Subconscious Inference in Peirce's Epistemology of Perception

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Abstract

Empiricists have traditionally assumed that an epistemic subject has immediate access only to some primitive perceptual objects, so that judgments about kinds, modal properties, and dispositions are parasitic upon and less certain than those about what is given in perception. Against this view, Peirce argues that perception provides doxastic warrants in virtue of subconscious inferential processes that constitute the content of a temporally extended perceptual episode. According to Peirce, perceptual judgments have an abductive logical form, and they supply the perceiver with novel hypotheses about the world. Though the production of these hypotheses is not subject to conscious control, it is subject to subconscious control, when a present percept is compared to other features of perceptual experience. By examining Peirce's account of the continuity and temporality of perception and his investigations of subconscious processes, this paper considers how experience can confirm or falsify prior beliefs and produce novel knowledge.

Keywords: Charles S. Peirce, Perception, Epistemology, Abduction, Temporality, Continuity, Subconscious Processes, Psychophysics.

Ordinary language treats reports of perceptual episodes as canonical justifications of beliefs. The challenge for empirically oriented epistemologists is to explain one's right to give credence to one's perceptual judgments. Traditionally, many empiricists have assumed that an epistemic subject is entitled only to some primitive judgments, so that judgments about kinds, modal properties, and dispositions are parasitic

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upon and less certain than those about the particulars given in perception. This paper contributes to an understanding of C.S. Peirce's alternative perceptual epistemology. According to Peirce's model, perceptual experience must be conceived as including previously encountered content and expectations about the future that are continuous with the thematic, "immediate" content of perception. Peirce's view is that perception provides doxastic warrants in virtue of subconscious inferential processes that constitute the content of a temporally extended perceptual episode. As a result, perceptual judgments are best conceived as having an abductive logical form, and hence as supplying the perceiver with novel hypotheses about the world. Though the production of these hypotheses is not subject to conscious control, it is subject to control by subconscious processes, in which a present percept is compared to other features of perceptual experience. Peirce's mature theory is able to explain both the capacity of experience to confirm or falsify prior beliefs and its capacity to produce novel knowledge.

I argue that Peirce's views on perceptual content developed in distinct stages, which roughly correspond to the sections of the paper. Sect. 1 argues that in the first stage, represented by his 1868 writings, Peirce defends a naturalistic realism motivated by a desire to reject both idealist and empiricist foundationalism. Key to Peirce's theory is his acceptance of the Kantian conception of mind as an application of categories through determinations of time. Sect. 2 considers Peirce's psychophysical research in the mid-1870s and early 1880s, which offers a new way of understanding the conscious perceptual act as emerging from subconscious activity, by which it is given meaning. Sect. 3 considers how his psychophysical findings, combined with his study of Cantor's mathematics in the 1880s, led Peirce in 1892 to offer a corrected, anti-nominalist conception of the temporality of experience. Sect. 4 argues that these temporal relations must be conceived in logical terms, as components of experience that give perception an abductive character. The final section shows how this abductive, subconscious form of perception emerges as its fundamental epistemic characteristic in Peirce's late work.

1. Realist Phenomenalism

Ordinary language treats reports of perceptual episodes as canonical justifications of beliefs. In order to defend doxastic commitments formed on the basis of perceptual experience, empiricists were long concerned with distinguishing unjustified justifiers, impressions or sense data, from their derivatives, ideas or mental conceptions.[1] But the genetic relation between mental states does not obviously bear on their logical relation, since the same perceptual experience might warrant different beliefs for agents with different views.[2] Insofar as it fails to make this distinction between the etiology and rationalization of a belief, classical

empiricism conflates a belief's rationality with its causal origin.[3] By Peirce's lights, Kant was a "phenomenalist" in the sense that he posited an identity between that which is grasped by the mind and that which is real. But as opposed to Humean phenomenalism, "what Kant called the Copernican step was precisely the passage from the nominalistic to the realistic view of reality." Far from confusing reasons and causes in a theory of impressions, Kant regarded "reality as the normal product of mental action, and not as a recognizable cause of it" (W2:470–471, 1871). Peirce's early Kantianism rejects a conception of the real object as what insensibly impresses itself on the mind in favor of a conception of it as something constituted by and for a reasoning subject.[4]

For Kant, objective knowledge is possible insofar as one can apply pure concepts of the understanding to intuitions through principles. Kant's view that it is possible for the "I think" to accompany any representation (B131) could be taken to mean that self-consciousness is constitutive of knowledge. But Peirce takes it to mean that for a representation to contribute to knowledge, it must be encountered from a consistent point of view, a field of experience in which its particular content is given meaning (W3:51–52, 1872). In this early work, Peirce employs Kant's transcendental aesthetic, according to which all experience depends on a synthesis in space, the form of all appearances of outer sense, and time, the pure form of sensible intuition (B42, 47), to set the foundations for his own polemic against the immediacy and infallibility of perceptual judgments. Yet as early as 1868, Peirce aims to offer a *naturalized* explanation of knowledge, adducing empirical evidence to confirm Kant's view that perception is synthetic.[5]

Perceptual synthesis is exemplified by the "filling in" of the blind spot in one's visual field. In filling in, the subject synthetizes spatial appearances to form hypotheses about the external environment (W2:197, 1868).[6] This temporality of perceptual synthesis is more perspicuous in tactile discrimination. Running one's fingers over a cloth, for example, one can feel that one part is softer than another. Though the sensation of the part's softness is apparently immediate, it is constituted by a synthesis of sensations gathered over the duration of the tactile episode. Peirce holds that this synthesis of data into a single experience could never emerge from a discrete stimulus. Thus "[i]t is not conceivable that the momentary excitation of a single nerve should give the sensation of space" (W2:198). Rather, it is through the coordination of excitations in the whole nervous system that the concept of extension can "reduce the phenomena to unity" and therefore account for the genesis of experience.

Though Peirce's examples of perceptual synthesis—discriminating texture, hearing pitch, and seeing a colored surface—suggest that he conceived of perceptual experience as consisting of "raw" content, he insists that sensory experiences are conceptual, though the concept

might not be articulated as an explicit hypothesis.[7] I shall argue in Sect. 4 that Peirce later came to understand perceptual judgments as having the logical form of abduction. Yet even at this early stage he conceives of perceptual judgment as a sort of hypothesis:

> [J]ust as we are able to recognize our friends by certain appearances, although we cannot possibly say what those appearances are and are quite unconscious of any process of reasoning, so in any case when the reasoning is easy and natural to us, however complex may be the premises, they sink into insignificance and oblivion proportionately to the satisfactoriness of the theory based upon them. (W2:199, 1868)

Peirce endorses the Kantian thought that the synthetic activity of perception puts the demonstrative content of the act ("*this* x") into the subject place of which it predicates the relevant concept ("my friend").[8] But the perceiver may not notice the predicative act by which he identifies his friend. Indeed, Peirce suggests that although the conceptual synthesis itself may become thematic in unsatisfactory perceptual activity, in satisfactory perception, the underlying synthesis remains invisible and can only be accessed through the adoption of a secondary, reflective attitude. In recognizing one's friend, one does not normally notice the inferential work that makes possible the identification. Rather, one perceives just the apparently "immediate" content, *there is my friend*.

Peirce's reconstruction of Kantian perceptual synthesis offers an escape from the nominalist's puzzle of how ideas or descriptions can arise from "raw" impressions. The problem never arises for the realist phenomenalist, who denies the possibility of "immediate" perceptual knowledge independent of a subject's view. Seemingly "raw" impressions are constituted by the forms of sensation, time and space, and arise from a background of the epistemic subject's previous, spatially and temporally continuous experience. However, whereas for Kant, time and space are *pure* forms of intuition, for Peirce, these forms are not a priori but rather a part of the living body of the perceptual subject. Peirce's naturalized forms of receptivity are thus to be understood as both constitutive of experience, insofar as they place a new sensation on the field of prior sensations, and as products of experience, since it is the succession of sensations (the rougher, then the smoother fabric) that constitutes the temporal field on which each moment is given content.

If perceptual synthesis justifies particular assertions (such as "there is my friend"), it is less obvious how it could license the use of universal and necessary concepts, such as those employed in the statement of the general laws of natural science (W2:200n, 1868). Since perceptual experience does not contain universal and necessary propositions, they must be inferred from a modification of experience. For Kant, this

modification is achieved via a schematic, imagined model, the construction of which can be described logically by dynamical and mathematical principles.[9] For my purposes, the two important principles are mathematical: The Principle of the Axioms of Intuition is that all intuitions are *extensive* magnitudes, where "extensive" means that the representation of the parts of a manifold makes possible and therefore precedes the whole (B202). That is, appearances are intuited through a successive synthesis of parts (B204). The Principle of the Anticipations of Perception is that in all appearances, the real object of sensation has an *intensive* magnitude (A166/B207), the degree of the sensation. In the absence of the reality, the magnitude of the sensation = 0, that is, one has no sensation at all (A168). Together, the two principles entail that the relationship between appearance and reality is a mathematical relation between two continua: "between reality and negation there is a continuity of possible realities and of possible smaller perceptions" (B211). Since extensive magnitudes in the world and intensive magnitudes in sensibility are both continuous (B217–8), the degree of every sensation corresponds to a degree of a quality possessed by the real object of sensation.[10]

Peirce accepts that there is such a correlation between extensive and intensive magnitude. But rather than conceiving of the relationship between conceptual knowledge and sensations in Kant's deductive terms, Peirce insists that sensations can themselves play a role in ampliative inference, that is, that they have content that can be added to a concept rather than merely being subsumed under that concept. Moreover, Peirce's naturalized understanding of Kantianism leads him to attribute the synthetic function necessary for perceptual knowledge not to the productive imagination of a transcendental subject but to the nervous system of a living animal. In other words, Peirce accepts the Kantian correlation of extensive and intensive magnitudes, but he rejects Kant's transcendental conception of this correlation.

In reconceiving Kant's realist and conceptualist explanation of perceptual knowledge along naturalistic and non-deductivistic lines, the emerging science of psychophysics presents itself as a promising method for investigating the laws of sensibility, which had only been hypothesized in Kant's first *Critique*. By 1878, Peirce promotes Fechner's psychophysics as the science that could uncover the exact relation between intensive and extensive magnitudes:

> There is a general law of sensibility, called Fechner's psycho-physical law. It is that the intensity of any sensation is proportional to the logarithm of the external force which produces it. It is entirely in harmony with this law that the feeling of belief should be as the logarithm of the chance, this latter being the expression of the state of facts which produces the belief. (W3:294)

Within the Kantian context, this law of sensation, far from expressing a mere correlation of measurements, is the key epistemic term linking intensive, subjective appearances to extensive, real objects. Though Kant saw that the correlation of these terms is a necessary condition for the possibility of knowledge, psychophysical measurement presents the possibility that this relation could be explicated empirically.[11]

2. Experimental Confirmation of Subconscious Perception

Extensive magnitudes such as length and pressure can be measured directly by tools such as rulers and barometers. But intensive magnitudes, as mere degrees of subjective sensory experience, cannot be measured directly. The basic methodological problem of psychophysics is, then, to obtain extensively measurable quantities that can serve as proxies for target intensive magnitudes. In his early experimental work on color perception, Peirce formulates the hypothesis that intensive magnitudes can be measured by means of small differences in sensation. In the following decade, Peirce and Jastrow apply this method by randomly increasing and decreasing a small weight on a subject's finger. By measuring a subject's estimates of changes of weight as well as his confidence in his estimate, their study uncovers the first experimental evidence for the existence of subconscious perceptual processes.

2.a. The Sensation of Light (1877–1878)

Peirce's "Note on the Sensation of Color" (1877), the earliest report on psychophysical research carried out in the United States, begins by articulating three hypotheses:

(1) *Apparent Light Hypothesis*: Each light's appearance depends solely on the mixture of constituent apparent lights, regardless of how the constituents are physically generated.

(2) *Young's Hypothesis*: Every sensation of light is completely characterized by three independent variables and coefficients, so that every sensation of light can be represented by an expression of the form Xi + Yj + Zk.

(3) *Fechner's Law*: The intensity of a sensation is proportional to the logarithm of the strength of the excitation, where a "barely perceptible excitation" is used as the unit (W3:211).

Together, these hypotheses predict that a constant increase of the brightness of constituent colors will result in a brighter mixed color but leave its appearance otherwise unchanged. But Peirce reports that this prediction is false: "I find, in fact, that all colors are yellower when brighter. If two contiguous rectangular spaces be illuminated with the same homogenous light, uniformly over each, but unequally in the two, they will appear of different colors" (W3:212). The comparison of two contiguous illuminated surfaces shows that as the intensity of

one light is increased, the surface it illuminates appears more yellow, independently of the ratio in which the constituent colors are mixed. At least one of the hypotheses needs to be amended.

By the summer of 1877, Peirce claims that while comparisons of the intensity of different colors are physically meaningless, such intensive magnitudes can be meaningfully compared in sensation, for example, when one judges that a red light is darker than a blue light. However, there is some uncertainty in the judgment of all such cases, the probable error of perceptual judgment (W3:236–237). As opposed to physical light, which is determined entirely by wavelength and amplitude, the intensive magnitude of the perception of a light is in part constituted by comparison to one's other perceptions.

A more programmatic argument for the view that apparent ("phenomenal") light is not determined solely by the properties of physical ("noumenal") light is offered in the first chapter of Peirce's *Photometric Researches* (1878), entitled "The Sensation of Light."[12] From measurements published by James Clerk Maxwell in 1860, Peirce argues that when a subject undergoes the perceptual shift from a lower wavelength (violet) to green, the wavelength of phenomenal green will be lower. When one shifts from a higher wavelength (red), the wavelength of phenomenal green will be higher (W3:384–387). Whereas a fixed wavelength completely determines physical color, phenomenal green is determined relative to the colors that the subject perceived prior to the shift.[13]

Having argued that the properties of physical light are insufficient to determine one's experience of color and intensity, Peirce concludes that, lacking further experimental evidence, speculation on the nature of the nervous system's contribution to one's experience of light would be idle. What is needed is a more exact way of capturing the intensity of sensations, a new technique of psychophysical measurement:

> So far we have adopted an arbitrary definition of the intensity of light which has no applicability except to lights differing in no respect except in intensity. We have now to consider another mode of measuring the intensity of all sensations which has much higher pretensions to real truth.
>
> If a certain force x applied to irritate a nerve produces a certain sensation, there is perhaps no addition to it δx so slight that the sensation produced by $x + \delta x$ will not in some slight majority of trials be pronounced more intense than that produced by x. (W3:387)

Peirce suggests that although there are thresholds of stimuli under which one is not aware of changes in sensation, a subject might correctly "guess" the intensity of sensations in repeated trials. Rather than being discovered in a single perceptual episode, the intensive magnitude

of a perception could be measured by recording repeated responses to stimuli. Measurements of frequencies of responses thus approximate the true intensity of a sensation, just as repeated discrete measurements—point estimates—approximate continuous functions. Peirce's methodological reflection serves as the basis for his discovery, six years later, of the first experimental evidence for subconscious processes. The experimental method pursued in the study of 1884 with Jastrow was already situated in Peirce's mind by 1878.

2.b. Small Differences of Sensation (1884)

The view that conscious perception arises from a subconscious background has been defended at least since Leibniz (1981, 53–54) maintained that that there are an infinite number of "petites perceptions" unaccompanied by "apperception" or reflective awareness. While petites perceptions are given directly but escape one's notice, apperceptive consciousness of one's perception is retrospective, requiring memory or retained content from prior petites perceptions. For example, the conscious perception of a color is made up of many minute constituents of which we have no consciousness (Leibniz 1981, 134).[14] Thus there appear to be thresholds under which one perceives but does not notice that one is perceiving.

Fechner's law seems to support the view that there is a threshold under which no difference of sensations could be detected (Behrens 1993, 312). But just as Leibniz held that the lapping of a single wave against the shore is imperceptible, while the accumulation of many waves produces the roar of the sea (1981, 53),[15] Peirce's Leibnizian interpretation of the law denies that there are real discontinuities in the intensity of sensation (Cristalli 2017, 41). Rather, Peirce and Jastrow's discovery of the first empirical evidence of the existence of subconscious processes suggests that thresholds apply solely to conscious perceptions.[16] Their method estimates an intensive magnitude through extensive measurements, in this case of *comparisons* of subjective estimates of changes of weight on part of one's body. These estimates are given in the subject's verbal report of his confidence in his estimate. By repeating the experiment many times on a single subject, one generates a distribution of the subject's estimates or "guesses."

Peirce and Jastrow obtain their measurements by taking turns as experimenter and subject. The experimenter uses a post-office scale to convey pressure to the index finger of the subject. By placing a piece of flannel in the pan of the scale and moving weights in and out of a pan with a rubber band attached to a lever, the experimenter can make minute alterations in the weight applied, without removing the entire weight from the scale. The experimenter's decision to increase or decrease the weight during a trial is determined by drawing cards

from a shuffled deck, thus randomizing the changes. In addition to reporting whether the change was an increase or a decrease, the subject also reports his confidence in his assertion. The important result of the experiment is that even when the subject reports no confidence in his assertion, his guesses track the changes of weight more accurately than his conscious reports of his confidence in those guesses.[17]

Peirce and Jastrow argue that although in any individual instance of perceptual discernment there is a threshold under which the subject is not conscious of the change, in repeated experiments, there seems to be no threshold for the comparison of sensations measured by the subject's guesses. Consequently, Fechner's concept of *Schwelle* or "threshold" does not apply in the case of the repeated experiment:

> we found the subject often overlooked this element of his field of sensation, although his attention was directed with a certain strength toward it, so that he marked his confidence as *zero*. This happened in cases where the judgments were so much affected by the difference of pressures as to be correct three times out of five. (W5:134–135)

In other words, *subconscious* sensations are not governed by thresholds but rather are correlated directly with the magnitude of the difference between the primary sensations. As the difference between pressures is diminished, the subconscious registering of the differences also diminishes. However, over a large number of trials, this subconscious process renders "guesses" that are better than random. As Jastrow would later put this point, "The simplest form of direct evidence for subconscious activity" are those sensory stimuli that

> seem to register no effect, yet can be experimentally shown to be capable of influencing our apperceptive process. This is but one sample of this form of evidence; others are contributed by the formation of habit, by unconscious inferential processes in normal sensation, by sudden budding forth of memory images and the like. (Jastrow 1903, 88-89)

Upon the repetition of the experiment, the extensive magnitude of pressure and the intensive magnitude of the subconscious perception can be seen to be correlated as two continuous functions.

Twenty years later, Jastrow summarizes the results of the 1884 paper as the first study that establishes how sub-threshold differences can contribute to judgments:

> if in the presence of such imperceptible or sub-threshold differences, one persists in making judgments, which are wholly without confidence—seem, indeed, to be mere guesswork, without any conscious application of that "local sign" which, if sufficiently magnified would

> serve as the ground of their differentiation—the percentage of correct judgments will be larger than mere guesswork would produce; and the percentage of success will be greater for differences of stimuli but slightly below the (conscious) threshold value than for differences considerably below that level. (Jastrow 1903, 81–82)

The existence of thresholds under which one does not consciously take notice of a sensory input does not imply that perceptual processes are discrete, as then-contemporary psychophysics assumed. Instead, thresholds are mere products of the boundary between conscious and subconscious information, which taken together show that intensive magnitudes are continuous, like the extensive magnitudes they track. The Kantian theory of knowledge, on which continuous, intensive magnitudes correspond to continuous extensive magnitudes, has been effectively naturalized. The experimental evidence of psychophysical investigation provides a methodological protective belt around the core idea of Kant's theory that perceptual epistemology is guaranteed by the object of perception being constituted in time and space.

3. The Continuity of Mental Content

Peirce and Jastrow's experiments suggest that sensory information not consciously grasped by a subject may influence that subject's beliefs, and hence that apparent thresholds do not cast doubt on the continuity of mental states. But this new conception of mind as continuously producing experience on a background of subconscious content requires a reevaluation of the epistemology of perception. Indeed, in "The Law of Mind" (1892), Peirce claims that in his 1868 account discussed above, he was "blinded by nominalistic presuppositions."[18] Whereas in his earlier essays it remained unclear how one could perceive thirds, here he articulates a new principle, the Law of Mind, which is that "ideas tend to spread continuously" losing intensity as they affect other ideas. On Peirce's new conception, as an idea recedes from consciousness, it becomes more abstract and affects an increasing number of other ideas (W8:136). Peirce's proposed law suggests that particular sensations, as they enter the stream of consciousness, have ever more general, though ever diminishing, doxastic consequences.

The key feature of this law is its synechism. The temporal continuity of mental contents requires that past ideas are not present merely "vicariously," as images of an original sensation. Rather, the generalized or abstracted content of previous perceptions is retained and forms the background on which present perceptions are featured. The continuous, synchronic connections among contents or "relations of ideas" are also given on this background. As Peirce puts it, "infinitesimally spread-out consciousness is a direct feeling of its contents as spread out" (W8:138). Consciousness being "spread-out" or "flowing" allows

particular perceptions to make one aware of general ideas.[19] Peirce's disocovery of subconscious processes in perception vindicates his naturalized Kantianism, according to which our thematic, "immediate" experience is constituted in time.

Peirce's reading of Cantor in 1884, however, led him to the view that Kant's own definition of continuity, as well as the resultant characterization of mentality, was fundamentally flawed.[20] Kant holds that a series is continuous if between any two members a third can always be found (A169). But, Peirce argues, this definition confuses continuity with infinite divisibility. Consider the sequence, continuous according to Kant's definition, of all rational fractions m/n, in which m and n are integers, listed in order of magnitude. Now suppose a "gap" were introduced into the sequence by excluding any two fractions and all that lie between them. According to Kant, this sequence with the gap is also continuous. Kant's definition of continuity must be false.

Peirce claims that Kant's property is necessary but not sufficient for a characterization of the continuum. It must be supplemented or "mended" with Aristotle's view that the parts of a continuum must have a common limit. On the resultant view, a continuum must satisfy two conditions:

> ***Aristotelicity***: a continuum contains the end point belonging to every endless series of points which it contains.
> ***Kanticity***: Between any points on a continuum, a third can always be found.

Together, Peirce holds, these properties are necessary and sufficient to characterize the continuum.

Peirce gives this definition of the continuum a vivid illustration, ultimately applying the concept in his description of mental content. Imagining a continuous surface that is partly red and partly blue, he asks whether the boundary line between the two colors is red or blue. Peirce's answer is striking:

> … red and blue, to exist at all, must be spread over a surface; and the color of the surface is the color of the surface in the immediate neighborhood of the point. I purposely use a vague form of expression. Now, as the parts of the surface in the immediate neighborhood of any ordinary point upon a curved boundary are half of them red and half blue, it follows that the boundary is half red and half blue. In like manner, we find it necessary to hold that consciousness essentially occupies time; and what is present to the mind at any ordinary instant, is what is present during a moment in which that instant occurs. Thus, the present is half past and half to come. Again, the color of the parts of a surface at any finite distance from a point has nothing to do with its color just at that point; and, in the parallel, the

> feeling at any finite interval from the present has nothing to do with the present feeling, except vicariously. (W8:145–146)

Just as the continuity of a spatially extended surface determines the qualities of the boundary points, so the continuity of temporally extended thinking determines the mind's content.

Peirce's argument in this passage depends on three main points. First, in the spatial case of the colored surface, the property of Aristotelicity requires that the value, the redness or blueness of a boundary point, be determined by the other points in its neighborhood. Because the neighborhood of each point on the limit is half-red, half-blue, an individual point on the boundary is neither wholly red nor wholly blue but is also half-red and half-blue. Second, assuming the premise that consciousness is temporally extended and continuous, Peirce argues that what is present to mind at an instant is neither wholly past nor wholly future but rather past-and-future. The experienced present is not a discontinuous, point-like representation of a fact but a determinate consciousness that is composed of retained contents and expectations. Third, it follows that the feeling of the present as present is a mere abstraction from the stream of perceptual experience. The feeling of presence is lived "vicariously" because it derives its nature from an abstraction of the temporal field in which it is embedded. The experienced present is nothing more than a secondary, reflective attitude upon the process of thinking as it extends through time.[21]

The spread-out-ness of mind underwrites the inferential role of its contents. From two temporally successive stages of a perception, a subject gains an inferential or "mediate" perception of the relation of the successive stages. Though Peirce offers few examples in this paper of 1892, one may recall the 1868 example of stroking a cloth: there the rougher and softer textures of the cloth give rise to a mediate perception of the whole, temporally and spatially extended cloth. Considered in terms of the object, the mediate perception is spread out over the duration in which the stimulus is produced. From the subject's perspective, however, the idea of the object is grasped in its generality only in the final stage (W8:138). The diachronic accumulation of sensory inputs thus culminates in a synchronic consciousness of the object as falling under general concepts, that is, as being a certain kind of thing with certain qualities, in a certain spatial and temporal location. The inferential role of perception, its ability to justify beliefs, is thus dependent on the continuity of its content. In Peirce's view, "feelings have intensive continuity" (W8:147), that is, the content of a state of consciousness proceeds from previously given content with which it is continuous.

As the experiment with Jastrow showed, subconscious comparisons, without being featured in consciousness, explain why each "present" sensation has its specific quality: it is on the time horizon of other

sensations and expectations that the new feeling gains its value. But in order for Peirce's theory to render not just awareness but also knowledge, it is necessary to understand also how present consciousness reaches out to the future, to expected contents that are not given in prior experience. From early on in his career, Peirce supposed that perception concerns not only past and present facts but also gives one grounds for future actions. It follows that unlike deduction, which is completely determined by past content, perception is ampliative and thus has the capacity to add to one's prior knowledge. It is then unsurprising that as his theory of perception matures, Peirce increasingly comes to believe that perception has the peculiar logical form of abduction.

4. The Logical Form of Perception

I have been arguing that in the "Law of Mind," Peirce ascribes the epistemic capacity of perception to the continuity of mind. But as early as 1878, Peirce explained the novelty of perception, its ability to give one reasons for new beliefs, with the view that sensory perception itself has the logical form of abduction. He illustrates this by considering two configurations of dots (Figures 1 and 2).

Peirce claims that these figures provide the same doxastic resource to an observer, though one may have different attitudes towards them. He writes, "To believe that any objects are arranged as in Fig.1, and to believe that they are arranged in Fig.2, are one and the same belief; yet it is conceivable that a man should assert one proposition and deny the other" (W3:264). The two figures depict the same configuration of objects in reality. Thus, to believe that chairs, for example, are ordered in the configuration of Fig.1 is to believe that they are ordered in that of Fig.2. However, one might erroneously endorse the view that an arrangement of chairs corresponds to the first figure but not to the second figure.

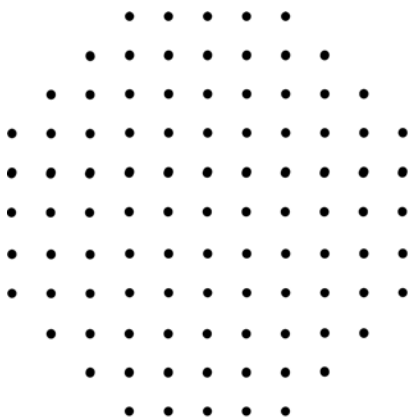

Fig. 1

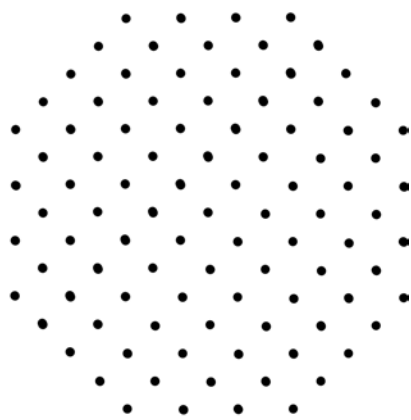

Fig. 2

This capacity to perceive the same doxastic content under different guises—and indeed to be misled by such guises—depends on there being a sub-doxastic capacity to grasp objects, which Peirce later calls perceptual judgment. Since perception allows one to have novel beliefs, Peirce argues that perceptual judgment has the logical form of abduction, in which the conclusion is explanatory of the premises. Abductive reasoning has the form:

> The surprising fact, *C*, is observed;
> But if *A* were true, *C* would be a matter of course.
> Hence, there is reason to suspect that *A* is true. (EP2:231, 1903)

This form of inference is ampliative in the sense that, while it lacks deductive validity, it allows one to add to one's corpus of beliefs. As Levi (1991, 72) puts it, while deduction involves the recognition or elaboration of a doxastic commitment that an agent has already undertaken, in abductive expansion, the "conclusion" is a change in doxastic commitment. Abduction also differs essentially from induction, which draws a general principle from a number of cases. Importantly for this paper, abduction is the only form of inference that introduces novel ideas (W3:325, 1878).

Perceptual novelty and the logic of abduction come together in "The Law of Mind" with Peirce's argument that a "feeling which has not yet emerged into immediate consciousness is already affectible and already affected" (W8:150). Insofar as it is temporally constituted, a direct feeling is connected inferentially to hypotheses about the past and future. This connection is formed by habit "by virtue of which an idea is brought up into present consciousness by a bond that had already been established between it and another idea while it was still in futuro" (*ibid.*). The data of sensation are never encountered in raw form but are always given meaning on the basis of past experience, so that "when a feeling emerges into immediate consciousness, it always appears as a modification of a more or less general object already in the mind" (*ibid.*). Adopting the word "suggestion" to describe this inferential connection, Peirce concludes that "in order that the general idea should attain all its functionality, it is necessary, also, that it should become suggestible by sensations" (W8:151). Because of the temporal continuity of mental content, perception implicitly suggests hypotheses that relate the perceptual episode to prior and possible future experience. Perceptual judgment sometimes goes wrong, such as when one forms the false hypothesis that chairs arranged according to Fig.1 could not be arranged according to Fig.2. But the abductive form of such judgment ensures that one's hypotheses are revisable, as new data are added to one's stock of prior perceptual hypotheses.

Anderson (1986, 162) has argued that if abduction introduces new ideas, giving the grounds for deductive and inductive inference, its logical and psychological aspects can be distinguished. Logically, the fundamental question is how one ought to form hypotheses. Of the trillions of hypotheses that one might form to explain a phenomenon, scientists are typically able to reach a correct hypothesis after a few "guesses." How to structure a search space of hypotheses thus appears to be the fundamental logical problem about abduction. Psychologically, however, the structuring of a search space need not be achieved through conscious control by a scientist. Rather, controls on the formation of hypotheses may be provided by evolution. Abduction can therefore be considered a kind of "instinct" for forming certain hypotheses as the result of the evolutionary development of a species and from the experience of the individual. Though it still demands a logical *justification*, the scientist's capacity to put constraints on a search space may be psychologically explained by appealing to his ability to call on prior experience in forming present hypotheses (Roth 1988, 133–135). I have argued that the continuity of perception is what entitles the suggestion of one content by another, conferring on perception the capacity to justify beliefs.[22]

5. Peirce's Mature Theory

I have argued that for Peirce, seeing that *x* is φ, whatever else it might involve, gives one reason to believe that *x* is φ. Moreover, Peirce holds that experience serving a rational role is consistent with a broadly naturalistic world view. This harmony of rational epistemology and naturalistic ontology is plausible insofar as facts of nature may be discovered through repeated experiences that have meaning, allowing the investigator to form rational beliefs through continuous experience. As Wilson (2018) makes clear, in his later work Peirce distinguishes between the percept or perceptual awareness of an object, and the perceptual judgment, or conceptualization of that object. The important point for my purposes is that perceptual judgments can be about real things—including modal properties, kinds, dispositional and causal properties, and even being real itself—that are not candidate objects of perceptual knowledge for traditional empiricism.

According to Peirce's anti-nominalist empiricism, "The elements of every concept enter into logical thought at the gate of perception and make their exit at the gate of purposive action; and whatever cannot show its passports at both those two gates is to be arrested as unauthorized by reason" (EP 2:241, 1903). This image of gates and passports represents neither a world impressing itself on an inactive knower nor a mind constructing a world from its own resources. Rather, the view is that perceptual knowledge is both constituted by knowers in the sense that it emerges from their activity of making hypotheses and is directed to an independent reality. In his Harvard Lectures (1903), Peirce writes,

> [T]he perceptive judgment is the result of a process, although of a process not sufficiently conscious to be controlled, or to state it more truly, not controllable and therefore not fully conscious. If we were to subject this subconscious process to logical analysis we should find that it terminated in what that analysis would represent as an abductive inference resting on the result of a similar process which a similar logical analysis would represent to be terminated by a similar abductive inference, and so on *ad infinitum*.… [T]his process of forming the perceptual judgment, because it is subconscious and so not amenable to logical criticism, does not have to make separate acts of inference but performs its act in one continuous process. (EP 2:227)

Because abduction is the logical form of perception, the hypotheses formed in perceptual inferences seamlessly integrate with fully conscious, doxastic hypotheses. To recognize the continuity of these conscious and subconscious acts is to admit that perceptual acts are neither applications of general concepts nor generalizations of concepts. Rather, perception consists in formulations of novel hypotheses about reality.

But does one really have a reason, in virtue of having formulated some perceptual hypothesis, to believe that hypothesis? In what sense can a perceptual judgment be justified? This question has proved problematic for some interpreters of Peirce. Assuming that Peirce is committed to the view that perceptual judgments are based on a single observation, Brogaard (1999, 138) argues that they could not be false under standard conditions. Though the point about falsity depends on how one elaborates the concept of "standard conditions," Brogaard's view incorrectly suggests that Peirce saw individual perceptual judgments as being formed solely by an immediate percept.[23] But Peirce should claim that an isolated observation must fail to justify *any* belief about a fact. Rather, a perceptual episode derives its justificatory status from the temporally spread-out content with which it is continuous. When one judges perceptually, one confirms or disconfirms prior hypotheses. In so doing, one reasons abductively to form a novel hypothesis that explains one's other perceptions. Indeed, Peirce's third "cotary" proposition is that "abductive inference shades into perceptual judgment without any sharp line of demarcation between them" (EP 2:227). Though the process that culminates in a perceptual judgment cannot be controlled consciously, the hypotheses formed in perceptual activity are themselves reason-giving judgments about the world.

Peirce's dual commitments to anti-nominalism and to empiricism rest on his view that the warranting role of perceptual judgment depends on the continuity of perceptual content. This determination of present content by its continuous connections to prior content allows for judgments about general contents, contradicting the nominalism of traditional empiricism. Moreover, because perceptual experience

includes previously encountered content and expectations about the future continuous with the featured object of consciousness, commitment to the justificatory status of perception need not rest on any problematic conception of "immediate" sensations. Rather, perception has an abductive logical form, providing doxastic warrants in virtue of subconscious inferential processes that constitute a temporally extended perceptual episode. Though one can go wrong in any given instance, perception supplies one with a constant stream of novel hypotheses about the world, guesses that tend to be right over the long run. It is because they have this abductive function that perceptual episodes serve as canonical justifications for our assertions about reality.

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NOTES

1 Hume's (*Treatise* 1.1.2.1) characterization of the idea as a mental copy of the immediately encountered impression is the most obvious example of this distinction. In twentieth-century analytic philosophy, this genetic relationship is captured in the distinction between sense data, which are immediately known by "acquaintance," and the definite descriptions that are derived from them (see Russell 1917, 152–55).

2 See Gupta 2011, 207. I follow Gupta in using "view" as shorthand for an epistemic subject's antecedent concepts, conceptions, and beliefs.

3 At the extreme, this would make epistemology a sub-discipline of psychology. On this view, knowledge claims would amount to mere indications of one's disposition to endorse certain hypotheses. Since dispositions on their own lack the rational standing to warrant a belief, knowledge would amount not to the correct grasp of a fact or concept but to mere confidence in one's own powers (see Kaufman 1958, 19).

4 Rorty argues that Peirce's anti-nominalism in the epistemology of perception is part of a larger rejection of strategies meant to reduce Thirdness. For example, the Humean phenomenalist might try to reduce knowledge of cats to "primitive" sense data, such as patches of color. The Peircean response is that what makes a bundle of sense data identifiable as a cat is that the perceiving subject must be in the habit of saying "cat" when he encounters it. Thus, "any 'reduction' of cats to patches will, therefore, miss the reference to a logical interpretant which makes the cat a cat" (Rorty 1961, 203).

5 Stovall (2016) argues that the push to naturalize Kantian and post-Kantian accounts of mind, purpose, and normativity was motivated by the rise of Darwinian thought in the nineteenth century. Far from replacing normative and purposeful explanations of human activity with blind mechanism, Stovall suggests, the Darwinian revolution suggested that these explanations could be made naturalistically intelligible (see Stovall 2015, 21–23). The present paper may be fruitfully understood as pursuing one strand of this movement: Peirce's naturalization of the Kantian theory of perceptual knowledge.

6 Dennett (2006, 66) argues that such synthetic activity need not be conceived as a synthesis of imagery. Rather, "when the brain takes the suggestion" from a perceptual experience, it forms "a belief or expectation, not painting a picture for itself to look at." The kind of synthetic activity involved in filling-in, then, may be conceived in purely inferential terms, without making reference to mental images.

7 Whether perceptual experiences have conceptual or non-conceptual content has been a matter of vigorous debate over the last decades. For a recent, clarifying contribution to this question, see Cahen 2017.

8 Kantian perceptual representings are, as Wilfrid Sellars put it, "in a generic sense, conceptual, though not sortal or attributive…" such that there is no primitive content that escapes subsumption under the schematized categories. Thus, even the use of demonstratives—here put in the subject place (*this* x)—involves the "conceptual structure of space and time" that is "built into their logical powers" (Sellars 1967, 642).

9 Kant's doctrine of principles gives explicit rules for how sensations justify assertions about reality. These are either mathematical principles, which could not be doubted even if one doubted all the contents of one's intuitions (B199), or dynamical principles, preconditions of empirical thought in some experience (B200).

10 Though Kant insists that these principles are regulative but not constitutive of the objects of experience (B222, A180), they require that the degree of any sensation be correlated to the magnitude of a real object in the world. Thus, they do seem to be constitutive of what counts as a potential object of knowledge.

11 For a discussion of Peirce's place in the intertwined traditions of psychophysical research and Kantian philosophy, see Cristalli (2017).

12 For example, if two lights of the same amplitude and wavelength fall on the same point of the retina, the amplitude of the noumenal light is doubled, while the phenomenal light might appear to be greater or lesser than the doubled amplitude. Similarly, mixes of two different pairs of noumenal lights could have the same phenomenal effect. This distinction corresponds to that made by Maxwell between the optical (physical) and chromatic (perceptual) properties of light (Maxwell 1860, 58).

13 Peirce did not view his own result as a falsification of the law but rather as a specification of it: "the (at least, approximate) truth of *Fechner's psychophysical law* is now fully admitted, that as the *vis viva* of the exciting force increases in geometrical ratio the sensation increases in arithmetical ratio" (W3:388).

14 Leibniz goes so far as to argue that the law of continuity, expressed in the slogan "nature makes no leaps," requires that just as the science of nature postulates sub-perceptual corpuscles, so the science of mind ("pneumatology") must postulate subconscious perceptions. He also claims that since each soul has petites perceptions of minutely different intensities of every quality in the universe, what is in a soul is discernible from what is in every other soul; this is how each soul is individuated (Leibniz 1981, 56–58). See Itelson (1890) for discussion of the resemblance of Leibnizian petites perceptions to Kantian intensive magnitudes.

15 Quoting this example, Jastrow (1903, 80) contrasts it with relative thresholds, which depend on the comparison to other stimuli. For example, two bowls of water might seem equally warm to the finger though not to a thermometer. Considering retrospectively his work with Peirce, Jastrow argues that relative thresholds are of primary interest to the study of subconscious phenomena. This is so because "when differences gradually decrease they fall into the region of the psychologically imperceptible, though the physical differences of the stimuli concerned may readily be established by simple physical tests." Jastrow's later interpretation suggests that he considers his results with Peirce to have shown that all perceptual thresholds are relative rather than absolute. This view was perhaps anticipated in 1874 with Brentano's (1995, 6) assertion that it cannot be maintained, on a priori grounds, that "just noticeable" sensations have a constant magnitude.

16 For the priority claim, see Jastrow (1903, 81); (1916, 724).

17 That is, if one excitation were slightly more intense than another, it would be judged so in the long run: "the multiplication of observations will indefinitely reduce the error of their mean." Rather than being due to thresholds, the errors are "brought about by the sum of an infinite number of infinitesimal causes" (W5:123).

18 Misak (2013, 28) describes Peirce's break from Kant in the early twentieth century as a radicalization of his antecedent break from the empiricist tradition. Indeed, Peirce is not opposed to British Empiricism so much as its nominalist underpinnings (see Misak 2013, 40–41).

19 Peirce's description bears a close resemblance to William James's theory, on which transitive parts of consciousness, which form the relations among the substantive parts, are themselves directly perceived. For discussion of this theory, and its usefulness in empirical psychological investigation, see Gurwitsch 1943.

20 Havenel (2008, 93) dates Cantor's influence on Peirce to an article published in *Acta Mathematica* in 1884, in which Cantor defines a continuous set as

one whose points are concatenated and perfect. Thus, given two points t and t', two properties should be satisfied:

> ***Concatenation*:** For any given distance ε>0, there is a finite number of points, $t_1,\ldots, t_i, t_{i+1},\ldots,t_n$ between t and t' such that $|t_i - t_{i+1}| < \varepsilon$; and
> ***Perfection*:** There is a more-than-finite number of points between t and t'.

In "The Law of Mind," Peirce objects that although Cantor's definition can be used to distinguish between continuous and non-continuous series, it lacks the perspicuity of a satisfactory definition of continuity. Peirce's objection is threefold: Cantor's definition rests on metrical rather than topological concepts, rather than conveying a positive notion it defines continuity by negation, and it does not display the properties of the continuum to our intelligence (W8:139). Though Peirce will further amend his own conception of continuity, Havenel (2008, 96–97) observes that this work marks an Aristotelian turn in Peirce's thought.

21 See Havenel (2008, 101) for discussion of Peirce's changing views on the color of the boundary points.

22 Justification can be defined in a thin behavioral sense as the function of a machine to carry out a valid syntactical transformation, or in a thick sense, as requiring that a subject grasp a concept. For a discussion of the difference between mechanical inference and the "originality" of abduction, see Burks (1946, 304–305).

23 Brogaard (1999, 151n20) is aware of the shading of abductive inference into perceptual judgments. However, she maintains that perceptual judgments are singular and beyond criticism. Certainly, Peirce wishes to say that perceptual judgments lack control in the sense that one cannot choose what one perceives. But that does not suggest that perceptual judgments are beyond questioning and further investigation.