

Perceptual Imagination as Anticipation in Helmholtz : Critical and Metacritical Dimensions in Helmholtz's Account of Human Vision

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Abstract

This paper takes Hermann von Helmholtz's (1821 – 1894) psychophysiological theory of perception as a point of departure in examining the conditions of possibility for the process of objectification. It is argued that the epistemological framework of Helmholtz's optics can be analyzed transcendently on two levels of analysis, namely *critical* and *metacritical*. Both levels are concerned with the way in which objectivity is constituted, but while the former is concerned with the imposition of structure by our cognitive organization, the latter deals with the constitutional role of constraint. It is demonstrated how this general epistemological strategy could also help structuring the questions involved in accounting for the internal models that necessarily underlie the activity of anticipation. More specifically, this paper argues that Helmholtz's work could provide some powerful insights into the notion of 'constraint', that is considered to be crucial in accounting for the ability for anticipation.

Keywords: Hermann von Helmholtz, anticipation, constraint, objectification, Kant, Fichte.

1 Introduction

In the past decades, philosophers of perception seem to have become increasingly aware of the shortcomings of approaches to human vision that characterize perceiving as a mere *cognitive* activity of processing sensory information¹. Recently however, sensorimotor theories of perception are trying to overcome the strict separation between sensory perception and the generation of behavior, underlying this so called 'information processing paradigm', by stressing the intimate connection between seeing and acting². As Gross et al. (1999) note, this latter paradigm seems to imply that behavioral decisions are made on the basis of a sensory representation, where the latter is *prior to the former*. By definition then, this account can only make sense of reactive, or 'data-driven' behavioral decisions, and will have a hard time explaining *proactive* (or

¹ Gross et al. (1999).

² This new perspective is most prominently represented by the 'enactive approach', developed mainly in the works of Alva Noë (see for example Noë (2004)).

top-down) adaptive behavior, or in Dennet's words: '*the ability to coordinate with the future*³', that characterizes complex living beings.

As Friston & Stephan (2007) suggest, Hermann von Helmholtz's (1821 – 1894) perception theory is quite interesting in this respect, because it can be considered as an extraordinary detailed account of how perceptual learning and inference serve exactly as a means to *maximize* this ability to coordinate with possible future events, or in other words: the ability to anticipate. In fact, Helmholtzian perception seems to be essentially anticipatory *in nature* (as I will illustrate in section 2)⁴. Therefore, a historical detour through the epistemological foundations of the Berlin scientist's psychophysiological optics, could certainly provide some general insights into the fundamental nature of anticipation.

More specifically, Helmholtz's theory of human vision could serve as a point of departure to investigate the conditions of possibility of anticipation as a *determinate* activity, in the Fichtean sense⁵:

'what does a 'determinate activity' mean? And how does an activity become determinate or determined? Merely by having some resistance posited in opposition to it – posited in opposition: that is to say, a resistance that is thought of by means of ideal activity and imagined to be standing over against the latter⁶'

The determinateness of anticipation lies in the fact that although it is an activity that is directed towards the (imaginary) realm the possible (and even the preferable), it necessarily remains tied to, or *disciplined* by, a degree of reality, that is maybe best captured with the theoretical notion of 'constraint'. This aligns with Stepp and Turvey's (2010, p.150) assertion that the ability to anticipate is essentially constituted by⁷:

'(a) the existence of constraints (on the states of the environment and on the states of the organism's body), and (b) sensitivity, on the organism's part, to the existing constraints. By definition a constraint on a thing or process means that the thing or process cannot exhibit all of its potential variety.'

This suggests that the internal models of the environment that are involved in anticipation, consist at least partly of an internalization of external constraints, and thus presuppose a preceding process of objectification. As I will show, Helmholtz's work on perception could offer some powerful insights into the constitutional role of (sensitivity to) constraint in this objectification process, and especially into the way in which the 'sensitivity to constraint' could be operationalized on a psychophysiological level. This account, and especially the Fichtean background against which it was constructed, could

³ In Stepp and Turvey (2010).

⁴ Gross et al. (1999, p. 1101) summarize this action-oriented approach to human vision as follows: '*Perception is assumed to be a generative process of anticipating the course of events resulting from alternative sequences of hypothetically executed actions.*'

⁵ Fichte (2005 [1798]), p. 12.

⁶ Ibid. p. 12.

⁷ See also Kljajic (2001, p. 404) for example, who states that the process of anticipation is constantly (and necessarily) mediated by (the experience of) the resistance of the environment to a person's intentions.

be said to proceed from the basic assumption of a foundational, or non-objectal subjectivity⁸ as a formal condition for the internalization of external reality.

It is important to notice however, that Helmholtz's elaboration of this general idea is not restricted to the activity of anticipation, but was meant to provide an answer to what he considered to be one of the most basic epistemological problems confronting the theory of human vision, namely that of distinguishing between (the qualitatively identical) states of excitation arising from external objects, and those arising from pure mental states such as 'memories, intentions, wishes, moods.'⁹ Consequently, it will be treated within this general framework in what follows.

Recognizing reality as constraint is one thing, making sense of it is another. So on the other hand, a transcendental account of anticipation should address the question of how the materiality – obtained through the sensitivity for constraint – is structured *a priori* by our cognitive organization, thus enabling the formation of meaningful (or adequate) internal models. Whereas the above mentioned problem of 'constraint' could be said to pertain to the fundamental *origin* of the (possible) content of such models, this question has to do with their *necessary form*. At a more general epistemological level, this concern has to do with the formal conditions for something to be *comprehensible*. Here again, the epistemological basis of Helmholtz's theory of perception is interesting, in its insistence on the fact that this kind of comprehensibility is tied to the *a priori* functioning of the causal law.

I will discuss the way in which Helmholtz deals with both of these issues in detail, by taking his 1855 statement 'to see is to understand sensation' as a point of departure¹⁰. Two possible ways of accounting for the conditions of possibility for 'understanding' implied will be suggested, in accordance with the double structure of the philosophical concerns mentioned above, namely as a matter of (1) cognitive structuring, and (2) the recognition of constraint.

Moreover, this double structure could be said to reflect the historical progression from Kant's critical project to Fichte's radicalization and extension of transcendental idealism through a theoretical shift which is described by Steigerwald (2003, p. 112) as a change in focus from¹¹:

'the interrogation of how cognition in general is possible to an interrogation of how a *critique* of cognition is possible [...]', For Fichte this metacritique required attending to the activity of the I [Ich] in thinking, to thinking or acting with the I in all its cognitive processes.'

⁸ See section 2.2. The term 'non-objectal [ungegenständlich] subjectivity' was introduced by Schleiermacher to refer to a core subjectivity, and the essence of personhood, and could be considered as an analogue to Schelling's 'original [urständig] subjectivity', and to Fichte's elaboration of the immediate acquaintance of (self-)consciousness with itself (Frank (2007, p. 152)). Frank (2007) uses the term as a more general characterization of the (originally idealistic idea) of a kind of irreducible subjectivity, which means amongst others that it is not produced by a reflective activity or a sensory intuition, but on the contrary, is 'already familiar with itself before reflection' (p. 152).

⁹ Helmholtz (1995 [1878]), p. 349.

¹⁰ Helmholtz (1896 [1855]), p.100.

¹¹ See also Zöller (2009).

In other words: on the one hand there is the critical (Kantian inspired) question of *comprehensibility*, and on the other hand the metacritical (Fichtean inspired) question of the constitutional role of *constraint*. In what follows, I will address the way in which Helmholtz deals with these questions in that order, in order to preserve this historical logics. In conclusion, I will show how the general insights gained from this historical inquiry could inspire a transcendental approach to anticipation from a critical and a metacritical perspective.

2 Understanding Understanding : a Transcendental Perspective

As a way of clarifying the basic outline of his theory of human vision, Helmholtz¹² frequently appeals to the metaphor of language. More specifically, he insists that the processes involved in perceptual learning and perceptual understanding show great similarity with those underlying language acquisition and comprehension¹³. Sensations, according to Helmholtz, are natural signs or symbols, similar to the individual words of a language, and as such, (1) they do not *resemble* that which they signify and (2) their interpretation has to be learned through practice and experience¹⁴. Helmholtz therefore describes sensations – in themselves nothing more than subjective states of excitation or functional activity¹⁵ – as ‘*a language given us with our organization by which external objects discourse to us*’¹⁶.

It is important to notice that this last sentence implies that not every sensation counts as a sign, but only those belonging to the ‘discourse of external objects’. This is what motivated Helmholtz to introduce the distinction between objective and subjective sensations¹⁷, in his Treatise of Physiological Optics. Whereas both indicate a sensory change, the former are caused by *objective* activity (and have an external origin), while the latter denote the effect of *subjective* activity (and are thus internally generated). Furthermore, Helmholtz insists that sensations as such carry no *intrinsic* marker regarding their origin. For the sake of clarity, I will refer to this core assumption of Helmholtz’s theorizing as the *original underdetermination of sensation* in what follows.

¹² See for example Helmholtz (1995 [1869; 1878; 1892]).

¹³ In ‘The Theory of Vision’ Helmholtz (1995 [1868], p. 201) states for example: ‘*There is a most striking analogy between the entire range of processes which we have been discussing, and another System of Signs, [...] I mean the words of our mother tongue. [...] First, the child has to guess that the sounds it hears are intended to be signs at all; next the meaning of each separate sound must be found out, by the same kind of induction as the meaning of the sensations of sight or touch [...].*’

¹⁴ The main point here is that just as the word ‘table’ for example, does not resemble the physical object it signifies, a state of functional activity (sensation) does not resemble its cause (Helmholtz (1910 [1867]), p. 20. Obviously, an important difference between sensations as signs and the symbolic structure of language, lies in the fact that the former are not human creations, but determined by our physiology. The language metaphor used by Helmholtz is however useful in understanding that sensations *denote* physical objects, just as the individual words of a language denote their meaning. For a comprehensive account of the difference and relation between representation – resemblance – symbolization and denotation, see for example Goodman (1976).

¹⁵ Helmholtz (1995 [1868]) p. 149.

¹⁶ Helmholtz (1995 [1869]), p. 222.

¹⁷ Helmholtz (1910 [1867]), p. 17.

2.1 The Causal Architecture of Representation: Helmholtz's Kant

For Helmholtz, the process of understanding a sign (in the sense of understanding its meaning) comes down to *finding the law that regulates it*¹⁸. The underlying assumption here is that objective sensations (signs) relate to their cause in a *systematic* manner, that is: every object is associated with a particular system of signs, or has an idiosyncratic way of presenting itself to the senses¹⁹. What is meant by 'the law' in this context can be better understood through the language-metaphor: every external object or event has a particular way of *discoursing* with our senses, or in other words: it is associated with a specified system of signs that we learn to decipher through experience²⁰. This systematicity reveals itself only through time, since it does not pertain to isolated signs (which are essentially arbitrary), but to their law-like succession, or combination. The inferential process, through which a sensation is understood as the law-like *expression* of an external object or event (as a stable and enduring cause²¹), Helmholtz describes as a process of *unconscious inductive inference*.

What distinguishes Helmholtz from strict empiricist theories of perception such as those elaborated by J.S. Mill and David Hume however²², is the fact that according to the former, the law of causality is not *derived* from inductive inference. It is rather the other way around: the capacity for inductive inference (and determining law-likeness) depends upon causality as an a priori, transcendental law²³. The experience of law-likeness, is thus not a contingent figment of imagination as it is in Hume for example, but a *necessary* condition for experience itself. As Hatfield (1993, p. 557) puts it, Helmholtz asserted that the mind '[...] is driven to seek the lawful,' and 'can only comprehend a nature that is lawful.' I would consider this to be a critical aspect of Helmholtz work, because it answers the question of 'what it is to understand' by means

¹⁸ Helmholtz (1995 [1869]), p. 208-209. From what follows it should be clear that the faculty of understanding in Helmholtz shows a striking similarity with that of Kant, namely as the 'faculty of cognition of rules (and thus cognition through concepts) [...]' (Kant (2006 [1796], p. 91). The central concept for Helmholtz is that of causality, which is not derived from experience, but instead has to be presupposed as a condition of possibility for the comprehensibility of appearances.

¹⁹ Helmholtz (1995 [1878]).

²⁰ Helmholtz (1995 [1869]), p. 222.

²¹ The existence of causes as the invariable source of changing phenomena, remains a hypothesis, and the only thing that we can know factually, is the law-like (Helmholtz (1995 [1878], p. 360).

²² It should be noted however, that Helmholtz was without doubt influenced by Mill's account of inductive inference in his formalization of the inductive processes underlying vision (see for example Helmholtz (1910 [1867])).

²³ Helmholtz (1995 [1878]), p. 363: 'The law of causality [...] expresses a trust in the complete comprehensibility of the world. Comprehension [...] is the method whereby our thought masters the world, orders the facts and determines the future in advance. [...] The law of causality [...] is an a priori given, transcendental law. A proof of it from experience is not possible, since the first steps of experience [...] are not possible without employing inductive inference, i.e. without the law of causality.' It should be noted however, that Helmholtz's formalization of perceptual judgment as an inductive inference, was definitely influenced by Mill, as Helmholtz himself explicitly recognizes (see for example Helmholtz (1910 [1867]), and Erdmann (1921)). But as Schiemann (2009) points out, besides the similarities, there are also significant differences, especially pertaining to the epistemological status of the principle of causality as an a priori principle in Helmholtz, and an empirical concept in Mill.

of a critical examination of what is needed in order for something to be *comprehensible*. And what is needed, according to Helmholtz, is the a priori imposition of structure upon any possible 'given', which logically precedes all a posteriori organization of empirical reality.

One of the epistemological implications of this line of thought is that our knowledge can pertain only to *effective* reality or 'actuality' [Wirklichkeit], and not to a kind of mind-independent reality²⁴. Helmholtzian 'actuality' literally denotes reality as it *acts* upon (or causally interacts with) our senses. The ability to represent this reality can thus be nothing more than: '*to be able to think how something happens [...] or the power of imagining the whole series of sensible impressions that would be had in such a case*²⁵'. That is: imagining possible effects of hypothesized causes.

It is interesting to notice how an (objective) idea for Helmholtz has a distinctive *generative* character, and could be interpreted as a predictive model, which coordinates the interaction with the environment. Based on this representation, a perceiver is able to predict possible future sensations tied to the presence of the hypothesized object or event. This generative side of perception could therefore best be described as explicitly anticipatory in nature, allowing for pro-active engagement with the environment, rather than mere reactivity to what is *actually* present in sensory experience. From this perspective, it is quite understandable that Helmholtz is often credited for laying out the foundations of the now popular paradigm of perception as Bayesian inference²⁶. However, it would be wrong to characterize the Helmholtzian perceiver as a mere 'observer-with-calculator', as I will show in the next section²⁷.

The emphasis Helmholtz puts on the fact that *what* something is, is only represented in terms of *how it (inter)acts*, can hardly be overestimated. Theoretically, this amounts to a definition of objectivity not in terms of *truth* (or exact correspondence) per se, but in terms of the practical *adequacy* of a representation for an *agent*²⁸: '*Our ideas cannot be anything but symbols [...] for things we learn how to use in order to regulate our movements and actions.*'

To summarize: at this first (critical) level of analysis, Helmholtz establishes causality as a transcendental condition for the comprehensibility of the 'discourse' of external reality. The interpretation of an *objective* sensation is thus conditioned a priori by the rule that 'similar objects produce similar signs²⁹'. In Kantian terms: the materiality of experience (sensation) is necessarily conditioned by the form of understanding, and in Helmholtz this comes down to the a priori imposition of law-likeness (as causality) to all sensations.

²⁴ Helmholtz (1995 [1878]).

²⁵ Helmholtz (1995 [1870]), p. 229.

²⁶ See for example Kersten (2004).

²⁷ The idea of 'observer-with-calculator' is invoked by Stepp and Turvey (2010) to refer to those accounts of anticipatory systems in which the agent is considered to be represented in isolation of the anticipated system.

²⁸ Helmholtz (1910 [1867]), p. 19.

²⁹ Helmholtz (1995 [1868]), p. 166. Helmholtz actually establishes rules of this form to be the only possible correspondence relation between representations and the external world.

At this point, Helmholtz encounters a fundamental problem, namely the fact that in perceptual processes, some of the experienced sensory changes are not the effect of an external activity, but originate in the perceiving subject himself: the sensory effects of self-generated movements³⁰. Given the fact that Helmholtz maintains what I have called the original underdetermination of sensation, this poses a genuine problem for his theory of perception: if there is no intrinsic difference between self-generated affection and external affection, this means that the presence of sensation *as such* is not enough to account for the materiality of experience. This materiality can only be derived from *a sign*, that is: a state of affection that is judged to originate from an external source.

These considerations prompt Helmholtz to give a (philosophical and physiological) account of foundational, non-objectal subjectivity which I like to consider metacritical, because it underlies the very possibility of analyzing (perceptual) knowledge in terms of matter and form (signs and laws). This dimension of Helmholtz is concerned with the conditions of possibility of apprehending a sign *qua* sign, which, according to the Berlin scientist, is only possible '[...] *after we know how to complete the separation of that which the Ego can and cannot change.*'³¹ According to Helmholtz, this ability is fundamentally dependent upon what he calls 'können', or knowledge of our own causal efficacy, that is: '*being acquainted with the particular innervation of muscles, which is necessary in order to produce any effect we intend by moving our limbs*'³².

2.2 Perception and Constraint: Helmholtz's Fichte

The underdetermination of sensation in Helmholtz prevented him from assuming an original differential awareness of the activity of the Self on the one hand, and the activity of a Non-Self on the other. An investigation of what it is to 'understand sensation' should therefore go beyond the mere cognitive activity involved in linking a sign to its meaning. Instead, it should address the conditions of possibility for a sign to function as a sign *for something that is not contained in it*, that is: for a sign to be apprehended as the effect of external activity, *in contrast with* subjective sensations. The awareness of what is objective originates exactly from this experience of opposition, and as such, the epistemological status of the object in Helmholtz's theory is defined in a purely negative way, namely as that which is independent from (and opposed to) our will³³.

The awareness of an objective constraint to our own intentionality, however, necessarily involves a parallel understanding of this very intentionality, or in other words: of the causal efficacy of the subject. Only then can a state of opposition arise that allows a discrimination between subjective sensations or activity, and objective

³⁰ Here again, the language metaphor can help to gain a better understanding of what this means: as a child we learn how to speak by manipulating our vocal apparatus in such a way, that we can produce the intended sounds, and these in turn are immediately perceived as being the products of agency. The same is the case with respect to the perceptual process: if we move our eyes, we seem to know intuitively that some sensory changes are the effect of our own activity, and not of a change in the external world.

³¹ Helmholtz (1995 [1878]), p. 362.

³² Helmholtz (1995 [1868]), p. 198.

³³ Helmholtz (1995 [1892]), p. 405.

ones. According to Helmholtz, this is given through the immediate awareness of our impulses of will (marker for autonomous causation or intentionality), as a conditions of possibility for inferring the presence of external objects. As Westheimer (2008, p. 7) puts it: 'through knowledge of the actuated movement it can be determined what in the changes of the sensory impressions can be ascribed to the movements; what remains, by inference, is of the real world'. This process Helmholtz describes in Fichtean terms: 'Fichte's appropriate expression for this is that a Non-ego forces recognition of itself vis-à-vis the Ego'³⁴. Self-consciousness is thus established as a constitutive dimension of empirical or objective consciousness.

Helmholtz however did not satisfy himself with this abstract analysis, and tried to establish a physiological basis for the sense of agency [können], through his concept of 'muscular feeling'. This concept comprises three kinds of sensations, namely sensations of '(1) the intensity of the effort of will [the feeling of innervation], (2) the tension of the muscles, that is, the force by which they try to act, and (3) the result of the effort, which [...] makes itself felt in the muscle by a contraction which actually takes place [...]'³⁵.

The Fichtean spirit of this analysis can hardly be denied³⁶. To illustrate this, we could turn to Fichte's *Sittenlehre*, which was published in 1798, and aimed at an examination of the conditions of possibility for agency [Wirksamkeit]. Some have suggested that this Fichtean concern is in fact to be considered as 'an extension of Kant's Transcendental Deduction from the *I think* to the *I will*'³⁷. This matches with Fichte's complaint in the introduction of the *Sittenlehre* that up until that time, the main focus of philosophy had been theoretical, in the sense that philosophy was mainly concerned with asserting 'the correspondence of our representations with things that exist supposedly independently from those representations'³⁸. But how is this experience possible, if the I in the 'I

³⁴ Helmholtz (1995 [1878]), p. 361.

³⁵ Helmholtz (1910 [1867]), p. 243. These kinds of statements have lead philosophers such as Fullinwider (1991) to state that Helmholtz had transformed Kant's transcendental law of causality into a physiological process. In my view, this interpretation might be based upon a conflation between two levels of analysis in Helmholtz's writings, namely the analysis of 'I will' (meta-critical) and that of 'I know' (critical), which give rise to his postulation of two interdependent causal circuits in the constitution of empirical consciousness. *Different* because they each rule over one of the two realms that Helmholtz kept so cautiously apart: objective force, and human will (See for example Helmholtz (1995 [1869], p. 208), (1995 [1878]), Krüger (1994)).

³⁶ It should be acknowledged however, that determining the extent to which Helmholtz's theory of perception was indebted to Fichtean philosophy remains somewhat problematic, to say the least. Although Helmholtz does recognize the value of Fichte's thought as a suitable philosophical background of his theory of perception (see for example Helmholtz (1995 [1878]), he was certainly somewhat ambivalent towards it (as he was towards post-Kantian idealism in general). For some interesting accounts of the Helmholtz-Fichte relation see for example Heidelberger (1994) and Turner (1977).

³⁷ Beck (1996), p. 277. Frank (2007) suggests that Fichte's attempt to found an irreducible subjectivity is actually a response to the Kantian difficulties with accounting for the way in which the 'I' grasps itself as a subject, in a non objectal manner. An objectal representation of the Self would be one that is the result of a reflection through which the subject is actually objectified; the problem with these so called reflection models of self-consciousness, according to Frank, is that they (1) are circular (since they presuppose that which they want to explain, and (2) cannot differentiate between the consciousness of an object and self-consciousness.

³⁸ Fichte (2005 [1798]), p. 8.

know', doesn't somehow *know itself*, in order to represent something that is independent from it? Determining how the subject of consciousness represents itself, is indispensable according to Fichte, because it is constitutive for the experience of a world that exists in its own right.

In this way, Fichte's inquiries into practical philosophy lead him to the conclusion that the concepts of free will and voluntary acts are not just important within the restricted domain of ethics, but have a constitutive role in experience itself³⁹. As such, Fichtean epistemology transcends the traditional differentiation between practical and theoretical philosophy: the analysis of the conditions of possibility of 'Wirksamkeit' (agency) amount to the formulation of principles that are basic to answering the questions of theoretical philosophy. As Fichte puts it: '*our freedom itself is a theoretical principle for the determination of our world.*'⁴⁰ Martin (forthcoming, p.12) summarizes this line of thought as follows: '*To experience of resistance one must somehow also experience oneself as striving toward or for something – an endeavor that one finds thwarted by the resistance of the world.*' The main point Fichte tries to make throughout his *Sittenlehre* is the fact that the awareness of the 'I' as 'The ground of change in the world', which is at the root of agency is unmediated and non-reflective, and could therefore be considered as an a priori for experience itself⁴¹, according to Martin (forthcoming).

3 Conclusion

The line of reasoning I presented in this paper aligns with the paradigm shift in the philosophy of perception mentioned in the introduction, as it is based on the assumption that an 'objective percept' does not have a cognitive value *in its own right* that can be analyzed independently from the goals and ends of a living, acting being. Instead, it offers a more general perspective on perception as a property of an adaptive living being exhibiting proactive, as well as mere reactive behavior⁴². I offered an analysis of this perspective by means of Helmholtz's statement 'to see is to understand sensation', and more in particular of the formal conditions underlying the understanding implied. As I have shown, these formal conditions can be analyzed on two different levels, critical and metacritical, which deal respectively with (1) the way in which our cognitive organization imposes its structure upon the possible matter of experience, and (2) the way in which (the sensitivity to) constraint plays a constitutional role in objectification.

³⁹ Ibid.; Martin (forthcoming).

⁴⁰ Fichte (2005 [1798]), p. 70.

⁴¹ Martin (forthcoming).

⁴² In my view, one of the most interesting implications of this approach, is that it could inspire a new perspective on epistemological questions pertaining to the objective nature of our representations. More specifically, this analysis suggests that representations qualifying as objective, don't do so by virtue of their alleged correspondence with a thing like reality, but instead through their capacity of enabling *adequate* interaction with the environment.

One of the most important insights that can be gained from this investigation is the fact that prior to the question of how an organism relates to the environment through internal models, another problem should be addressed, namely the question of how the *materiality* of experience comes to be determined in the first place. In Fichtean terms, this materiality has the epistemological status of a Not-I, constraining the activity of the I. For Helmholtz, this insight amounts to the recognition of *agency* as a constitutive dimension of experience, as the ability to *know* presupposes a knowledge of the ability to *act*, thus establishing an intimate connection between the two in accounting for the constitution of external reality in perception.

As stated in the introduction, this double layered transcendental investigation into the epistemological background of Helmholtz's psychophysiological optics could definitely help in formulating some interesting suggestions for the theoretical approach of anticipation as a determinate activity. First of all, it demonstrates in the most general way that every interaction between an organism and its environment requires (or becomes determined by) (1) the imposition of structure, and (2) the sensitivity to constraint. The difference between these two questions is essentially based on their opposing 'direction-of-fit'⁴³: where the first is concerned with the conditions enabling the comprehension of the external world through subjective organization, the second pertains to the way in which subjective states of excitation first come to be externalized.

To be sure: both represent the flipside of what is essentially a unitary act. The gain of distinguishing between the two becomes clearer however, if we take into consideration the possible 'prediction-errors' that can arise in the process of anticipatory engagement with the environment⁴⁴. It could be hypothesized that this process can fail at two different, but interdependent levels. First of all, prediction-error could originate from a rather superficial level, and be due to a misapplication of law-likeness for example, or because of an incomplete comprehension of the laws at stake. In this case a re-sampling of the environment, or a correction in our cognitive representation of the environment could in principle suffice to reduce the margin of error. At a more fundamental level however, there could be a dysfunction in the internal mechanisms through which we are aware of our own intentionality, resulting in an analogue disturbance in the ability to discriminate between subjective activity (or agency) and objective activity. Since the latter seems to be more fundamental than the former, it is not unthinkable that this will automatically lead to impairments on the more superficial, cognitive level. On the other hand, judgmental errors that have to do with the mere cognitive grasp of the environment, do not necessarily imply that there is something wrong with what could be called the *discriminative* ability. If we consider anticipation to be the generative side of perception (as suggested in section 2.1.), these respective flaws or deficits correspond to the phenomena of illusion on the one hand, and hallucination on the other.

The pertinence of this theoretical analysis has become especially clear in contemporary neurophysiological research with regard to deficits in the sense of agency (and anticipatory capacity) in pathologies such as schizophrenia. A crucial aspect of

⁴³ Martin (forthcoming).

⁴⁴ Friston & Stephan (2007).

Helmholtz's (and Fichte's) account of agency is that it is founded in, and constitutive for a *non-objectal* subjectivity, or the assumption that the sense of Self that is not primarily derived from sensory intuitions. This idea has resurfaced in contemporary neurophysiological research in relation to the 'efference copy model', as a new approach to action control. This paradigm states that copies of motor commands (an efference copy which could be considered to be an indicator of willed or voluntary movement⁴⁵) and visual feedback signals are constantly compared in an internal comparator mechanism. In the case of incongruence between this internal prediction and the actual feedback, a sensory event is ascribed to an external cause⁴⁶.

In the past decades, it has been established empirically that psychotic symptoms may be due to a deficit in this internal mechanism, leading for example to the typical feelings of alien control or other 'passivity experiences'⁴⁷. However, recent findings suggest that disturbances in this internal mechanism might also lead to *exaggerated* feelings of control⁴⁸. Voss et al. (2010) ascribe this to a shift from predictive to retroactive ascription of the self-authorship of actions. In the terminology I have proposed within the context of this paper, this could be said to imply a shift from (unmediated) non-objectal subjectivity, to (sensory mediated) objectal subjectivity, in which the sense of agency is not internally generated, but derived from sensory changes. If we take into account the possible shift to objectal subjectivity, malfunctions in the efference copy system could just as well cause feelings of excessive control in schizophrenia. In general, these findings suggest that the ability for objective representation indeed requires some kind of foundational subjectivity, and demonstrates the possible relevance of the metacritical investigation I presented in this paper.

References

- Beck, G. (1996). From Kant to Hegel - Johann Gottlieb Fichte's Theory of Self-Consciousness. *History of European Ideas* 22: 275-294
- Blakemore, S.J. et al., (1999). Spatio-Temporal Prediction Modulates the Perception of Self-Produced Stimuli. *Journal of Cognitive Neuroscience* 11 (5): 551-559.
- Erdmann, B. (1921). Die Philosophischen Grundlagen von Helmholtz' Wahrnehmungstheorie. *Abhandlungen der Preussischen Akademie der Wissenschaften* 21: 3-25
- Fichte, J.G. (2005 [1798]). *The System of Ethics*. Cambridge: University Press
- Frank, M. (2007). Non-Objectal Subjectivity. *Journal of Consciousness Studies* 14 (5-6): 152-173
- Friston, K.J. & Stephan, K. (2007). Free-Energy and the Brain. *Synthese* 159 (3): 417-458
- Fullinwider, S.P. (1991). Darwin faces Kant: a Study in nineteenth-century Physiology. *The British Journal for the History of Science* 24 (1): 21-44

⁴⁵ Sass & Parnass (2003).

⁴⁶ Synofzik et al. (2008).

⁴⁷ See for example Blakemore et al. (1999).

⁴⁸ Sass & Parnass (2003); Voss et al (2010).

- Goodman, N. (1976). *Languages of Art. An Approach to a Theory of Symbols*. Cambridge: Hackett Publishing
- Gross, H.M. et al. (1999). Generative Character of Perception: a Neural Architecture for Sensorimotor Anticipation. *Neural Networks* 12 (7-8): 1101–1129
- Hatfield, G. (1993). Helmholtz and Classicism: The Science of Aesthetics and The Aesthetics of Science. In Cahan, D.: *Hermann von Helmholtz* (522-558). California: University of California Press.
- Heidelberger, M. (1994). Helmholtz' Erkenntnis- und Wissenschaftstheorie im Kontext der Philosophie und Naturwissenschaft des 19. Jahrhunderts. In: *Universalgenie Helmholtz* (168-185). Berlin: Akademie Verlag
- Helmholtz, H. von (1896 [1855]). Ueber das Sehen des Menschen. In Helmholtz, H.: *Vorträge und Reden, Ersten Band* (85-119). Braunschweig: Holzstiche
- Helmholtz H von (1910 [1867]). *Treatise on Physiological Optics*. Translated from the third German Edition/Edited by James P.C. Southall. New York: Dover Publications.
- Helmholtz, H. von (1962 [1868]). The Recent Progress of the Theory of Vision. In Cahan, D.: *Science and Culture* (127 – 203). Chicago: University of Chicago Press.
- Helmholtz, H. von (1995 [1869]). On the Aim and Progress of Physical Science. In Cahan, D.: *Science and Culture* (204 - 225). Chicago: University of Chicago Press.
- Helmholtz, H. von (1995 [1870]). On the Origin and Significance of Geometrical Axioms. In Cahan, D.: *Science and Culture* (226-248). Chicago: University of Chicago Press.
- Helmholtz, H. von (1995 [1878]). The Facts in Perception. In Cahan, D.: *Science and Culture* (342 - 380). Chicago: University of Chicago Press.
- Helmholtz, H. von (1995 [1892]). Goethe's Presentiments of Coming Scientific Ideas. In Cahan, D.: *Science and Culture* (393 - 412). Chicago: University of Chicago Press.
- Kant, I. (1796 [2006]). *Anthropology from a Pragmatic Point of View*. Cambridge: University Press
- Kersten, D. (2004). *Object Perception as Bayesian Inference*. Annual Review of Psychology 55: 10.1-10.32
- Kljajic, M. (2001). Contribution to the Meaning and Understanding of Anticipatory Systems. *Proceedings of CASYS 2000 : COMPUTING ANTICIPATORY SYSTEMS*, Daniel M. Dubois (Editor), American Institute of Physics, AIP CP 573, 400-411
- Krüger, L. (1994). Helmholtz über die Begreiflichkeit der Natur. In: *Universalgenie Helmholtz* (201-215). Berlin: Akademie Verlag
- Martin, W.M. (forthcoming). Fichte's Transcendental Phenomenology of Agency. In: *Fichte: System der Sittenlehre*. Edited by Merle, J.C. and Schmidt, A. Berlin: Akademie Verlag
- Noë, A. (2004). *Action in Perception*. Cambridge: MIT Press
- Sass, L.a. & Parnas, J. (2003). Schizophrenia, Consciousness, and the Self. *Schizophrenia Bulletin* 29(3): 427-444
- Schiemann, G. (2009). *Hermann von Helmholtz's Mechanism: the Loss of Certainty*. New York: Springer Verlag.

- Steigerwald, J. (2003). The Dynamics of Reason and its Elusive Object in Kant, Fichte, and Schelling. *Studies in the History of the Philosophy of Science*, 34: 111-134
- Stepp, N. & Turvey, M.T. (2010). On Strong Anticipation. *Cognitive Systems Research*, 11 (2): 148 – 164
- Synofzik, M. et al (2008). *I Move, therefore I am: A New Theoretical Framework to Investigate Agency and Ownership*. *Consciousness and Cognition* 17: 411-424
- Turner, R. S. (1977). *Hermann von Helmholtz and the empiricist vision*. *Journal of the History of the Behavioral Sciences*, 13: 48–58
- Voss, M. et al (2010). Altered Awareness of Action in Schizophrenia: a Specific Deficit in Prediction Action Consequences. *Brain* (133): 3104-3112
- Westheimer, G. (2008). Was Helmholtz a Bayesian? *Perception* 37 (5): 642-650
- Zöller, G. (2009). From Critique to Metacritique. Fichte's Transformation of Kant's Transcendental Idealism. In Sedgwick, S.: *The Reception of Kant's Critical Philosophy* (129-146). Cambridge: University Press