if such a neurological reduction or elimination of qualia is possible, however, it still remains to explain the *subjective* sensation of the *objective* neural activity and how phenomenological characteristics emerge out of electrochemical activity in a neuron (or perhaps out of any other substance in the same functional role). Along these same lines, Jackendoff (1987, p. 13–14) has noted “it is one thing to provide neurological *distinctions* among qualia—to say that one bunch of neurons is activated for blue, another for red, another for saltiness—but quite another to explain how blueness *as you or I perceive it* arises from what our brains are doing.” Thus, although neurological reduction may tell us how qualia seem to be instantiated or represented in our brain and nervous system, neurological reduction per se does not tell us why our qualia (and other subjective experiences) are as they are and exhibit the subjective qualities they do.

A consideration of phenomenological properties is therefore necessary, and tactics such as denial, elimination, or redefinition of qualia err by failing to take into account the distinctions between subjective sensation and objective neural activity and between knowledge_{sp} and knowledge_d. For example, both Dennett’s answer to the black-and-white Mary and his general argument that qualia do not exist ignore the existence of knowledge_{sp}; in the former case, Dennett ignores that knowledge_{sp} cannot be obtained while within the black-and-white room, and in the latter case, he ignores that experience of some kind (i.e., knowledge_{e,sp}) occurs in a (nonpathological) response to a stimulus even if there are confusions or uncertainties regarding aspects of the

experience. Although some of Dennett's (1991) points regarding qualia and cognitive processing may be well taken (most notably his argument for distributed representation rather than an "observer" sitting in a "Cartesian Theater," see Hubbard, 1994b), his denial of phenomenological characteristics and his restructuring of phenomenology into a heterophenomenology more akin to literacy criticism than to perceptual experience misses the essence of (nonverbal) qualia and of imagery. Similarly, Churchland's insistence on neurological reduction and elimination of qualia ignores the question of how phenomenological characteristics emerge out of electrochemical activity in a neuron (or perhaps out of any other substance in the same functional role).

A Place for Qualia in Psychological Theories

Traditional arguments for the importance of qualia have often relied on *gedanken* experiments of the type discussed here concerning Mary in the black-and-white room and Fred's differentiation of red₁ and red₂. Although these philosophical arguments may be more or less convincing, it would also be helpful to demonstrate a more empirical usefulness of qualia. As suggested earlier, it may initially appear that qualia are not important for a low level of prediction of behavioral responses to certain types of stimuli. For example, an automobile driver in America will (hopefully!) come to a stop when the top light on a standard vertical American traffic signal is illuminated, and this stopping behavior should occur regardless of any idiosyncratic differences in the subjective hue or even regardless of whether the driver has a normal or an inverted spectrum. However, this example may be misleading because it emphasizes only a portion of the total qualia, the subjective experience of hue. It could be argued that the discrimination of which position on the traffic signal is illuminated involves determining which location is subjectively brighter, and the experience of which is brighter and of the difference in illumination levels involves qualia. Thus, even when qualia appear superfluous in predicting behavior, it may simply be that the wrong aspects of qualia are being considered (e.g., hue instead of brightness).

If we are not content to simply predict behavior, but rather wish to understand and explain those behaviors, then a consideration of qualia becomes more important. This point was clearly illustrated in the consideration of the Turing test and Chinese Room scenarios discussed earlier and can also be made with less artificial examples. For example, consider the case of two persons who ate identical meals and then at dessert decline slices of a pie made from seven different layers of chocolate. How might we explain such chocolate-avoidance behavior? Are the diners full? Do they not like chocolate? The behavior of the diners to that point does not reveal an answer, but an explanation of their chocolate-avoidance behavior may lie in their subjective experience: they may already feel satiated, they may not like the taste of chocolate, and so forth. Importantly, the different diners might even have different reasons for declining dessert (perhaps even unrelated to qualia per se, e.g., fears of weight gain), but in many cases we would not necessarily be able to explain their behavior unless we considered their subjective experience. This example also underscores the point made earlier that qualia (or the desirability of a particular quale) may be influenced by modulating factors such as attitude or perhaps emotional valence.

The distinction between knowledge_{sp} and knowledge_d also points to a place for qualia within psychological theories and supports the notion that a consideration of qualia can aid in predicting and explaining behavior. It may be the case for at least some types of stimuli that if we knew the content of a person's knowledge_{sp} about some stimulus, we might be able to predict his or her actions more accurately than if we knew the content of his or her knowledge_d about that stimulus. For example, both a cigarette smoker and a nonsmoker may possess knowledge_d of the dangers of smoking to respiratory health, yet knowledge_{sp} of inhaling cigarette smoke of a cigarette smoker and a nonsmoker may exhibit different qualia and be associated with different subjective experiences. Knowledge_{sp} may better distinguish between the individuals and thus be a better predictor of whether one of the individuals would voluntarily smoke a cigarette if the opportunity were offered to him or her than knowledge_d would be. More generally, if we know that one person finds a particular stimulus pleasant and a second person finds that same stimulus aversive, then knowledge of their different subjective experiences regarding the stimulus might let us more accurately predict the objective behavioral responses to each person to that stimulus. Indeed, according to this idea, even simple conditioning models or procedures should be mindful of qualia, as it is the subjective experience that determines (at least in part) whether a given stimulus is reinforcing or aversive.

From the examples just given, it might appear that consideration of qualia is a less-than-desirable option that is useful only as long as our knowledge of an individual's learning history is incomplete. If we had complete information about an individual's learning history, then that individual's response to any stimulus might be accurately predicted without having to consider the subjective experience. For example, if we knew that one of the diners who refused the chocolate dessert was diabetic or had a history of anorexia, then that objective behavioral information might have predicted that diner's response to the chocolate dessert. However, an appeal to learning history as a way to eliminate qualia is reminiscent of Dennett's response to the black-and-white Mary in that both strategies appeal to a complete descriptive knowledge in an attempt to diminish the importance of subjective experience; in essence, both learning theory and Dennett's objection focus on an extensive knowledge_d and ignore knowledge_{sp}. Although it is certainly true that a more extensive knowledge of an individual's learning history might improve the accuracy of prediction of that individual's behavior, it need not be true that even a complete knowledge of an individual's learning history would provide a complete explanation and that no additional information could be gained by a consideration of subjective experience. Even if we possessed a complete knowledge_d based on an individual's learning history, we would still need to consider that individual's knowledge_{sp} of the stimulus before we could be said to have complete knowledge of his or her cognition and behavior.

Presumably all individuals would exhibit at least some knowledge_{sp} of any stimulus they encountered, and so this leads to perhaps the most important reason for incorporating a consideration of qualia into our psychological theories: people (and based on phylogenetic similarity, presumably at least some other organisms) have subjective experiences. In Nagel's terminology we can say that there is something it is like to be a person (or other organism) perceiving and experiencing some stimulus. Even if the subjective experience is merely epiphenomenal and doesn't play a causal role

in behavior, the subjective experience still exists, and if it exists, then in any complete or mature cognitive science it should be explained regardless of its importance or role. Furthermore, even if for some types of behavior more abstract representations offer a better description of the data and offer better predictions (e.g., semantic priming, schema-consistent distortions in memory, etc.), at least a part of our knowledge (e.g., episodic memory, autobiographical memory) remains experiential in nature, and psychological theories which do not include this experiential component must be incomplete.

PART II: WHERE IS THE "IMAGE" IN MODELS OF "MENTAL IMAGERY?"

The black-and-white Mary, Fred's red₁ and red₂, and the inverted spectrum arguments have traditionally been presented as addressing the qualia of perception. Similarly, the discussion of the modified Turing test and Chinese Room scenarios focused on evaluation of the qualia of perception. The discussion focused on the qualia of perception because the traditional arguments for qualia considered perception, but the arguments can easily be recast to address qualia in imagery; for example, instead of showing black-and-white Mary and color Jane pictures over a video monitor, we can simply ask them to visualize the objects and report on the color portrayed in their images. Indeed, the argument for a consideration of qualia in imagery is even stronger, as the subjective colors imaged by black-and-white Mary and color Jane would undoubtedly be quite different (as could easily be revealed by a matching-to-sample or production procedure). Consideration of the sensory-like aspects of imagery highlight the similarities between the experiences of perceiving a stimulus and imaging that stimulus, and so before considering the role of qualia in different models of imagery we will briefly consider a possible relationship between the qualia of imagery and the qualia of perception.

Functional Equivalence of Imagery and Perception

Looking at an image in the "mind's eye" is often subjectively similar to the experience of inspecting a physical object with the physical eye, and this similarity of the subjective experiences of imagery and perception might result from imagery sharing (or otherwise utilizing) at least some of the processes or structures that are normally used in perception. This idea has been referred to as *functional equivalence* (Finke & Shepard, 1986) and *perceptual equivalence* (Finke, 1989) and is supported by psychophysical (e.g., Baird & Hubbard, 1992; Farah, 1985), chronometric (e.g., Brooks, 1968; Hubbard & Stoeckig, 1988; Kosslyn, 1980; Shepard & Cooper, 1982), and neurophysiological (e.g., Farah, 1988; Farah, Weisberg, Monheit, & Peronnet, 1989; Kosslyn, 1994) evidence. Indeed, Jackendoff (1987) has gone so far as to suggest that the "visual buffer" in Kosslyn's (1980) theory of imagery is in fact equivalent to the "2½ D sketch" in Marr's (1982) theory of vision. Shepard and Podgorny (1978) pointed out that many cognitive processes seem to resemble perceptual processes, and to a perhaps surprising extent many techniques initially developed for the study of perceptual processes have been fruitfully adapted to the study of cognitive processes (e.g., see Algom, 1992; Hubbard, 1994a).

Although many researchers accept that images are processed by at least some mechanisms that are similar to or even identical with the mechanisms used in the processing of percepts (e.g., Farah, 1985, 1988; Finke, 1980, 1985; Finke & Shepard, 1986; Kosslyn, 1980, 1987, 1994), such a position is not universally accepted (e.g., Pylyshyn, 1981, 1984; Chambers & Reisberg, 1985). After an extensive review of the literature, Finke and Shepard (1986) concluded that while different alternative explanations for each empirical result can be given, the hypothesis of a functional equivalence between imagery and perception is the single best overall explanation for results across a wide domain of experimental tasks. If we grant at least a partial functional equivalence between perception and imagery, then we can extend Raffman's claim that certain perceptual discriminations cannot be described and the importance of the distinction between knowledge_{sp} and knowledge_d to imagery. In essence, imagery might contain a type of knowledge_i, that is, sensory–perceptual information included within the image but that cannot be described. If there is at least a partial equivalence between perception and imagery, then it is possible that information that may have begun as knowledge_{sp} is recreated within an image as knowledge_i.

Depiction and Description

The characteristics of knowledge_{sp} or knowledge_i contribute to the subjective sensory–perceptual experience of imagery and, as discussed earlier, help make an image different from a description. What are the specific characteristics of knowledge_{sp} or knowledge_i that make imagery different from description? Kosslyn's (1980) distinction between descriptive (propositional) and depictive (quasi-pictorial) representations may shed light here, as this distinction is similar to the distinction between knowledge_d and knowledge_{sp}. Descriptive representation parallels knowledge_d and is abstract, arbitrary, possesses a truth value, need not possess any isomorphism between parts, and need not specify certain properties (e.g., a description of a box need not list the color of the box). Depictive representation parallels knowledge_{sp} and is concrete, nonarbitrary, need not possess a truth value, possesses a (functional) isomorphism,⁷ and must specify certain properties.⁸ What makes an image an "image"

⁷ In Kosslyn's (1980) theory the medium is quasi-pictorial; that is, it performs many of the same functions as a picture, the most important of which is the preservation of metric space. For example, if on a real object points A and B are farther apart than points C and D, then this spatial relationship is also preserved in the image of that object. This does not mean that images are literally pictures in the head or must correspond precisely with the features of the referent objects; indeed, such a position is clearly untenable as, for example, an image of a green elephant would then itself have to be green and shaped like an elephant. While the medium in which images occur preserves those (spatial) relationships that would be found in the object, the nature of this preservation need not be physically isomorphic with the object, but may be functionally isomorphic. Shepard and Chipman (1970) have referred to this functional preservation as second-order isomorphism [although Pomerantz and Kubovy (1981) have suggested that this notion of second-order isomorphism more properly describes the similarities between relations among percepts and relations among images, rather than any similarities between a physical object and the representation of that object in the physical brain].

⁸ For example, Kosslyn's (1980) ideas about depiction suggest that properties such as color, size, shape, orientation, and location information are not independent within a visual image and that specification of a value on one dimension requires simultaneous specification of values along other dimensions. For

is the way that information is represented; specifically, images involve a recreation of sensory experience and qualia in a way (depiction) that mere abstract remembering (description) does not.

The Tiger Stripes Objection

One objection to a purely depictive view of images is given by Dennett (1981), who suggests that we can often image objects without having to specify certain aspects or properties of the imaged object. For example, Dennett suggests that if he images a tiger, and that image is purely depictive, then he ought to be able to specify (i.e., count) the number of stripes on his imaged tiger. Dennett, however, claims that his image of a tiger could have an indeterminate number of stripes, thus leaving him unable to count those stripes. Dennett takes this supposed inability to count stripes on an imaged tiger as evidence of a descriptive (rather than depictive) character to images because a description, unlike a depiction, need not explicitly specify the number of stripes. Dennett's idea of description is also consistent with studies showing that subjects often are unable to "see" an alternative interpretation of (e.g., reverse) an image of an ambiguous figure (Chambers & Reisberg, 1985; Reisberg, Smith, Baxter, & Sonenshine, 1989; but see Finke, Pinker, & Farah, 1989; Peterson, Kihlstrom, Rose, & Glisky, 1992); in fact, Chambers and Reisberg (1985) have similarly suggested that images must be accompanied by a description and that it is this description that prevents subjects from reversing an imaged ambiguous figure.

Any apparent ambiguity of stripes on Dennett's tiger, however, need not invalidate the role of depiction (and hence the importance of qualia) in images. Even if we grant for the moment that clear, distinct, and potentially countable stripes may be seen on an actual tiger, it is probable that a person who visually perceives a tiger does not know how many stripes the tiger has either, especially if the perception is of short duration or occurs under less than optimal conditions. With plenty of time and a ready supply of tiger tranquilizer handy, one could always corner a real tiger and then count the stripes, but then additional information concerning the tiger would be continuously available, and so the intrepid counter need not rely on his "first glance" or "first impression," but can take the time to look at each stripe individually. Similarly, perhaps an initially imaged tiger might not have a determinate number of stripes, but if attention is directed toward the area of stripes (perhaps by "zooming in" on that region, see Kosslyn, 1980), stripes may resolve themselves and be counted. Thus, denying a sensory-like component to imagery merely on the basis of an image recreating some scene with less than perfect accuracy or less than optimal

example, try to image a square that doesn't have a specific size, location, or orientation. In contrast, it is quite easy to achieve a nonimaginal format (such as a propositional network) in which values for some qualities could be listed without specifying values for other qualities. Similarly, Hubbard and Stoeckig (1992) speculated on the nature of depiction in musical images and have suggested that just as the depiction of a visual object by a visual image specifies basic information about the color, size, shape, orientation, and location of that object, so then must the depiction of a musical "object" by a musical image specify basic information such as pitch, loudness, duration, timbre, and temporal sequence. For example, it intuitively seems quite difficult to image a specific pitch without extending it in time or without some particular loudness or timbre.

resolution is unfair because it is highly doubtful that perception under similar “first glance” temporal constraints would fare significantly better.

By basing his rejection of qualia on the claim that he is unable to count the stripes on an imaged tiger because the stripes are blurry, fuzzy, or indistinct, Dennett presumably would have to admit to experiencing qualia if the stripes on his imaged tiger were not blurry, fuzzy, or indistinct, that is, if the stripes were clear, distinct, and well-focused. Dennett’s seeming criteria for the existence of qualia of clarity and distinctiveness quickly lead astray, however, because these criteria suggest that subjective sensory-like experience of a blurry visual stimulus would be impossible. Although the conclusion that blurry qualia cannot exist might be a delight to one who has misplaced eyeglasses or is suffering from an alcoholic hangover, it is simply incorrect. Our experience of qualia does not include just the clear, distinct, and well-focused, but it also includes the blurry, the indistinct, and the ambiguous. As discussed earlier, qualia of some type are experienced upon perception or imaging a stimulus regardless of a person’s knowledge, experience, or sophistication about that type of stimulus or regardless of how clear, distinct, or focused the percept or image is. Denying the existence of subjective experience on the basis of less than optimal or uncertain qualia is simply incorrect, and denying a sensory-like component to imagery merely on the basis of an image recreating some scene with less than perfect accuracy or less than optimal resolution is similarly incorrect.

A More General Ambiguity Objection

Dennett’s tiger stripes objection is based on a purported ambiguity in a portion of a mental image. Fodor (1981) has also suggested that mental images may appear ambiguous unless the image contains or is accompanied by a descriptive or schematic component or tag. For example, Fodor discusses the difficulty of distinguishing an image of “John is fat” from an image of “John is tall.” In the image of “John is tall,” John would still have to have some shape. What shape would we use? If we use the same shape as in our “John is fat” image, then how can our representational system distinguish between the two separate thoughts that “John is tall” and “John is fat?” According to Fodor, the only way to distinguish between these two images is by a schematic tag which specifies either “tall” or “fat.” Wittgenstein (1953) proposed a similar dilemma: How would a representational system distinguish between an image of a man climbing up a hill and an image of a man going backward down a hill? Ignoring for a moment the issue of whether images need to be “interpreted” in this way or not, we can call this position the argument from ambiguity. The argument from ambiguity suggests that a description must be appended to (at least some) images in order to clarify the ambiguity of exactly what is portrayed in the image, and so the image would need to be at least partially schematic. In other words, the image would contain or be tagged with knowledge_d. It might then be argued that imagery does not correspond to sensory–perceptual experience (knowledge_{sp}) and that qualia are not therefore a property of images.

The argument from ambiguity fails because it assumes that knowledge_d accompanying an image eliminates, negates, or overrules qualia arising from knowledge_{sp}. In essence, the argument from ambiguity fails for the same reasons that Dennett’s tiger

stripes objection and Dennett's earlier objection to black-and-white Mary fails: knowledge_{sp} is ignored. A person experiencing an ambiguous image is still experiencing something, and that experience corresponds to the knowledge_{sp}, the qualia, of the image. Subjective experience does not need to be certain or unambiguous in order to be counted as subjective experience; the qualia of a perceived or imaged stimulus correspond to the experience of that stimulus regardless of how vivid, faint, clear, or ambiguous that stimulus may be. In other words, a stimulus does not have to be clear, distinct, and completely understood before a person can have any experience of it. As discussed earlier, a myriad of factors such as training, background knowledge, or sophistication may influence the quality of an experience, but a person will still have some subjective experience when presented with a stimulus regardless of his level of training, background knowledge, or sophistication. Even if some schematic knowledge_d is tagged to or otherwise incorporated into the image, as long as at least some knowledge_{sp} (or perhaps knowledge_i) contributes to the image, qualia of some sort will be experienced.

Qualia in Models of Imagery

In Part I we established the broad importance of qualia and subjective experience to models and theories attempting to understand and explain cognitive and behavioral processes, and we will now narrow our focus and examine how well the primary contemporary approaches to imagery account for qualia. The discussion of depiction and description suggests that knowledge_{sp} is more depictive than descriptive, and so we will focus primarily on the depictive spatial analog models. It will be suggested that although spatial analog models may account for some of the qualia associated with spatial transformation (e.g., duration), it is not clear how nonspatial qualia may be accounted for within spatial analog models. It will also be suggested that schematic models of imagery do not offer an accounting of qualia because the abstraction inherent in schemata may not allow recreation of the precise sensory–perceptual experiences; in essence, schematic knowledge would be abstract knowledge_d and not concrete knowledge_{sp}.

Qualia in Analog Models

The most fully developed theory of visual imagery is surely that put forward by Kosslyn (1980, 1981, 1994), who posits two major components to visual images: the surface representation (which depicts an object) and the deep representation (which contains the information held in long-term memory that is used in the creation of the surface representation). The surface representation occurs in an analog medium which Kosslyn calls the “visual buffer.” The visual buffer of imagery may be shared with visual perception and is a “functional space,” with its functionality defined by the way various cognitive processes access locations in the buffer. For example, the preservation of functional space in an image is shown by the finding that subjects take longer to scan across a greater imaged distance, just as they would take longer to visually scan across a greater perceived distance (Kosslyn, Ball, & Reiser, 1978). Once the surface representation is created, there are a number of syntactic processes

that may operate on it, including procedures that generate, inspect, and transform visual images.

Although the surface representation corresponds to what we "see" when we "see" a visual image, the precise status of qualia within the surface representation is not clear. In fact, Kosslyn's model has been instantiated in a computer program (Kosslyn & Schwartz, 1977), and the computer presumably would not (or need not) experience the same qualia as a human being. Kosslyn discusses the visual buffer as though it were a CRT screen in which various pixels are either "turned on" or "turned off," thus resulting in an "image" that is little more than a simple line drawing. While this may certainly be a useful approximation toward a model of visual imagery, it is not clear how far the CRT metaphor can be extended for visual imagery (for one limitation, see Hubbard & Baird, 1993) or whether the CRT metaphor can account for the full richness of imagery in other modalities (although see Hubbard & Stoeckig, 1992, for speculations on how Kosslyn's approach might be adapted for a first approximation toward a model of musical imagery). Thus, even though Kosslyn's model successfully captures a great deal of data concerning the *spatial information* in an image [in fact, Kosslyn & Pomerantz (1977) define an image as "a spatial representation like that underlying the experience of seeing an object during visual perception"], it is not clear if it is able to capture the full range of the *qualia*.

Another theory of imagery based upon analog representation has been proposed by Shepard (1981; see also Shepard & Cooper, 1982). Shepard's notions were originally based on the finding that subjects required greater amounts of time to compare targets if the targets differed by greater degrees of angular disparity, but his notions have subsequently been broadened to include many types of rigid and some nonrigid types of spatial transformation. For example, consider two different physical objects, A and C, which are actually the same shape but appear to be different because they differ by some physical transformation such as rotation or translation in either the picture or the depth plane. Shepard (1981) suggests that in establishing the equivalency of the physical objects A and C, the mental representation of object A is transformed and compared to the mental representation of object C and that during transformation the mental representation of A must pass through an intermediate form B, just as the physical object A would have to pass through an intermediate form B. For example, in rotating a physical object from the upright to 90°, the object has to pass through all of the orientations intermediate to the upright and 90°, and in mentally rotating an imaged object from the upright to 90°, the representation of the object has to similarly pass through all of the orientations intermediate to the upright and 90°.

The intermediate states of the mental representation have a one-to-one correspondence with the intermediate states of the physical or proximal stimulus, even when the physical object is not seen while in the intermediate state (see also Cooper, 1976). Shepard and Chipman (1970) suggest that such a one-to-one correspondence or isomorphism between a physical object and the mental representation of that object is not a correspondence involving elements (i.e., a first-order isomorphism), but may be a correspondence in function or processing (i.e., a second-order isomorphism). The possibility that the correspondence between an object and the mental representation of that object is a first-order isomorphism involving elements may be easily ruled out

(e.g., a visual image of a pink elephant would not itself be pink and shaped like an elephant), but the similarities in the time required to mentally manipulate an image and to physically manipulate an object support the possibility of a more abstract second-order isomorphism. Shepard (1981) further suggests that such a second-order isomorphism would be one of complementarity more than one of similarity or resemblance.⁹ This complementarity cannot be concrete but must be abstract or functional, and Shepard suggests that sensory processes “preserve structural information only in a very abstractly isomorphic or ‘paramorphic’ form . . . they certainly do not preserve it in any concretely isomorphic form” (1981, p. 292).

What would be the place of qualia in a scheme such as Shepard’s which is based more on complementarity than on resemblance? Pomerantz and Kubovy (1981, p. 432) point out that “The two domains that Shepard and Chipman showed to be isomorphic are *percepts* and *images*, rather than physical objects and mental representations. . . . There is a need for two concepts—one to denote the relation between imaginal representations and perceptual representations, and the other to denote the relation between the world and mental representations. . . . We propose to reserve ‘second-order isomorphism’ for the former concept and ‘psychophysical complementarity’ for the latter.” Pomerantz and Kubovy (1981, p. 433) further suggest that “it should be clear that psychophysical complementarity (physical–mental correspondence) implies second-order isomorphism (imaginal-percept correspondence).” Although this may be true, such an implication need not be a biconditional, and so while it may be possible to gain insight on the nature of qualia by looking at the isomorphisms or resemblances between imagery and perception, it is not clear how to best examine correspondences or complementarities between mental representations and real world objects.¹⁰ Nonetheless, given psychophysical complementarity and that both percepts and images involve mental representation (and if any version of the functional equivalence hypothesis is correct, perhaps even the same types of mental representation), to the extent that we grant qualia to percepts, we may also safely grant them to images.

Spatial Analog Representation, Qualia, and Knowledge-Weighting

Much of the data underlying both Shepard’s and Kosslyn’s theorizing about imagery is based on studies of mental rotation and image scanning. In imaging a rotation

⁹ Shepard points out that the mental representation which would best serve recognition or controlling functions need not physically resemble the stimulus and, as an analogy, discusses the relationship between a lock and a key. While a lock and a key certainly need not physically resemble each other, the relationship between a lock and key is complementary, as the structure of any given key will match the structure of (i.e., fit into and unlock) only one lock (or at least a limited number of locks). Thus, our mental representation of an object should be complementary, and not necessarily similar, to that object. Such mechanisms are not unprecedented in biological evolution; for example, both protein production and DNA replication coding mechanisms have been proposed to involve such lock and key-like complementarities.

¹⁰ Although such an argument sounds vaguely Kantian . . . if we cannot speculate on the relationship between mental representations and real world objects, how can we possibly come to know the noumenal object-in-itself? It is the nature of this connection between our mental representations and real world objects that Shepard (1981), however, sees as the central question of perception.

or scanning across an image, spatial aspects of the image are manipulated. A limited subset of qualia may be captured by the analog media hypothesized to underlie spatial transformations in imagery (e.g., the experience of duration), but it is not yet clear how far, if indeed at all, the analogies, correspondences, or isomorphisms extend beyond considerations of spatial transformations to include nonspatial aspects of qualia. While certain first-order isomorphisms have been rejected (and rightfully so), to what extent could there be some type of analog representation in the absence of spatial information? What would be the characteristics or properties of a nonspatial analog representation? Even though spatial analog models do an admirable job of capturing some of the functional spatial aspects of imagery, it is not clear how a spatial analog model can account for nonspatial qualia.

Although the theoretical claim that the medium underlying visual imagery preserves the functional nature of physical space does not specifically address issues of nonspatial qualia,¹¹ the literature on spatial transformation and image scanning is beginning to be broadened to include aspects of experience that are not purely spatial. For example, more massive objects often feel subjectively heavier, and when a person carries a heavier object that person may move more slowly than when he or she carries a lighter object; this aspect of the subjective experience seems to have been captured in the finding by Intons-Peterson and Roskos-Ewoldsen (1989) that subjects required longer to imaginably travel between two locations when they imaged themselves carrying a cannonball than when they imaged themselves carrying a balloon. In this case, qualia associated with muscular effort appears to have penetrated the image and produced a “knowledge-weighted” image. Even though Intons-Peterson and Roskos-Ewoldsen’s (see also Intons-Peterson & McDaniel, 1991) notion of “knowledge-weighted” images may begin to incorporate other, nonspatial aspects of subjective experience in imaginal recreation, it remains to be seen how far this approach will allow incorporation of nonspatial qualia.

It may be important to broaden the notion of knowledge-weighting to include a distinction between knowledge_{sp}-weighting and knowledge_d-weighting because it is possible that the two different types of knowledge might influence the image differently or reflect different degrees of cognitive penetrability. One possibility is that penetration of such purely subjective elements reflects knowledge_{sp}-weighting, whereas the penetration of imagery commonly discussed as involving tacit knowledge, demand characteristics, or experimenter bias reflects knowledge_d-weighting. A second possibility is that weightings which apply across a wide range of stimuli reflect a more abstract knowledge_d and weightings which apply across a more limited range of stimuli or to a specific stimulus reflect a more concrete knowledge_{sp}. A third possibility is that the type of weighting is determined by whether a person has had specific sensory–perceptual experience with a physical counterpart of the imaged object (knowledge_{sp}) or generalizes based on other knowledge (knowledge_d). It would also be extremely important theoretically to determine the extent to which weightings of either type were flexible and under conscious or tacit control.

¹¹ Although not addressing qualia per se, Kosslyn’s (1980) notions about depiction may be interpreted as suggesting a necessary role for qualia. To the extent that depiction requires specification of the stimulus along nonspatial dimensions, then nonspatial qualia may be recreated within the image.

Qualia and Schematic Models

A different conception of visual imagery, one not requiring an analog form of representation, has been proposed by Neisser (1976), who suggested that images may be conceptualized as schemata that have been decoupled from a perceptual cycle. Neisser (1976) sketched out what he referred to as a *perceptual cycle*, a cycle consisting of three activities which in turn influence each other. In the perceptual cycle, schemata direct exploration of the world. Exploration results in sampling the objects in the world, and this sampling in turn modifies the schemata. These modified schemata direct further sampling of the world, and so on. When schemata become detached from this schema–exploration–object cycle, those schemata in isolation are experienced as images. Could qualia be specified as detached schemata? It seems as if by definition the necessary abstractness of schemata would forbid this. While schemata might be adroit at describing the sampled environment, it is not clear how schematic conceptions could account for the depictive elements of images. If an image was merely schematic, why could we not image a color without an extent, or a pitch without a timbre, as we could easily do if we were merely describing rather than depicting the stimulus?

Neisser's ideas could be adapted slightly so that instead of being a detached schema, an image would be a separate entity that would be controlled by a schema. Although the precise nature of the schematic control is unknown, we can speculate that such control could perhaps result from either deliberate decision-making or non-conscious knowledge-weighting similar to that proposed by Intons-Peterson and her colleagues. Neisser (1976, pp. 130–131) states that “the experience of having an image is just the inner aspect of a readiness to perceive the imaged object,” and so we could postulate a schema which, in any given situation, could then choose among a number of different images. One of these images could be compared to the incoming perception, and a comparison between the image and perception would be made. If the schema were useful, then in the majority of cases the incoming perception would match the image, and this matching could facilitate perception and recognition processes. Hubbard and Stoeckig (1988) found such facilitation when subjects judged whether an imaged musical tone or chord matched a subsequently perceived musical tone or chord, but Stadler and McDaniel (1990) found that judgments concerning characteristics of imaged letters did not facilitate subsequent judgments of perceived letters. The data are thus mixed on whether such facilitation occurs, but even so, such an extension of Neisser's ideas somewhat begs the question—even if an image is not a schema but is merely controlled or directed by a schema, it still is not clear what that image (with all its qualia) might be.

Another difficulty with a purely schematic explanation of qualia is that schemata might not capture all of the distinctions within qualia. This difficulty is consistent with Raffman's (1993) claim that we can make perceptual discriminations that cannot be described and is also consistent with other evidence indicating that the memory representation is far richer and more detailed than pure schema models generally account for (for a review, see Alba & Hasher, 1983). Perhaps a part of the richness that schema models have difficulty in accounting for includes qualia, as qualia are by definition concrete and specific and not abstract and general. A person may be

capable of experiencing the richness of qualia during perception (or imaginal memory), and yet not possess a schema of sufficient detail to allow subsequent specification, abstraction, or classification of that stimulus.¹² In other words, perhaps schemata include and specify knowledge_d but do not include or specify knowledge_{sp}. Thus, given the schematic nature of Neisser's conceptualization and the difficulties of schemata in accounting for qualia, it is not clear how an approach based solely on the idea of decoupled schemata might account for qualia.

Methodological Issues in Studying Qualia

Broadening of spatial analog models to include or incorporate more nonspatial qualia entails experimental assessment of nonspatial qualia, but the study of qualia is difficult because qualia are not directly observable by an experimenter. Until Shepard's (1978) hypothetical cerebroscope is developed and direct experience of someone else's qualia is possible, qualia can only be studied indirectly. We consider here some of the potentially more common ways to assess qualia and suggest that nonverbal psychophysical methods may (at this time) be the preferred experimental method because psychophysical techniques may minimize contributions from knowledge_d. We also address two additional methodological issues, verbal labeling of sensory qualities and differing levels of expertise, of which investigators should be mindful.

Experimental Techniques

One early method of studying qualia and the other subjective contents of consciousness involved the use of self-report and introspection, but difficulties with self-report and introspective data have been extensively documented (e.g., Lyons, 1986; Nisbett & Wilson, 1977). Although not explicitly addressing the issue of qualia, Johnson (1988; Johnson, Foley, Suengas, & Raye, 1988) recently advocated an "experimental phenomenology" approach in which subjects rate (usually on a 1–7 scale) whether various aspects of either a remembered perceived event or a remembered imagined event are vague or clear and distinct. To the extent that this type of approach taps the sensory-like aspects of perceived, remembered, or imaged events, rating scales might be useful in assessing qualia. However, the use of self-report or rating scales may introduce a potentially dangerous confound because reports of knowledge_{sp} must be filtered and relayed through a person's verbal knowledge_d. Given that there may be important aspects of subjective experience that cannot be verbally reported (Raffman, 1993), there may be critical or salient aspects of qualia that are not tapped by self-reports or rating scales. Chronometric measures were used extensively

¹² An excellent example of the experience of qualia in the absence of explicit schemata for classification can be found in a consideration of ear training for the recognition of musical intervals. Both musically trained and untrained listeners could experience the sound of a musical interval; a person who has undergone ear training could also categorize that interval (e.g., octave, fifth, etc.), but a person who has not undergone ear training could not successfully categorize the interval. The sound of the interval would reflect knowledge_{sp} of the interval, and this would be possessed by both musically trained and untrained listeners. The correct classification of the interval size would reflect knowledge_d of the interval, and this would be possessed by musically trained listeners but not by untrained listeners. Importantly, both trained and untrained listeners could experience the qualia (i.e., obtain knowledge_{sp}), but only the trained listeners would then be able to further specify, abstract, or classify the stimulus.

in the development of the spatial analog models of imagery (e.g., Kosslyn, 1980; Shepard & Cooper, 1982), but it is not clear how useful chronometric measures will be in assessing nonspatial qualia in which duration is not a critical factor.

Better methods for assessing qualia involve the experimental subject nonverbally externalizing his or her qualia. For example, a person could be asked to form an image of some previously learned stimulus and then choose which exemplar (from a set of exemplars) most closely matches a particular quality in the image. Antrobus, Hartwig, Rosa, Reinsel, and Fein (1987) used this technique with subjects awakened from REM sleep who subsequently picked which photograph from a set of photographs exhibited illumination and contrast levels similar to those experienced in the just-experienced REM dream. Other methods could be drawn from the literature on memory psychophysics; for example, subjects could produce a stimulus matching some aspect of their remembered qualia. Baird and Hubbard (1992) provide several examples of how psychophysical techniques may be applied to the study of imagery and memory; in fact, much of the data in both classical (e.g., Stevens, 1975; Gescheider, 1985) and memory (e.g., Algom, 1992; Hubbard, 1994a) psychophysics examine aspects of qualia, but these data typically have not been interpreted in those terms. One caution, however, is that production methods would be preferred over estimation methods because estimation methods involve verbal responses which might contaminate the response with knowledge_d. Block (1980b) suggests that psychophysics can only examine the functional aspects of sensation and not the qualitative aspects, but such a dismissal may be overly harsh; to the extent a subject matches or judges sensations (or sensory qualities of images) that subject matches or judges qualia.

Additional Methodological Issues

In addition to the normal methodological concerns (e.g., demand characteristics, tacit knowledge, experimenter bias, etc.) accompanying studies of imagery (and perhaps perception), there are two other methodological issues that we should be especially mindful of in assessing qualia. One issue is that subjects may base their responses not on their experience of qualia, but on a verbal label, description, or categorization of qualia. In other words, instead of forming an image of a stimulus and basing their response upon that image, subjects would merely remember the verbal label attached to that stimulus (e.g., a subject asked to form an image of a previously perceived hue may not image the hue, but instead remember the word "red" which would reflect a judgment made during the previous perception). Thus, the subject would actually use knowledge_d of the verbal label, rather than knowledge_{sp} of the experience, in the experimental task. Even if such a subject used knowledge_{sp}, the hue that is imaged would be based upon a verbal label and thus might be a more stereotypical or focal hue than the hue that was actually presented. While such a verbal strategy would be useful in reducing the load on memory or other cognitive processing, much of the qualia would be lost or irretrievable. Reliance on knowledge_d may be diminished by the use of stimuli that are not easily verbally labeled or categorized (e.g., highly irregular visual shapes, artificially synthesized auditory timbres) because in the absence of an available verbal label observers may have to depend more heavily upon an image of the sensory qualities.

A related issue is the expertise and knowledge_d of the individual in the domain under study. In some domains (e.g., recognition of colors or simple shapes) expertise may vary little over a population, but in other domains (e.g., musical knowledge) expertise may vary widely over a population. Some theories of the development of expertise propose that knowledge structures within the area of expertise are abstracted and become more schematic as learning and expertise are acquired (e.g., Chase & Simon, 1973; Ericsson & Smith, 1991; Lesgold, 1984); therefore, experts' judgments might be based more on knowledge_d and novices' judgments might be based more on knowledge_{sp} (e.g., musicians are thought to represent music more linguistically or abstractly than are nonmusicians, Bever & Chiarello, 1974; Halpern & Bower, 1982). Alternatively, it is also possible that expertise might increase knowledge_{sp} or sensitivity to qualia; for example, an expert painter might be sensitive to subtle variations of hue and saturation that are not processed by a nonexpert, and a person knowledgeable about fine wines might detect subtle differences between different vintages that would not be noticeable to a person with less knowledge or experience. It is not yet known if any specific principles might govern whether experience or expertise increases or decreases the reliance, use, or sensitivity to qualia in any given domain; specification of these principles, if any, remains an empirical question.

SUMMARY AND CONCLUSIONS

Qualia are an inherent and important aspect of mental imagery. Indeed, it is the subjective sensory-like experience that makes an image an image, but existing theories of imagery do not appear to address or acknowledge the majority of qualia. Qualia, however, are more than just a component of mental imagery; subjective experience is a critical component of perception and of our interactions with the physical world. Numerous examples of the importance of qualia and subjective experience were drawn from the philosophical literature, and examples of the importance of qualia to the prediction of subsequent objective behavior were given. The Turing test and Chinese Room scenarios were adapted to assess potential differences in subjective experiences, but such purely behavioral tests were rejected when it became clear that such behavioral criteria of qualia were inadequate. Although it initially appeared that at least some prediction of low level behavior could be successfully made without considering qualia, it was suggested that explanation or understanding of that behavior required a consideration of qualia. Qualia were shown to be important even in simple discrimination tasks (e.g., which stimulus is experienced as brighter?) and conditioning tasks (e.g., is a stimulus experienced as reinforcing or as aversive?).

Many approaches to mental imagery within cognitive psychology focus on the relationship between imaged spatial transformations and physical spatial transformations. This focus on the rules of spatial transformation is a very syntactic approach, whereas the suggested focus on qualia and subjective experience might be considered a more semantic approach. As a consequence of the syntactic focus of previous investigation much of the richness of (especially nonspatial) qualia has as yet remained unexplored and unexploited in research and models of mental imagery (with the possible exceptions of some preliminary research on eidetic imagery, e.g., Haber, 1979). The extension of sensory-perceptual aspects of qualia from perception to imagery

highlight the similarity of the qualia of perception and the qualia of imagery, and it was suggested that perhaps these similarities could be accounted for by some sort of functional equivalence between the processes or the structures involved in imagery and in perception. More pessimistically, Block (1980b) has suggested that psychology (in its current incarnation) is incapable of explaining qualia. Given that much of the research in this area has focused primarily on syntactical aspects of imagery and not on semantic aspects of imagery such a verdict may be premature.

Even if theorists who have argued that qualia do not exist or do not play any functional or causal role are correct, psychology still has to account for the source and strength of our apparent qualia. Although it may be helpful for construction of artificial cognizers or for rehabilitation of injured organisms to know the neurological correlates of our subjective experience, it is not sufficient to claim (as does Churchland, 1988) that our sensations are merely identical with neural spiking patterns. There is a gap between our knowledge of the objective anatomy and physiology and our knowledge of how that anatomy and physiology produce the subjective experience, and that gap may not be closed by an identity or a definition, nor will it go away if it is ignored. What we have done here is to point out the importance of the qualia in prediction and explanation in psychological models in general and also to caution that many investigations of imagery to this point have not addressed qualia. In essence, our models of imagery do not appear to have addressed what makes an image an image, a possibly unique form of representation—the subjective sensory–perceptual experience of qualia.

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