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Adam Reeves, Birgitta Dresp

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Perceptual Categories derived from Reid's "Common Sense" philosophy

Adam Reeves, Birgitta Dresch-Langley

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Abstract

The Scottish ‘common sense’ philosopher Thomas Reid argued that perception can be distinguished on several properties from several other categories of experience, such as sensation, illusion, hallucination, mental images, and what he called ‘fancy’. We do not treat Reid in detail but rather we extend his analysis to other categories using criteria similar to his. We score each of five properties for each of 11 mental categories, provide statistical measures of their mutual dependencies, and illustrate how these philosophical distinctions bear on current empirical studies in human vision.

Introduction

The Scottish ‘Common Sense’ philosopher Thomas Reid (1710–1796) became known for his theory of perception and its wider implications on the epistemology of science, and also as the defender of an agentic theory of free will. He published important criticisms of the philosophies of Locke, Berkeley and Hume and is also well known for his influential contributions to philosophical topics such as ethics, aesthetics and the philosophy of mind. The legacy of his philosophy is found in some contemporary theories of perception, free will, and the philosophy of belief. Also, he formulated some, at the time ground breaking, ideas on the explanatory power of representational theories of perception, which are intended to explain the fact that our mental states connect us to real objects and provide us with knowledge about these objects. Reid (1786) observed that, absent understanding how we connect our minds to physical objects, it is of no use to simply say that we do this by mental representations, there being no obvious reason why the perception of a mental intermediary (such as an object representation) would be more of a source of knowledge than the direct and immediate perception of that physical object. Thus the representational theory did not explain what it was intended to explain. Instead, Reid proposed a number of detailed arguments, combined with nuanced reasoning and attention to the then-believed physiology, to describe how the categories of perception arise. Our aim is to characterize these categories in current terms on the basis of Reid’s analysis. Reid extended his analysis to imagery and ‘fancy’, that is, mental representations not directly connected to experience, which we also discuss. Our aim is not provide a detailed exegesis of Reid or even a commentary on his contributions to philosophy and epistemology, all of which have received scholarly attention, but rather, to rely on Reid to illuminate, and, we hope, expand, current scientific terminology in perception research. We accept his foundational principle that, at the object level, “That those things do really exist which we distinctly perceive by our senses, and are what we perceive them to be”, despite the existence of illusions which we take in general to be examples of reduced stimulus information rather than evidence that things are not what we perceive.

What is ‘perception’?

According to Thomas Reid (1786), perception is knowledge of the external world through direct experience, as mediated by a distal sense such as vision, hearing, or touch. By ‘knowledge’ is meant correct belief; that is, if I perceive an apple before me, then there must be an apple. The everyday terms ‘see’ and ‘hear’ are ambiguous in this respect, although context can make them clear, as in ‘I see an apple’ versus ‘I see a fairy’. Reid’s definition clarifies that, to be perceived, an object must exist, must be sensed (by what we call a distal sense, eye, ear, or nose), must be experienced, and must be believed to exist (‘fixation of belief’). For example, ‘I see a dagger before me’: if so, my eyes must be focused on the dagger, it must be present, I must experience it as a dagger, and I must believe it to be there. The Scottish School of Common Sense in Philosophy advocated an empirical approach, to some extent at the expense of a deeper analysis of the logical conditions of knowledge in epistemology and ontology; thus, the various mental categories and their properties are asserted rather than derived. Such an approach might not satisfy modern philosophers but we believe it is suited to the current state of Psychology.

Reid’s definition of perception nicely captures daily experience, and seems intuitive; in particular, it excludes the right cases. One does not ‘perceive’ an object that is not present. If a blind person imagines an object that is actually present, he still does not perceive it visually. If a skeptic saw a real UFO landing in a field but thought it must be illusory, then he did not perceive the UFO. If one walks downstairs while asleep (in stages 3 or 4) one senses the stairs but one does not perceive them, to judge from reports of somnambulists when abruptly woken.

Reid’s definitions invite us to not only to ask what perception actually is, but also what is it not. Are sensation and perception, for example, one and the same thing? Sensation, like perception, procures us with knowledge of the external world through direct experience (of the senses). Once a needle inserted into our skin has triggered a sensation of pain, we are unlikely to forget it, and we will know in the future, whenever a needle approaches our skin again, that it will cause pain and may try to avoid it. In this respect, sensation is very much like perception; it governs the planning of adaptive behavior and allows us to cope with real-world constraints. Yet, there is more to sensation: sensations, unlike perceptions which are experienced when we are awake and fully conscious, arise at different levels of consciousness, during wakefulness, sleep or

anesthesia, and they may be present in the absence of a real-world stimulus triggering them, as in the case of phantom limb sensations (Guéniot, 1868; Ramachandran, 1998). Critically, in Reid's system, perception and sensation differ epistemologically: that is, perception is 'public' in that, if I claim to perceive something that is not there, I am wrong (I am not perceiving but hallucinating), whereas sensation is 'private'; no-one can gainsay my report of pain or pleasure, no matter what external or even physiological events occur. Thus perceptions can be tallied by accuracy, while sensations can only be rated, not independently validated. In these respects, Reid's 'common sense' account cannot be reconciled with the idea from classical psychophysics that perception and sensation are both parts of sensory continua, but can be reconciled with the distinction made in measurement theory between accuracy and rating, which becomes basic.

Contra Reid, modern textbook usage in Psychology, like most scientific writing, regularly conflates sensation with perception, treating them both as extensions of the sensory organs. However, sensation and perception are distinct, even in awareness. Stroking an object with one's fingertips, one perceives the shape, but senses the texture or roughness; the latter, but not the former, change with the pressure and speed of the stroke. Pain is sensed; a distant view is perceived. Reid's point is that sensation requires stimulation but not fixation of belief about an external cause or object, and surely this view is to be preferred to the modern one. An even grosser confusion is revealed by a recent, superficially attractive, quotation: "There is a deep sense in which we all know what perception is because of our direct phenomenological acquaintance with *percepts* — the colors, shapes, and sizes (etc.) of the objects and surfaces that populate our visual experiences. Imagine looking at an apple in a supermarket, appreciating its redness (as opposed, say, to its price) and anticipating the delicious juicy sensation it will cause in the mouth when you dig your teeth into it, *that* is perception in its deepest sense" (Firestone & Scholl, 2015). In an otherwise outstanding paper, these authors here conflate perception, sensation, and even hallucination, all of which can give rise to identical appearances but in Reid's analysis are quite distinct.

Reid's definition of perception, though helpful, involves some difficulties. First, it does not encompass animal perception; one can check on the animal's senses, but how does one know that an animal is aware of, and believes in, the food in front of it? Those of us who accept Darwinian evolution and reject Creationism would not want to proclaim consciousness and fixation of belief

as necessarily exclusively human. Luckily, we now have Alex the African Grey parrot, who can tell us in no uncertain terms, in English, what he experiences, including visual illusions (Pepperberg, 2002). Reid's definition also excludes unconscious perception, so we follow 19th century practice in adding the term 'subliminal' to cover perceptions in which both awareness and belief are absent. Finally, the neural substrate of 'fixation of belief' remains to be clarified. The fMRI shows that frontal lobes, subcortical structures, and cerebellum are equally involved in mental imagery and visual perception (92% voxel overlap), suggesting that images and percepts share similar access to memory, interpretation, and action control (Ganis, Thompson, & Kosslyn, 2004). However, responses to images and percepts differ in superior parietal lobule (the precuneus) and parahippocampal and fusiform gyri, and parietal differences reflect belief status, as Zaitchik *et al.* (2010) found that the attribution of belief engaged the superior temporal sulcus and inferior parietal lobule. Future research will be needed clarify the role of the brain in the fixation of belief.

Categories of experience

As defined by Reid, perception can be distinguished from several other categories of experience. These categories form the rows of Table 1, and are as follows: perception, sensation, illusion, hallucination, mental image, and 'fancy', the latter term being Reid's but expanded on by S.T. Coleridge. To these we have added several modern categories: affordance, body image, subliminal percept, *ganzfeld*, and *eigengrau*. The list may prove incomplete, but it incorporates insights from neurology, psychophysics, and ecological optics. In adding categories, we lose some of the clarity of Reid's presentation, and we risk the inclusion of dissonant elements, but we remain true to the 'Common Sense' goal of making philosophy useful, in particular to experimental Psychology. Rather than claiming our categories are necessary or exhaustive, we take the weaker approach of "categorical descriptivism" (Carr, 1987), which is easier to defend but is limited to describing categorical structures suggested by our thoughts, experiences, intuitions, and language.

- INSERT TABLE 1 ABOUT HERE -

Each category in Table 1 is scored on five properties; whether a distal stimulus is required; whether an external object is needed; whether proximal stimulation is needed; whether conscious

awareness is required; and whether belief needs to be fixed. Four of these properties derive directly from Reid's definition of perception (that an object must exist, must be sensed by a distal sense, must be experienced, and must be believed in); we added a fifth, whether a proximal stimulus is needed, as this is not implied by the others. The properties are complete to the extent that they define all the ways experience and reality can inter-relate structurally – that is, without regard to specific content.

We scored each property as 1 if it held true of a category, -1 if it did not, and 0 if it was irrelevant or ambiguous, ensuring that all scores are in the same direction, from perception (+1) to fancy (-1). Between perception and fancy lie the intermediate categories, which we now characterize in the order shown in Table 1 from the most to the least reality-oriented.

Perception

As discussed, we take Reid's (1786) definition of perception literally: to be perceived, an object must exist, must be experienced, must be believed to exist, and in addition, there must be a proximal stimulation to a distal sense (eyes, ears, touch, smell). Thus percepts are scored +1 on every property in Table 1. We take 'must be experienced' to cover three important sub-cases; perception of the whole (Silvestri et al., 2010), modal completion, and a-modal completion. The first case occurs when an object is fully visible; the second and third cases refer to objects seen behind partial occluders. In the modal case, the brain completes or fills-in the missing information such that the entire object is experienced consciously, whereas in the a-modal case, the perceiver sees and experiences only a part, but knows the whole. To illustrate, take two pencils, and place them on a table with one crossing over the other. The top pencil is seen in its entirety, whereas the bottom pencil; is seen modally if one fixates away from the pencils and a-modally if one fixates at the cross point. A-modal completion illustrates a form of 'apperception' (Herbart, 1816), that is, knowledge of an object that goes beyond the immediately present but which is not necessarily verbal. (A reader who is uncertain of this may take two unnamed, novel, objects and still experience a-modal completion.) Given our understanding of 'to be experienced', a-modal completion is also perceptual, just as long as the object, such as a pencil, is really there, because the parts that are experienced lead to the feeling of knowing the shape of the whole, but we would have no quarrel with a reader who wishes to expand our list of properties and define a sub-category for perceptions of partially occluded objects.

Affordance

An ‘affordance’ is a feature of the physical environment that permits (‘affords’) a behavior, such as the ground being flat enough to permit running (Gibson, 1979; Carello & Turvey, 2003). It is listed here as a mental category because, in Reid’s system, the fact that a physical feature permits a behavior means nothing unless this information is connected to a mental state; Reid cannot be described as a behaviorist. An affordance requires proximal and distal stimuli (both scored 1), but not necessarily an ‘object’, as affordances can specify actions or behaviors that relate to landscape, air, or sea, not just to specific objects (scored 0). Since the information specifying the affordance must be attended to affect action (Gibson, 1979), we indicate this by ‘awareness’ and ‘belief’ (scored 1). Affordance appears very similar to Perception in Table 1, but they also differ in their emphasis on environmental information and action (affordance) versus neural processing and awareness (perception) in a manner not captured in Table 1 but discussed again at the end of the paper. For now, note that affordance and perception are far from equivalent (and neither is equivalent to action, despite the Gibsonian equation of perception with action.)

Sensation

A ‘sensation’ is a mental event requiring processing activity in a sense organ or at higher levels of brain integration, as in the case of phantom limb sensations. Sensation requires a sense organ to register a proximal stimulus (score 1), as when one senses light or sound, or one feels bodily pleasure. Proximal stimulus in normal (unpathological) seeing and hearing are nearly always caused by a distal stimulus (score 1), although one can see stars when one rubs one’s eyes – only proximal stimulation occurs in that case. Sensations do not require that their origins be interpreted; there is no necessity that an object exist, or nor that belief be fixed (scores 0), though they may be. One can feel pain without assigning a cause. Because sensation is so tied to the sensory nerves, it can be defined medically as the response in the brain to neural activity originating in the sense organ, but for us, the phenomenal nature or magnitude of the sensation (Dresp-Langley, 2012, 2013, 2014, 2015, 2016), rather than the information channel communicating it, is primary.

Illusion

An illusion in psychology is a mistaken percept, one that one may know is wrong but typically cannot correct – being ‘cognitively impenetrable’. Classic examples include the Mueller-Lyer, Poggendorf, and wagon-wheel illusions; modern illusions include a host of motion-generated illusory percepts. In all cases, one is aware of the object, but the brain seriously misinterprets it, so we score 1 for awareness and -1 for object. Indeed, illusions typically derive from incomplete stimulation, as pointed out by Gibson (1979); when we see real objects, we rarely experience illusions. Illusions do produce beliefs (score 1), though these are false. Illusions require proximal stimuli – they are not hallucinations (score 1). Distal stimuli are commonly present but are not required (score 0), as in the cutaneous ‘rabbit’ (Geldard & Sherrick, 1972). Proximal or distal stimuli must clearly differ from their illusory interpretations; for example, punctate stimuli may be experienced as a continuously- flowing stream, as when a sequence of consecutive notes is experienced as a ‘run’, or a sequence of animated cartoons from the 1920s gives rise to visual apparent motion despite being jerky.

Illusions may be optical, as when objects reflect light in a specific way, suggesting perception of physical matter or objects (water, gold, *et alia.*) that are not present. To the extent that an illusion is of optical origin as, for example a mirage that can be captured by a camera, it needs no explanation in terms of the mind (Dresp-Langley & Grossberg, 2016). However, some illusions straddle the boundary between optical and perceptual (Spillmann, Tseng, & Dresp-Langley, 2015), as when a glittery surface appears wet; (and) in such cases, the stimuli are marginal, not incomplete. We have not included a sub-category for this case, although a complete taxonomy of illusions would do so (Gregory, 1997).

Body Image

A body image can be kinesthetic, tactile, motor, or some combination of these. Body images are generally accurate enough to support behavior, as in running through a narrow opening. A body image differs from a visual image of one’s body in being partly motor. False body images exist as, for example, in *anorexia nervosa* where people perceive themselves as unrealistically fat, or in schizophrenia where they may perceive parts of their body as distorted or slowly disintegrating (*dysmorphophobia*). After surgery or amputation, body images or perceptions of

one's body "as it was before" may occur, as demonstrated for example by the famous phantom limb observations where patients describe sensations including strong pain in members after amputation as if these members were still part of their body (e.g. Guéniot, 1868, Ramachandran, 1998). In extreme cases, the body image is sufficiently dysfunctional to impede simple activities, such as walking through a narrow opening or picking up a cup. How should we categorize body images ? According to Reid's definition, there must be a proximal stimulus, i.e. an afferent input to the brain, and there must be a belief that the body (or part of it) it exists and has such-and-such a form (both scored as 1). There is no external object (score -1), so body images are surely not perceptions. Distal stimuli are not essential, but the body image may be influenced by them, as demonstrated by a 'tilted room' which distorts the sense of being upright (score 0). The body image may be brought to awareness, as during an activity like dressing, but this is not essential as it can fade from view without ceasing to affect behavior (score 0).

Hallucination

A 'hallucination' is a form of false percept where the subject is aware of, and his belief is fixated on, an event that appears to take place in the real world (both score 1), but distal stimulation and real-world objects are absent (both score -1). An example is the man who 'mistook his wife for a hat'. Hallucinations do not have to, but may involve proximal stimuli (score 0), understanding that such stimulation may arise within the brain (Allen, Laroi & McGuire, 2008; Grossberg, 2000) as well as within the sense organs. We do not here enter into the enormous literature on hallucinations or their sub-categories, but think that all can be characterized as in Table 1.

Subliminal perception

A 'subliminal percept' requires both a proximal and distal stimuli stimulus (scores of 1), and an interpretation of the distal stimuli at some level of neural processing, but one that paradoxically escapes awareness (Dresp-Langley & Durup, 2009, 2012) and, of course, fixation of belief (scores of -1). An external object may, but is not required to, create a subliminal percept (score 0). Despite its effects, the subject claims there is no stimulus at all, as in meta-contrast masking (Scharlau & Neumann, 2007), continuous flash suppression (Lin & He, 2007), and in human blind sight (Weiskrantz, 2009). This is strong evidence that subliminal perception exists, and is

not simply an artefact of criterion-shifting in the sense of signal detection theory, and so requires its own category.

Mental images

A ‘mental image’ is a sight or sound that reproduces an object of perception, or combines such objects in an agglutinative fashion, from memory (Boumenir et al., 2010, 2014), thus, in the absence of a distal stimulus (score -1). There is no belief in the external reality of the image (score -1): if one believed in it, one would be hallucinating. There needs to be some proximal stimulus, although it may be distant from the resulting mental image, as when the mere feel of a carpet triggers an image of the carpet in front of a fireplace with a cat asleep on it (score 1), to account for the ‘concrete’ nature of the image (images that have no proximal stimulus at all are classified as ‘fancy’). Some authors assume that mental images and percepts are similar, perhaps differing only in vividness (Hume, 1739), but psychophysics shows this equation is false (see Arterberry, Craver-Lemley, & Reeves, 2002), even though images and percepts can generate similar EEG signals (La *et al.*, 1990). Images and percepts are far from equivalent in Reid’s analysis (see Table 1.)

Ganzfeld and Eigengrau

A *Ganzfeld* is a uniform fog, in which visual stimulation by light is too even for distinct objects to be visible. The auditory equivalent would be white or pink noise; in both cases, there is a proximal stimulus (score 1). The *Eigengrau* corresponds to the internal level of uniform stimulation generated in the eye (or, analogously, in the ear), independent of proximal stimulation, which may or may not add to the *Eigengrau* (hence, score 0). A distal stimulus, an external object, and belief in external reality are contra-indicated for both categories (scored -1). One is aware of a *Ganzfeld* (score 1), but not necessarily the *Eigengrau* (score 0). Both categories may seem esoteric, but have proven critical in sensory Psychology since Fechner and therefore have a place in Table 1.

Imagination or ‘fancy’

At an opposite extreme from perception is ‘fancy’ or pure imagination, in which the mind invents fantastical visions or sounds that are unrestricted by reality and can be summoned or

dismissed at will (Reid, 1786). Such fancies are bound by the colors and sounds that exist in nature or in artifice – but their combinations, like abstract painting or musical symphonies, go far beyond mere concatenation, eliciting complex and often novel sensory experiences. A fancy is not believed to be external (score -1). No form of stimulation, proximal or distal, is involved, and awareness of external stimuli is ruled out (score -1), as a fancy is not an image. Imagination is an essentially creative process, but typically receives input from memory and perception. The extent of this input is critical. A portrait or landscape painter may view or recall the image he is painting, however altered from reality, implying it is not a fancy; only a pure invention counts as fancy, ruling out much realistic art. That fancy scores -1 on each property makes it the literal opposite of perception.

What can we learn from the analyzing the scores?

As already stated, we scored each property in the same direction, with 1 representing reality and -1 fancy. The use of an arithmetical scoring scheme for mental categories is novel and admittedly debatable, and using a ternary system (1, 0, -1) may be too crude. Still, a score sheet such as Table 1 illuminates a useful vocabulary of mental states in the perception/ imagery literature, and perhaps offer up some new insights. Given the scores in Table 1, one may look for numerical patterns within them. Table 2 provides an index of how different the categories are from each other. Each entry is the root-mean square (RMS), that is, the square root of the mean squared differences between categories, the mean being taken over the 5 properties. RMSs are scaled to lie between 0 and 1 by dividing by the maximum possible value. Squaring ensures that the differences (1, 0) and (0, -1) count the same, as +1, instead of cancelling. To illustrate from the first column, since perception and affordance differ little, RMS is small (0.22); since perception and mental imagery differ more, the index is higher (0.67). Perception and fancy differ maximally (1.0). Diagonal elements are all zero since categories do not differ from themselves. (The upper triangle is a reflection of the lower one and would be redundant.)

--- INSERT Table 2 ABOUT HERE ---

Subsequent Tables present more advanced statistical comparisons. Table 3 compares the categories, not in absolute units like RMS, but rather in terms of variability, since scores that differ absolutely may nevertheless co-vary (example; each Ganzfeld score equals twice the

corresponding Eigengrau score +1). Table 3 is the variance/co-variance matrix, in which diagonal elements (in italics) are variances and values below the diagonal are co-variances. Perception and fancy are constant with no variance, and so are excluded. Table 4 extracts from Table 3 the proportion of variance in each category ‘accounted for’ by each other category as indexed by r^2 , the square of Pearson’s correlation coefficient, the ratio of the covariance to the geometrical mean of the two category variances. Table 4 shows how much the categories predict each other, r^2 being 100% between *Ganzfeld* and *Eigengrau* and greater than 40% for 7 other pairs (bold-face in Table 4). In the remaining cases r^2 is small, indicating that these categories approach independence. To the extent independence holds, the mean score for each category provides a measure uncontaminated by the other categories. Mean scores are provided in Table 1 and plotted against category in Figure 1. These means agree well with the author’s intuitions concerning realism; the higher the mean score, the closer to perception and therefore the more reality-based, but the reader may have other intuitions and may wish to re-score properties and re-calculate the mean scores as desired.

--- INSERT Tables 3,4 ABOUT HERE --

--- INSERT FIGURE 1 ABOUT HERE ----

Similarly, one can ask if the five properties (not the categories) are distinct or redundant ? This can be answered by finding r^2 , now the variance in each property accounted for by each other property, taken across all 11 categories. Table 5 shows how the properties inter-relate; most of the r^2 values are satisfyingly low, implying near-independence, with only one pair (object and distal) over 40%.

--- INSERT Table 5 ABOUT HERE --

Are our five properties complete? Since, following Reid, we define perception as knowledge of the external world through direct experience, we have implicitly adopted a ‘constructivist’ view of perception (Norman, 2002), in which elements of the world (distal stimuli, objects) produce sensory impressions via proximal stimulation, which in turn give rise to awareness and ultimately to decisions about what is ‘out there’ (and the fixation of belief to an extent necessary to guide behavior.) Given that each of these steps can be scored as present, absent, or indifferent, the five properties appear to summarize the essential steps in perception, imagery,

and sensation, and can be regarded as complete in this sense. However, Table 1 necessarily ignores interactions among categories - Wagner could compose music (fancy) only when he could touch velvet (sensation). It ignores the role of feedback and thus the top-down effects of attention, expectation, and memory on perception and sensation. Finally, it says nothing about how action controls on-going environmental information pick-up (Gibson, 1979), and so does not capture how behavior feeds back on perception. However, we can say a little more about this important point. In Norman's (2002) two systems theory, constructivism applies to the ventral system for visual object recognition and knowledge, but not to the dorsal system that controls bodily actions dependent on Gibson's ecological variables such as optic flow. Analogously, constructivism applies to hearing and interpreting meaningful sounds, such as speech, specific sounds, bird song, and other auditory cues, but not to ecological variables such as sound volume, distance, profile analysis, or echo suppression. Constructivism also applies to touch and smell as sensory systems giving us interpretable information about external objects – the stink of an abattoir, the soft feel of corduroy, the touch of a hand – but not to the background information that specifies bodily states – the breathability of the air, the pressure on one's feet (needed for activities such as running or balancing) or the feel of one's own clothing. Processing background information, we contend, should be demarcated from perception of objects- of what is in the world. Hence, our classification of affordance as distinct from perception in contrast to what we see as Gibson's conflation of perception, affordance, and action.

Without a classification system such as that given in Table 1, the fundamental categories of mental experience will be necessarily confused. For example, in their review, Firestone & Scholl (2015) classify six frequent methodological errors in the literature claiming 'top-down' or cognitive effects on perception, errors which they rightly say must be avoided if top-down influences on perception are to be firmly established. However, their definition of perception in terms of appearance and not in terms of veridicality, *contra* Reid, weakens their conclusions; only if fixation of belief is included in the very definition of perception can appropriate empirical test cases be analyzed.

Color as a test case

Color provides an interesting, if complex, test case for the classification. Color is just one of many attributes, such as texture, shape, and size, but one that has been intensively investigated

for more than a century. Color categories provide a natural interpretation of the color experience, one which is ‘public’ – that is, can be verified by others. Interestingly, all trichromats agree that wavelengths around 580nm look ‘yellow’, despite vast differences in retinal signaling due to differences in the relative numbers of the three classes of cones across individuals and, within individuals, across retinal eccentricity. Following Reid, if one ‘perceives’ a yellow sun, it cannot be orange or grey; likewise, if one perceives a red apple, it cannot be a green apple or a red banana. Critically, narrow-band spectral lights isolated in a small aperture will be placed in the same order by every trichromat, to a tolerance of a few nanometers, so color perception is to this extent veridical even when disassociated from known references or shapes. This does not imply identity of experience or appearance across individuals; the colors of narrow-band lights could be inverted (Bloc, 1990: my short-wavelengths seen as ‘red’ not ‘blue’) or down-shifted (my ‘green’ seen as your ‘yellow’), but still, color *order* is perceived. Color illusions exist: every trichromat will see a particular combination of red and green light (a broad-band signal) as matching a narrow-band yellow light, a case in which the common, publically-verifiable response is physically incorrect due to metamerism. (Metamerism occurs because wavelengths are summed in the cones, so with a limited number of cone types, metameric lights – those which provide identical sensations – must exist; furthermore, being identical at the cone level, they logically cannot be distinguished at any subsequent level of the visual system.) Of greatest interest here, *color constancy* provides a critical test of color as a ‘perception’. To the extent that the color of an object can be identified independently of the chromaticity of the illumination striking the object, the goal of perception is being met; to the extent that the color and brightness of the illuminating light affect the color appearance of the object, perception has failed. Since the light at the eye is a product of illumination and reflectance, perceiving the object color requires discounting the illuminant. Most individuals can do this; for example, they can perceive and recall the colors of familiar objects such as a handbag correctly, no matter what the illumination is (Weiss, Bloj, & Gegenfurtner, 2015). Even when the ‘object’ is just a colored square surrounded by other squares, as in painting by Mondriaan, most individuals can both report the object color (showing reasonable color constancy). They can also report the light at the eye coming from the same colored square without discounting the illuminant (Arend & Reeves, 1986), a distinction we characterized operationally as a ‘paper match’ task or as a ‘direct match’

task, but here, following Table 1, we characterize it more boldly as a perceptions of object color versus a sensations of light.

Color vision (Dresp-Langley & Reeves, 2012, 2014) also provides a contrast between perception and affordance (Gibson, 1979, chapter 6). Color can afford specific actions, such as walking on a wet or soft surface versus jumping over it, or picking a ripe fruit, or knowing the time of day. In each case, the information provided by the environment is ‘nested’, object colors being located within local environments that are in turn bathed in the illuminating sky-light. Mechanisms have evolved for extracting information with survival value, by taking advantage of nesting, but information not relevant for survival is ignored; thus, there need be no fully general perceptual systems, which we regard as Gibson’s greatest insight. Thus the red-yellow-green categorical structure is perceptual – it is required for picking fruit, for example (Sumner & Mollon, 2003), but the rainbow colors are sensory – the rainbow cannot be touched and does not afford perception, only pleasure. True, the long, middle, and short wavelength sensitive cones must undergird both sensation and perception, but beyond this, and the inevitable metamerism, receptor coding generates no further constraints. Thus the enormous body of color research devoted to understanding how wavelength is encoded by the eye and brain, and how object color is perceived, has nothing obvious to say about affordance. Only an analysis of the visual environment can tell us what color can do for us, what actions it can or cannot afford. Thus Pinna & Reeves (2015) argued from the need for color to both hide and define distinct objects and parts that the visual purpose of color is to promote the emergence of the whole, to support a part-whole organization in which components reciprocally enhance each other by a-modal completion, and to reveal fragments and hide the whole (camouflage). In sum, there is a chromatic parceling-out process of separation, division, and fragmentation of the whole. These processes have been revealed in human psychophysics but not yet in animals, so their evolution, unlike the evolution of photoreceptors and other low-level sensory mechanisms, is as yet unknown.

The peculiar status of ‘perceptual illusions’

In Reid’s system (1786), perception and illusion are clearly distinct. What sense, then, can one make of ‘perceptual illusions’ other than hallucinations (in which the object of perception is missing)? To be ‘perceptual’, an illusion must reveal a true state of nature. An important

example occurs when one steadily looks at a sheet of white paper placed on a grey background. The paper is, and it appears to be, uniform white. Nevertheless, only the edges of the paper provide sensory signals; due to receptor adaptation, the center of the white area generates exactly the same retinal responses as the dark grey surround. The receptors correctly signal that the light level increases as the eye traverses a dark-to-light edge (if eye movements are stopped with wax, and the head clamped, the percept of the white paper disappears and all seems grey: Mach, 1914). Therefore the basis for the white sensation exists as a thin frame surrounding the white expanse. The white experience is nearly entirely generated in the brain as a result of having no information to the contrary; that is, *not* seeing any different light levels within the white area. This lack of sensation is the cause of the visual brain ‘filling-in’ from the white-coded edges into the center, giving rise to an illusory white percept. The illusory nature of the percept can be seen clearly when the edges are bichromatic. In the now famous ‘watercolor’ effect of Pinna (Pinna, Brelstaff & Spillmann, 2001), an outer line of purple with an inner line of orange, drawn on white paper, creates an illusory wash or fill-in color of orange over the entire extent of the drawing. In the ‘back-lighting’ effect, an illusory halo is seen surrounding a figure due to its bichromatic edges, one that creates a sense of volume (Pinna & Reeves, 2006). But in the case of white paper on a grey field, it *really is* uniform white; the illusion generated in the visual brain corresponds to reality, and is seen as such. Hence, we must paradoxically accept ‘perceptual illusion’ as a sub-category of perception. In this sense, almost all of the visual field is a perceptual illusion, since the brain must correct sensations that have been distorted by the optics of the eye and retinal processes. But to the extent that the corrections are valid ones, the final outcome will correspond to reality, sufficiently well to permit object recognition and other actions (walking, swimming, etc.) that rely on perception. Therefore, perceptual illusions are ultimately in the same general category as percepts. They do not lead to delusions but rather permit the perceptual system to produce to best perceptual hypothesis possible when stimuli are incomplete and ambiguous. Such is the Bayesian hypothesis of perception. Counter examples such as the water-color effect, though remarkable, are generally of small magnitude and probably do not affect adaptive visual behavior.

The particular status of moods and emotion

In Reid's common-sense philosophy, perception, sensation, and emotion are categorically different. In the traditional view, perception indeed provides knowledge, whereas sensation triggers emotion, and emotion typically disrupts knowledge. Still, it is obvious that emotion can also heighten perception and action, as when a rush of aggressive feeling supports critical plays in football, or desire heightens sensitivity to another's pattern of gaze. Modern Psychology has no overarching theory of emotion/perception interactions, but it does have an enormous accumulation of examples of such interactions, all ignored in Table 1. For example, darker colors illicit somber moods, lighter ones induce more cheerful ones. Strongly saturated colors and weakly saturated ones also elicit different moods. Moreover, mental associations between specific colors and specific perceptions are readily made, as a pool of red color on the tarmac may readily be perceived as a pool of blood, even if it is just a pool of paint. Interactions of this sort speak to a larger frame of reference in which emotion and feeling tone are included, as well as sensation, action, imagination, and perception.

Conclusion and perspectives

As pointed out earlier herein, our analysis of Reid's philosophical approach to perception remains true to the Common Sense School's goal of establishing useful categories and it is incomplete. We followed an approach of "categorical descriptivism" (Carr, 1987), describing a categorical structure suggested by our thoughts, experiences, intuitions, and language, rather than providing a rigorous systematic account. Also, Reid's philosophy does not explicitly address the fact that we use sensory processes triggered by smells, sounds, and sights to reduce uncertainty about the environment we live in. Despite the undeniable ecological relevance of multisensory perception in helping us cope with uncertainty, empirical support from natural systems is rarely placed within an adaptive framework. The field of psychophysics provides a model for the study of sensory processes by studying behavior. Using Reid's categories as such may not help us understand the evolutionary significance of multimodal perception or lead to predictions about the conditions under which stimuli combine effectively. However, a key outcome of our analysis is that the processes by which we perceive stimuli can be grouped into different categories with different scores according to Reid's own definition of perception.

Some thoughts for the future emerge from our analysis. First, we suggest that the categories described here can be applied to multisensory stimuli, not only visual ones. Second, despite the

potential for a multicomponent stimulus to reduce uncertainty relative to a single-component one, we may not necessarily utilize all of its components. The category analysis inspired by Reid's philosophy will benefit from examining the effects of multisensory stimuli further. Multisensory stimuli may be defined as stimuli occurring in Nature within the same context of time and space, but processed by different sensory channels. This may lead to redefine Reid's idea of 'perception' in terms of the observable product of signal reception, integration, and processing in a larger realm than just the visual one, on which Reid's analysis was focused. Whether or not 'multisensory' and 'multi-perceptual' systems will turn out to differ in the ways that we claim visual perception and sensation to differ will become clearer as multisensory research progresses. Most important, clarifying terms should both aid empirical research and facilitate communication between philosophers who rely on intuition and scientists who do not. Finally, we rather hesitantly have put forward an example of what we might call 'computational philosophy', in which a perhaps simplistic ternary scoring system permits statistical analysis, with the hope that others may take advantage of this approach when appropriate.

TABLE 1: scores

Properties

Category	Mean	Distal	Object	Proximal	Aware	Belief
Perception	1.000	1	1	1	1	1
Affordance	0.800	1	0	1	1	1
Sensation	0.600	1	0	1	1	0
Illusion	0.400	0	-1	1	1	1
Body Image	0.200	0	-1	1	0	1
Hallucination	0.000	-1	-1	0	1	1
Subliminal	0.000	1	0	1	-1	-1
Mental Image	0.000	-1	0	1	1	-1
Ganzfeld	-0.200	-1	-1	1	1	-1
Eigengrau	-0.600	-1	-1	0	0	-1
Fancy	-1.000	-1	-1	-1	-1	-1

TABLE 2: RMS Differences across properties

category	pcpt	afford	sensat	illus	Body	halluc	Sublim	mental	Ganz	Eigen
perception	0.00									
affordance	0.22	0.00								
sensation	0.32	0.22	0.00							
illusion	0.50	0.32	0.39	0.00						
Body Image	0.55	0.39	0.45	0.22	0.00					
hallucination	0.67	0.55	0.59	0.32	0.39	0.00				
Subliminal	0.67	0.63	0.50	0.71	0.59	0.84	0.00			
mental image	0.67	0.63	0.50	0.55	0.59	0.55	0.63	0.00		
Ganzfeld	0.77	0.67	0.55	0.50	0.55	0.50	0.67	0.22	0.00	
Eigengrau	0.84	0.74	0.63	0.59	0.55	0.50	0.59	0.39	0.32	0.00
fancy	1.00	0.92	0.84	0.81	0.71	0.67	0.67	0.67	0.63	0.32

TABLE 3: variance/co-variance matrix. Values for perception and fancy are zero

Category	afford	sensat	illusi	body	halluci	sublim	Mental	Ganz	eigen
Perception=0									
affordance	<i>0.20</i>								
sensation	0.15	<i>0.30</i>							
illusion	0.35	0.20	<i>0.80</i>						
body image	0.30	0.10	0.65	<i>0.70</i>					
hallucination	0.25	0.00	0.75	0.50	<i>1.00</i>				
subliminal	0.00	0.25	-0.25	0.00	-0.75	<i>1.00</i>			
mental image	0.00	0.25	0.25	0.00	0.25	0.00	<i>1.00</i>		
<i>ganzfeld</i>	0.20	0.40	0.60	0.30	0.50	0.00	1.00	<i>1.20</i>	
<i>eigengrau</i>	0.10	0.20	0.30	0.15	0.25	0.00	0.50	0.60	<i>0.30</i>

TABLE 4: Variance in each category accounted for (r^2) by each other category. Perception and fancy have no variance and are excluded; *ganzfeld* and *eigenrau* are perfectly correlated ($r=1$) and are tabulated together. Bold-face indicates high values (those over 40%).

r^2	afford	sens	Illus	Body	Hallu	Subl	MentIm
sensation	0.38						
illusion	0.77	0.17					
Body Image	0.64	0.05	0.75				
hallucination	0.31	0.00	0.70	0.36			
Subliminal	0.00	0.21	0.08	0.00	0.56		
mental image	0.00	0.21	0.08	0.00	0.06	0.00	
Ganz/Eigen	0.17	0.44	0.38	0.11	0.21	0.00	0.83

Table 5: Variance in each property accounted (r^2) by each other property. The bold-face value is over 40%; all other values are low.

	Distal	Object	Proximal	Aware	Belief
Distal	1.000				
Object	0.491	1.000			
Proximal	0.326	0.222	1.000		
Aware	0.003	0.051	0.260	1.000	
Belief	0.180	0.021	0.088	0.238	1.000

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