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"Seeing Rain": Integrating phenomenological and Bayesian predictive coding approaches to visual hallucinations and self-disturbances (Ichstörungen) in schizophrenia

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ABSTRACT

We present a schizophrenia patient who reports "seeing rain" with attendant somatosensory features which separate him from his surroundings. Because visual/multimodal hallucinations are understudied in schizophrenia, we examine a case history to determine the role of these hallucinations in self-disturbances (Ichstörungen). Developed by the early Heidelberg School, self-disturbances comprise two components: 1. The self experiences its own automatic processing as alien to self in a split-off, "doubled-I." 2. In "I-paralysis," the disruption to automatic processing is now outside the self in omnipotent agents. Self-disturbances (as indicated by visual/multimodal hallucinations) involve impairment in the ability to predict moment-to-moment experiences in the ongoing perception-action cycle. The phenomenological approach to subjective experience of self-disturbances complements efforts to model psychosis using the computational framework of hierarchical predictive coding. We conclude that self-disturbances play an adaptive, compensatory role following the uncoupling of perception and action, and possibly, other low-level perceptual anomalies.

1. Introduction

We present a schizophrenia patient who experiences persisting visual hallucinations of "seeing rain" accompanied by somatic experiences of tickling and movement in the back of his head, which he experiences in his "brain," pressure on his eyes, and changes of temperature in his hands and legs. Because visual/multimodal hallucinations are understudied in schizophrenia, we examine this case to determine the role of these hallucinations in self-disturbances (Ichstörungen).

During the years 1915–1932, the Early Heidelberg School of Psychiatry (Gruhle, Mayer-Gross, Beringer) first developed and systematically described "self-disturbances" in schizophrenia. Kurt Schneider (1939) later incorporated many self-disturbances in his first rank symptoms. Despite considerable recent interest in self-disturbances, the history and importance of this initial work have been curiously neglected (for the history, see Mishara et al., 2015; Sterzer, Mishara, Voss, & Heinz, 2016; Kendler & Mishara, 2019; see Hermle, Oepen, & Spitzer, 1988, for Beringer's role).

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In defining self-disturbances, Gruhle (1915, 1922a, 1922b, 1929, 1932) proposed 2 components:

1. In "doubling of the I" (Doppelich), the self looks on her/his experiences passively as non-participatory bystander. Unable to detach but also unable to participate, everything plays before the patient as if on a theater-stage. Unpleasant bodily sensations, and other sensory disturbances (including hallucinations) are experienced as an "alienation from the perceptual world" (Entfremdung der Wahrnehmungswelt). Generally, we experience controlled and automatic processing as complementary, as working together seamlessly in everyday cognition, without giving much thought to how this takes place. However, for the patient with self-disturbances, the automatic processing underlying perception, movement, feeling, thinking, speech and volition is experienced as occurring independently of the "I," and therefore, as foreign, split-off in a doubled-I.
2. In the "paralysis of the I" (Ichlähmung) the automatic processes described in the doubled-I are brought under foreign control in violation of "the I's sphere of power" (Machtsphäre des Ich), i.e., in a one-sided relationship attributed to omnipotent agents. Although the patient may struggle with all the effort that can be mustered against these powers, the patient never triumphs.

In the first component, Gruhle describes the "alienation of the perceptual world" as an experienced change of the outer world, which is also experienced as a change of self. Changes of sensory experience early in the course of schizophrenia are "incomparable," "unlike anything experienced before" (Mayer-Gross & Stein, 1926, p. 361; Mayer-Gross, 1928, 1932). There is an initial hypersensitivity to stimuli in any or all sensory domains (Gruhle, 1922a, 1929, 1932).

With regard to the second component, the I-paralysis, Gruhle contends that thought insertion and other self-disturbances are "non understandable" according to Jaspers' (1910, 1913) definition of the term. For Jaspers, *understandable* developments of personality can be traced back to the patient's life history, personality and motivation. In contrast, nonunderstandable changes are not related to the patient's personality. Their lack of continuity with previous personality development is *explained* by an underlying as yet unknown neurobiological process of schizophrenia. These nonunderstandable changes "interrupt" the patient's development and connection to past life-history (Mishara & Fusar-Poli, 2013). Gruhle notes that inserted thoughts, thought withdrawal, and "made" feelings, actions, volitions (i.e., self-disturbances of the I-paralysis type) often concern harmless, mundane circumstances that are nevertheless controlled by foreign agency. A woman with schizophrenia is about to place soup on the stove. She has performed this same action innumerable times before. This time, however, she is absolutely certain that a foreign agent inserted the thought into her mind. Despite the absence of any obvious difference in content from other thoughts, the patient knows precisely which thoughts are inserted. When asked how she knows this, she responds: "I can't explain. I just know." Gruhle emphasizes that self-disturbances ("explained" by an as yet unknown neurobiological process) are experienced as foreign, new, and non-derivable from anything in the patient's history, motivation or prior personality. *Self-disturbances not only pertain to thinking, but nearly to all mental functions.* We (Sterzer et al., 2016) have argued that the aberrant salience in thought insertion may be characteristic of self-disturbances generally.

Gruhle indicates that the unknown organic schizophrenia process is reflected in an eruptive "basic mood" (Grundstimmung), which he describes as a primary symptom of schizophrenia. As with other primary symptoms, it cannot be derived from anything in the patient's prior development, life-history or motivation. Rather, the illness itself determines the basic mood of the patient, which occurs early in the course of schizophrenia with nonunderstandable changes of personality. Gruhle observes that attempts to treat the patient with psychoanalysis or other psychotherapies have no effect on the underlying basic mood. This suggests that an insidious organic process underlies the mood.

Gruhle's two components of self-disturbance involve different relationships to automatic processing. In the first component, the self experiences its own automatic processing as alien to self in the split-off self of doubled-I. In the second, the I-paralysis, the source of disruption to automatic processing in one's daily activities is now outside the self in omnipotent agents or forces.[1] These experiences are disturbing to patients and cause much suffering especially early in the illness. The foreign agents violate the patient's boundaries by means of intrusion into the person's most intimate sphere of personal existence (Straus, 1949). The omnipotent powers can "rape" the patient sexually from a distance (Kendler & Mishara, 2019; Schneider, 1939).

Gruhle's components naturally lead to the question: How is the self altered or changed in self-disturbances? For example, Gruhle observes that with self-disturbances of the second type, e.g., inserted or withdrawn thoughts, the personality is altered until complete paralysis of self. Jaspers (1910) had previously noted that the patient's prior personality can disappear with psychosis. This leads to a "new personality, developing in its own way analogously to the original one." In other words, the neurobiological process interrupts the development of personality with something completely new and foreign (Jaspers, 1910; Mishara & Fusar-Poli, 2013). Unable to find continuity with his/her previous life history, the patient experiences a radical change in personality. "The onset of psychosis happens, by definition, only once" (Grivois, 1999, p. 104).

Despite these observations, Kurt Schneider notes: "In psychotic transformations of self into something else, another person, a dog, a burning Christmas tree, the previous self is not obliterated; it persists in spite of the transformation and beyond it" (English translation slightly modified; German text, 12th edition, Schneider, 1980, English translation, Schneider, 1959, p. 57). Even in the most extreme circumstances of passivity in which one's own perceptions, feelings, actions, cognitions and volitions are experienced as "made" by powerful others, etc., something nevertheless preserves self through this suffering.

[1] Chadwick and Birchwood (1994) use the term omnipotence to characterize patient's experience of voices, but the term also applies, in our view, to I-paralysis.

To summarize:

I. Gruhle's two components of self-disturbance involve different relationships to automatic processing: 1. The self experiences its own automatic processing as alien to self in a split-off, doubled-I. 2. In I-paralysis, the disruption to automatic processing is outside the self under the control of omnipotent agents.
II. Kurt Schneider indicates that the self may be transformed bizarrely in schizophrenia. At the same time, and perhaps as a consequence, self is somehow preserved in its minimal functioning.

We propose that a disrupted perception-action cycle is at the heart of self-disturbances in schizophrenia as first depicted by the Early Heidelberg School. To demonstrate how features of self-disturbances and role of self can be studied in visual and multimodal hallucinations, we present the case of Alex below.

Gruhle's Heidelberg colleague Mayer-Gross applies the clinical phenomenological approach to indicate that low-level perceptual anomalies play a pivotal role in self-disturbances. He (1932) writes: "…by sticking faithfully to patients' reports of subjective experience, we consistently find descriptions which clearly go back to the sensory sources… the perceptual anomalies in beginning schizophrenia" (p. 353). We present the argument that the phenomenological approach to the subjective experience of self-disturbances complements efforts to model psychosis using the computational framework of hierarchical predictive coding (Sterzer et al., 2016).

To support our argument, we review the work of Husserl, founder of phenomenological method, V. von Weizsäcker, who developed the perception-action cycle concept, Hohwy and colleagues' account of "distrusting the present," and experimental evidence concerning prediction and non-conscious visual attention.

1.1. Case history of Alex: "seeing rain"

A 19-year-old patient, whom we call Alex,[2] first consulted a psychiatrist about two years ago. When Alex turned 18, his school grades declined and he appeared to lose his drive. Becoming withdrawn, he stopped meeting with friends. He did not complete his exams at school, which increased conflict with his mother. He countered that he had pushed away his old life; that the past life was over. He described himself as "inwardly inhibited." He reported difficulties falling asleep and other sleep disturbances. The psychiatrist at the time prescribed Mirtazapine (30–45 mg per day), which helped him sleep. Because of a tentative diagnosis of ADHD and the fact that he had been treated for learning difficulties as a child, Alex, three months later, was prescribed Methylphenidate which he reported helped him. Due to intoxication with alcohol and an unclear number and dosage of different types of medication (including Paracetamol, Mirtazapine and Methylphenidate) in what he described as a suicide attempt, Alex was admitted to a psychiatric hospital. He exhibited acute psychotic symptoms for approximately one week, including visual and auditory hallucinations. He remembers that he was talking to the grass and he started to "see rain."

After this psychotic episode, Alex was admitted to a day clinic. The visual anomalies persisted: He continued to see his surroundings in terms of a "thinly appearing rain." Moreover, he saw faces and pairs of eyes. These experiences frightened him. The faces were ghostly, blurry, and unrecognizable. He reported "ghosts in the wind," and, when alone, the feeling that somebody else was in the room. At that time, he was diagnosed with an adjustment disorder with depressive reaction and histrionic personality traits. However, due to persistent visual anomalies and paranoid thoughts, the treating psychiatrists considered a prodromal state of a schizophrenia spectrum disorder.

Alex was medicated with atypical antipsychotics and found that 150 mg of Quetiapine made him feel "down." His treatment was continued in a different day clinic, where the paranoid symptoms diminished and antipsychotic medication was discontinued. An antidepressive treatment with Venlafaxine was initiated. Nearly a year after the suicide attempt, the patient was discharged from the day clinic. However, the visual anomalies increased. He reported perceiving "too much" in that some sensory experiences were overly intense (i.e., smells and other stimuli were stronger than before). Alex was referred to our Early Diagnosis and Intervention Center for Beginning Psychosis, and finally, to our inpatient ward for diagnostic work-up and further treatment.

Upon admission to our inpatient ward, Alex presented with the above-mentioned visual anomalies and feelings of being observed. Concentration and memory appeared intact. Nevertheless, he reported that his thoughts were confused, and interfering with one another. Moreover, he reported thought broadcasting (his thoughts could be read or heard by others) and thought insertion (someone placed alien thoughts into his mind). He exhibited delusions of persecution (maleficent detectives placed surveillance cameras in the room) and ideas of reference (a TV program was there solely for him). Importantly, he stated that he felt himself to be a puppet presented to others. He continued to experience the "rain and faces". While the faces appeared intermittently, depending on whether he was in a "bad mood," the rain was "constantly" there.

Alex was diagnosed with schizophrenia and the diagnosis was discussed with him. The antipsychotic treatment was switched to amisulpride, which was rescinded due to extrapyramidal side effects. Alex's status worsened and a higher dose (600 mg) of quetiapine was initiated. The paranoid ideation and visual anomalies diminished and Alex felt comfortable returning to school after release from the inpatient unit.

He worked in a small supermarket and continued with regular appointments with a psychiatrist in private practice. During his stay in our inpatient unit, a structural magnetic resonance tomography revealed no significant abnormalities in visual cortex or other

[2] We have altered the patient's name and other details of his life to ensure that the patient retains confidentiality.

brain regions, and a consultation with an ophthalmologist showed no significant pathological changes that could account for the persisting visual anomalies. The patient reported that he does not abuse nicotine, or other substances.

1.2. Detailed description of the visual and multimodal anomalies

In an interview conducted six months after discharge from the inpatient ward, the patient explained that when his symptoms first arose, he experienced the intermittent occurrence of a phenomenon he calls "seeing rain." When present, the patient sees "thin greyish rain" everywhere. It appears to him as a transparent veil, and he describes it as tickling. It pushes on his eyes and he feels it in the back of his head, i.e., for him, in his brain. At first, he was quite frightened by these changes. Despite antipsychotic treatment, and despite reduction in occurrence, Alex continues to see the "rain" up to the present.

The rain appears more intense when indoors, which he explains by the presence of additional light. In bright light (including artificial light), he experiences the rain more intensely which seems to occur more frequently in mornings and evenings. When asked to describe the experience in more detail, Alex explains that he does not see raindrops or anything falling down. It appears to him as a transparent veil that consistently "wobbles" up and down. Although it does not seem to be three-dimensional, he describes it as a *wall* between himself and his immediate surroundings. *He cannot step into the rain and it does not change when he moves.* That is, he is unable to obtain any perspective on the rain other than the present, frontal one. However, he not only sees the rain. He also feels it as heat or coldness in his hands and legs. When he closes his eyes, he sees devil-like, evil-looking faces, and sometimes, only their eyes. He does not recognize the faces. Sometimes there are skulls.

After learning of his diagnosis, he believes that something is wrong with his metabolism. He reasons that the Methylphenidate overdose "destroyed his synapses."

2. Phenomenology of visual and multimodal hallucinations in schizophrenia: a neglected topic

Alex first reports "seeing rain" following an overdose of Methylphenidate in a suicide attempt. It appears to him as a wobbling "transparent veil" a "wall" that separates him from his surroundings. It is accompanied by somatic experiences of tickling, pressure on his eyes, "movement in his brain," and changes of temperature in his hands and legs.

Visual and multimodal hallucinations sometimes occur following acute toxicity due to Methylphenidate overdose. However, Alex's perceptual anomalies lasted longer than typical cases of exogenous psychosis due to stimulant overdose. With regard to Methylphenidate and other stimulants, Morton and Stockton (2000) comment, "psychotic symptoms usually arise with chronic abuse, but may also appear acutely with large doses of stimulants. These psychiatric and physical side effects resolve over a period of hours to weeks" (p. 162). These patients experience auditory and visual hallucinations with nearly equal frequency (e.g., Ellinwood, 1967). However, in Alex's case, the duration of the visual hallucinations, the accompanying somatic and other psychotic experiences, possibly first occasioned by acute overdose, persisted far longer than what could be explained by exogenous psychosis, thus contributing to the diagnosis of schizophrenia.

While visual and multimodal hallucinations are frequently reported in schizophrenia, often in early stages of the disorder, there is a surprising dearth of studies carefully examining the detailed phenomenology of these experiences and the related neurobiological mechanisms. In their review, Aleman and Larøi (2008) found prevalence rates of visual hallucinations in schizophrenia to vary between studies, but to be relatively high (e.g., 40% of schizophrenia patients (Mueser, Bellack, & Brady, 1990); and 54% (Bracha, Wolkowitz, Lohr, Karson, & Bigelow, 1989). In an experience sampling study, Delespaul and van Os (2002) found that patients with schizophrenia surprisingly experienced more visual hallucinations (62.5%) than auditory hallucinations (49.1%). Aleman and Larøi conclude that visual hallucinations are more frequent than previously thought. In one study (Bracha et al., 1989), the visual hallucinations had remained undetected in 43% of the patients prior to the study, suggesting that conventional means of assessing patients with schizophrenia often overlook visual hallucinations. Gauntlett-Gilbert and Kuipers (2003) found in a group of predominantly schizophrenia and schizoaffective patients (60%) that "visual hallucinations were associated with conditions of low sensory and social stimulation. In particular, 75% of visual hallucinations occurred when participants were alone, 65% when in a quiet place, and 55% in dim lighting conditions" (p. 365).[3] Based on reports of similar studies, Silverstein (2016) concludes that visual disturbances could be seen as "symptoms, endophenotypes, biomarkers, and predictors for schizophrenia." Silverstein and Rosen (2015) cite evidence for retinal pathology in schizophrenia, a topic that Mayer-Gross (Mayer-Gross, 1928, 1932) also considered.

3. Multimodal sensory anomalies, hallucinations and self-disturbances (Ichstörungen)

As indicated in the introduction, Gruhle (1915) first developed and systemized the self-disturbances concept (see Mishara et al.,

[3] Ralph Hoffman (personal communication to AM, August 27, 2015) reported that in his sample of patients with schizophrenia who receive repetitive transcranial magnetic stimulation (rTMS) treatment for chronic intractable auditory hallucinations, approximately 20–30% experienced hallucinations in other sensory modalities. Prolonged visual deprivation (through blindfolding) leads to visual hallucinations (Pascual-Leone & Hamilton, 2001; see Mishara, 2010a). Both simple (bright spots of light) and complex (faces, landscapes, ornate objects) hallucinations can occur and have been shown to be associated with activity-increases in the cortex (Merabet et al., 2004). Hoffman's (2007) proposes that social deafferentation (i.e., reduction of social input) in schizophrenia bears similarities to the effects of sensory deprivation.

2015; Sterzer et al., 2016).

In the 1920's, Heidelberg psychiatrists Mayer-Gross (1928, 1932) and Beringer (1927) conducted a phenomenological study of the effects of mescaline in healthy participants to model self-disturbances and psychosis. One goal of the study was to help participants, comprised of psychiatrists and medical students, empathize with their patients. For Mayer-Gross, the mescaline experiments "opened the way to explaining these non-empathizable forms of subjective experience, which, up till now, have occasioned very unsatisfactory efforts to interpret or *theoretically* understand these experiences" (Mayer-Gross & Stein, 1926, p. 386).

Mayer-Gross developed his approach to self-disturbances not only from detailed clinical observations, but also from the Heidelberg mescaline study. From his writings, it seems that he was profoundly moved by his own and his colleagues' experiences of the mescaline model psychosis. Perhaps for this reason, he took a particular interest in visual and multimodal hallucinations in schizophrenia, which were also prevalent during mescaline intoxication. As we document elsewhere (Mishara & Zaytseva, 2019; Sterzer et al., 2016), Mayer-Gross is herald of the 'perceptual anomalies' approach to schizophrenia, the view that low-level perceptual anomalies play a critical role in self-disturbances. The phenomenological psychiatrists Binswanger, Blankenburg, Conrad, Janzarik, Matussek, Straus, and others developed this view (for reviews, Uhlhaas & Mishara, 2007; Mishara, 2010b, 2012).

In self-disturbances of schizophrenia and model psychosis (mescaline), Mayer-Gross found the same fundamental transformations (grundsätzliche Abwandlungen) of sensory perception in its various modalities (visual, auditory, olfactory, gustatory, tactile, coenesthetic) and in the uncoupling of perception and action:

1. Lability of threshold (Schwellenlabilität, Mayer-Gross & Stein, 1926; von Weizsäcker, 1950a, 1950b): There is hypersensitivity to stimuli in any or all of the sensory domains (Gruhle, 1929), i.e., a magnification of *saliency* until it completely occupies consciousness (see Mishara et al., 2015; Sterzer et al., 2016). This may alternate with its opposite, a "reduced ability to detect nuance, dullness, emptiness, coldness, monotonous environment, which could also indicate a change in threshold." (Mayer-Gross & Stein, 1926, p. 370). There may be transitions from seeing everything as *new* and *equally important* to a "pallid grey and the apocalyptic mood that the world is coming to an end" (Mayer-Gross & Stein, 1926, p. 361). In apocalyptic mood, nearly everything without exception signifies something and nearly always something terrible (Gruhle, 1929). A patient reports (to AM) a green "film" covers the world (or, as we document here, the hallucination of "rain"). The world may take on the artificiality of a stage set (Conrad, 1958; Mishara & Fusar-Poli, 2013).
2. Patients experience fusion with their experience (difficulty to distance) and, at the same time, the experience is found to be independent from the self's activity or volition. The changes of sensory experience are "incomparable, "unlike anything experienced before" (Mayer-Gross & Stein, 1926; Mayer-Gross, 1928). Both patients and the mescaline experimental subjects have difficulty describing their experiences, and may invent their own vocabulary.
3. The Gestalt-structure of experience may vary from minimal or absent (e.g., Ganzfeld effect) to detailed, complexly elaborated objects, images, and scenes. For example, non-verbal auditory hallucinations, called akoasms, e.g., buzzing, whistling, roaring, are not necessarily deprived of meaning or structure, but their structure is quite different than auditory hallucinations;
4. Uncoupling of perception and action: Movements in self and others may be perceived as abnormally fast or slow. Resting objects may be seen as moving, or movements may be seen where there are none. Conversely, moving objects may appear as still.
5. Hallucinating may occur in more than one modality, what Mayer-Gross calls a "hallucinating together of the senses" (Zusammenhalluzinieren der Sinne). Synesthesia-like experiences may be present (see "reflex hallucinations" below).

We note that each of Mayer-Gross' above observations apply in some way to Alex's experience of "seeing rain." For example, with regard to #1, lability of sensory threshold, Alex reports both an increase of sensitivity to stimulation, and the experience of its diminishment. Some sensory experiences are more intense than usual. However, he also experiences a "wall" or "wobbling veil" between himself and his surrounding world. The "seeing rain" creates a separation between himself and his environment, which we will examine in our analysis. He experiences a diminution of the environment, which is accompanied by an increase of abnormal somatosensory experiences. In what follows, we focus specifically on the problem of the perception-action cycle (#4, above). The cycle involves a tightly coupled relationship between one's own exploratory, or other self-movements, and the continuously changing perceptions of the environment. This insight is fundamental to our phenomenological analysis of self-disturbances and its relationship with predictive coding.

4. Hallucinations as disrupted perception-action cycle

Alex is unable to step out into the rain. When he attempts to shift perspective, the rain does not reveal any other aspect of itself than what Alex already sees. That is, the patient cannot enter the rain, which as a "wall" or wobbling "veil" separates himself from the environment. The "rain" rather moves with the patient revealing only the side that the patient currently sees. *The fact that the rain moves with him indicates that he is unable to take distance from it, or view it from any perspective other than the current one.* The phenomenological psychiatrist, Straus (1978), (see Mishara, 1995) observes that we experience distance not in terms of an already objectively given space but also in terms of our own momentary ability for movement.[4]

[4] According to ancient Greek myth, Tantalus is unable to reach the fruit on the branch or drink from the water pool in front of him. Both recede with each of his efforts to reach them. In this sense, the most proximal objects may be experienced as immeasurably distant because no action will bring them closer. Distance is not only registered in perception, but also reflects one's capacity for movement.

If persons with schizophrenia are unable to "step out" of their current perspective and explore the hallucinatory object (or, for that matter, entire hallucinatory scenes, Mayer-Gross, 1928, 1932) by examining different aspects or sides of the object, how does this affect the ability to navigate the perceptual world, which serves at least implicitly as background to the hallucination? Mayer-Gross' co-researcher and co-author of the studies on mescaline and perceptual anomalies, J. Stein (Mayer-Gross & Stein, 1926), was working at the time in the Heidelberg neurology clinic under its director Viktor von Weizsäcker. The latter is considered the originator of the perception-action cycle concept (Fuster, 2006; Mishara, 2010a, 2010b, 2012; von Weizsäcker, 1933, 1950a, 1950b). The embodied perception-action cycle is fundamental to both phenomenological and Bayesian predictive coding accounts (Friston, 2010).

Previously von Weizsäcker's assistant, the phenomenological psychiatrist, Wyss (Wyss, 1973), describes a loss of perspective (Aperspektivität) during dreaming and other altered states of consciousness. With the loss of perspective there is a loss of distinguishing modalities of experience (i.e., different sensory modalities, but also the different cognitive modalities, such as remembering, imagining, thinking, etc.) We propose that (1) loss of perspective may be a defining feature of hallucinations in schizophrenia; (2) the loss involves disruption of the perception-action cycle; and (3) the patient with schizophrenia fuses the information between sensory and other modalities in a loss of perspective. That is, the person with schizophrenia is unable to benefit by integrating multimodal information efficiently.

To summarize so far: In its spontaneous emergence, the (visual/multimodal) hallucinatory object takes on an independence from self. *There appears to be little or no relationship between the subject's exploratory movements and how the hallucinatory object moves, or reveals itself.* The hallucination involves a disruption of the tight coupling between perception and action. One view is that this may involve a discrepancy in the timing of this coupling, and/or the timing of low-level perceptual processing in very brief, millisecond durations (Giersch & Mishara, 2017a, 2017b; for review, see Pienkos et al., 2019). Such a disturbance could also play a role in self-disturbance patients feeling estranged from their own automatic processing of perception, action, thinking, volition, etc.[5]

5. Phenomenological and experimental evidence of unconscious inference in the perception-action cycle

In early 20th century, the philosopher Edmund Husserl developed phenomenological method. The early Heidelberg School employed this method, with modifications, in their analysis of psychiatric disorders (Mishara & Fusar-Poli, 2013). Husserl examined the interrelationship between perception and action as critical to "unconscious inference," a term he borrows from von Helmholtz (1867). Both von Weizsäcker and Husserl observed that it is only through a tight coupling between perception and action that we are able to explore, identify and make use of objects in the environment.

In Husserl's view, the visual field is organized from moment to moment by the subject's possible ocular-motor movements, whereby each *actualized* movement, in an ongoing "chaining" of movements, predicts corresponding effects in the perceptual field. The perceptual field is comprised of cross-modal interactions from the various sense-fields. The whole visual field is structured, i.e., defined, at any given moment by the *possible* ocular-motor movements available to the subject at the moment (what Husserl calls kinestheses). Only the present movement is momentary winner in revealing the object in terms of its current aspect, which can then be manipulated in goal-directed action. However, the win is temporary. As soon as the kinesthesis is performed, it is displaced by the next anticipatory kinesthesis, which in turn brings about its own changes in perceptual experience, and so on (see next section on distrusting the present). As Husserl (1970) states, "the consciousness of world is in constant motion" (p. 108).

In examining Husserl's phenomenological analysis, we point to an experimental study that indirectly supports Husserl's views: Land, Mennie, and Rusted (1999) studied a well-learned task (making tea) in a natural setting to classify the types of monitoring action that the eyes perform. Previous research indicated that in everyday routine actions, we frequently have "little or no conscious knowledge of where our eyes are fixating at any instant." Using a head-mounted eye-movement video camera, which provided a continuous view of the scene ahead, as well as indicating foveal direction, they found that foveal direction was always close to the object being manipulated, with very few fixations being irrelevant to the task of making tea. The extent to which the eyes guide and monitor almost every component of the overall activity was surprising. Objects that were *about to be manipulated* were nearly always foveated, with *the centre of gaze* being moved by a saccade to within a degree or two of the appropriate part of the object or point in the scene. The authors conclude, "almost every act in the tea-making sequence is guided and checked by vision, with eye movements usually preceding motor actions… Although the actions of tea-making are 'automated' and proceed with little conscious involvement, the eyes closely monitor every step of the process. This type of unconscious attention must be a common phenomenon in everyday life."

Husserl's phenomenological analysis of eye-movement parallels the findings of Land et al. (1999). As we manipulate a thing for some use, the object 'reveals' itself at each moment from a certain aspect or side (in German, "Abschattung," i.e., adumbration, to foreshadow what is to happen next). That is, we predict this object to behave in terms of the aspects we have perceived/collected (from moment to moment) up to that point. In seeing an object, palpating a thing or making use of it, the object constantly changes in terms of the different aspects (Abschattungen) with each anticipatory shift of orientation. Nevertheless, we experience, with each shift, the object as an ongoing unity, with its own persisting identity. That is, the previous profile-aspects and the current one are expected (predicted) to belong to the same object. However, it is also possible that the object turns out not to be what we anticipated. We think the figure in the shop window is a mannequin until the person moves. Here, our original "expectation" (in Husserl's terms) is "cancelled" (the prior belief that it was a mannequin) and updated with the new sensory information.

[5] Note that we do not here enter into a discussion whether such experiences involve "depersonalization," a topic which was contentious during Gruhle's time. We save this discussion for another publication.

The “kinestheses” structure the perceptual field and enable the monitoring of each changing aspect of the object under consideration, a term which indicates that the movement itself has both kinetic (kinesis) and sensory (aesthesis) components (Claesges, 1964; Husserl, 1970, 1973). More recently, it has been proposed that two visual streams, kinesthetic and perceptual, are organized in terms of two reference-frames or coordinate systems, what Milner and Goodale (1995) called vision-for-action and vision-for-perception pathways (see also Paillard, 1991, 2005; Trevarthen, 1968; Ungerlieder & Mishkin, 1992; for application to schizophrenia, see Mishara, 2005, 2007). These pathways recruit body-centered (egocentric), and object-centered (allocentric) reference frames, respectively. Notably, the kinestheses structure the field of perception and yet their body-centered, or egocentric coordinates need not be experienced consciously (as in Land and colleagues' (1999) making tea example).[6]

Expectation (prediction) is pivotal to Husserl’s analysis of perception. Husserl (1973b) writes, “When we see a dog, we immediately anticipate its additional modes of behavior: its typical way of eating, playing, running, jumping, and so on. We do not actually see its teeth; but although we have never yet seen this dog, we know in advance how its teeth will look—not in their individual determination but according to type, inasmuch as we have already had previous and frequent experience of ‘similar’ animals, of dogs” (p. 331). Uhlhaas and Mishara (2007, pp. 152-3) comment: “There are anticipatory constraints that are open to revision or cancellation in their structure so that each aspect prefigures its successor in seamless transition as belonging to the same perceptual object. Because the type is anticipatory, it provides the rules by which each partial view is in turn synthesized into an object. The totality of the object is never experienced at once (Gurwitsch, 1964). The perception of a thing is a process, which goes beyond the information given (Bruner, 1973).”

The experience of a perceptual object is dependent on the kinestheses that first make the perception possible (Claesges, 1964; Husserl, 1973a). Each movement leads to a corresponding change in the “object’s” appearance. Conversely, a change in the object or some other part of the experiential field (what Husserl call a “contrast saliency” competing for attention), may pull for the person’s awareness, before the person has consciously identified the change or from where it is coming from. The kinesthetic orienting of awareness to its experiential field is motivated by competing affective strengths of contrast saliencies in the experiential field. In both cases, there is a prediction about what is about to happen before it occurs, which is often so rapid that it eludes focal awareness.

The kinestheses that structure vision, and the other sense-fields, involve a path from the present orienting kinesthesis to where in the field one must advert for optimal viewing (i.e., foveation) of the new, or moving object. This relationship of dependency is stated as: “If I move a particular way (X), then this particular aspect (Y) of the object will appear.” Although this relationship is not thought explicitly by the subject, it should be remembered that Husserl, following von Helmholtz (1867), finds that “unconscious inference” occurs at lower levels of perceptual synthesis (what Husserl (1966) calls “passive synthesis,” Mishara, 1990, 2012; Uhlhaas & Mishara, 2007). Moreover, von Helmholtz's (1878 (1971)) observation (cited by Friston, 2014, p. 119) resonates with Husserl: “Each movement we make by which we alter the appearance of objects should be thought of as an experiment designed to test whether we have understood correctly the invariant relations of the phenomena before us, that is, their existence in definite spatial relations.”

Phenomenology demonstrates consilience with recent models of active inference in the framework of predictive coding, which proposes that the brain uses a hierarchically organized predictive model of the world to infer the causes of data registered by the senses (Friston, 2005, 2008; Mumford, 1992; Lee & Mumford, 2003; Rao & Ballard, 1999; for enactive approach, see Gallagher & Allen, 2016; for schizophrenia, see Jardri, Duverne, Litvinova, & Denève, 2017). Computational approaches have conceptualized hierarchical predictive coding as Bayesian inference (Friston, 2005, see also Jardri et al., 2017). The underlying principle of Bayesian inference is that a prediction, which is commonly referred to as a prior belief, is combined with the observed sensory data to compute a posterior probability that updates the prior belief. The prior belief is considered merely a probability distribution over some unknown state and may or may not be consciously accessible (Adams, Stephan, Brown, Frith, & Friston, 2013; Sterzer et al., 2016). Moreover, there is an active, selective sampling of what we expect to experience based on our past knowledge about the current object, or objects that behave like the current object (Friston, 2010, see also Husserl, 1973b).

With regard to the predictive-coding account, Friston, Adams, Perrinet, and Breakspear (2012) write: “If perception corresponds to hypothesis testing (Gregory, 1980), then visual searches might be construed as experiments that generate sensory data…[whereby]

[6] How does the subject reorient to a *novel target without prior knowledge of its location in the peripheral visual field?* It is puzzling how computations in egocentric coordinates with regard to possible movements to not as yet known targets could be performed rapidly enough to reflexively reorient awareness prior to any conscious knowledge of where to look (Mishara, 2005, p. 141). Mishara (2007) notes, however, that “the body schema [responsible for ocular-motor, head, trunk orienting movements] provides a ‘path structure’ (Paillard (1999, 2005)), superimposed on a collection of separate points, a vectorial map which defines in egocentric terms how awareness is able to shift from a current ‘here’ to an anticipated but still not consciously known ‘there’… Nowak and Bullier (1997) coined the term ‘fastbrain’ for the fronto-parietal connectivity of the dorsal pathways which, according to the Milner and Goodale model (1995), mediate implicit visuomotor control (as well as sensori-motor transformations from other sensory modalities necessary for this control)…such a system of self as prospective openness, i.e., the ability to be affected by any point in its experiential field (structured by momentary, possible movement) *prior* to focal awareness had been anticipated by Husserl. The movement from an implicit egocentric to an explicit allocentric frame of awareness… involves reversing frames of reference… [whereby] the ‘efferent binding’ of ‘I move myself’ (for Husserl, the core of self-transcendence [i.e., the self-displacement of the current perspective] in time) involves both conscious and non-conscious components of a perception-action cycle.” (Mishara, 2007, p. 718). The perception-for-action system (Milner & Goodale, 1995) “relies on veridical information of the world that is not available to the [conscious] perceptual/knowledge system” (Wang, 2004). That is, the egocentric coordinates subservered by the “fast brain” are too rapidly performed and too short-lived to become available to consciously experienced scene based vision. Nevertheless, the strict subdivision in two visual systems subserving perception and action, respectively, as proposed by Milner and Goodale (1995) continue to be a matter of ongoing debate (Hesselmann, Darcy, Rothkirch, & Sterzer, 2018; Kopiske, Bruno, Hesse, Schenk, & Franz, 2016; Ludwig, Sterzer, Kathmann & Hesselmann, 2013; Schenk & Macintosh, 2010).

saccadic eye movements are optimal experiments, in which data are gathered to test hypotheses or beliefs about how those data are caused" (p. 1).

This relationship is also evident in the tactile domain. The phenomenological sense-physiologist, Buytendijk (1974) summarizes Viktor von Weizsäcker's concept of the perception-action cycle (Gestaltkreis): "The hand is feeler and gripper simultaneously. It fits itself to the touched object and moves the latter simultaneously…. This 'conversation' between hand and thing is a 'Gestalt circle' which starts from the coherency of an interruptible but continually self-constituting unity…" (p. 184)

The mutual dependency between perception and action in tactile identification of objects is well-known in patients with apperceptive tactile agnosia (astereognosis), who demonstrate "deficient palpation of objects, either by reluctance to manipulate the object or by a stereotypic pattern of manipulation that is independent of object qualities… a defect in the mechanism through which tactile impressions are collected to form an object" (Heilman & Valenstein, 2011, p. 275).

Viktor von Weizsäcker (1933, 1950a, 1950b) observes that action and perception require one another in complementary relationship when forming each momentary perceptual Gestalt in a self-organizing field. Weizsäcker's account anticipates the later Bayesian concept of active inference. Active inference is a Bayes optimal, normative formulation of action and perception, to minimize free energy (which, "under simplifying assumptions is just the amount of prediction error," Friston, 2009, p. 3) by weighting prediction errors in terms of their precision (reliability or inverse variability) (Adams, Brown, & Friston, 2015; Friston, 2010). Here, action selectively samples the environment by guiding sensory input according to expectations about hidden causes of the sensory data, whereas the resulting perceptions are able to update or change the predictions guiding the actions: "We are open systems in exchange with the environment; the environment acts on us to produce sensory impressions, and we act on the environment to change its states. This exchange rests upon sensory and effector organs (like photoreceptors and oculomotor muscles). If we change the environment or our relationship to it, then sensory input changes. Therefore, action can reduce free-energy by changing the sensory input predicted, while perception reduces free-energy by changing predictions" (Friston, 2010, p. 295).

In Husserl's account, movement (kinesthesis) structures the sense-fields. The perceptual field is not pre-given as coexistent sensory data in which the kinestheses subsequently orient to different aspects of a pre-existent field (see Mishara, 1990, 2012). Rather, the individual sense-fields are structured moment by moment by the *possible* movements of orientation relative to where one is currently attending consciously or unconsciously (Claesges, 1964; Husserl, 1973a). Each shift of attention is accompanied by the hypothesis: If I move so, then such and such an aspect will appear, and with it, the whole field adjusts to the projected path of the kinesthesis and the *optimal* perception of the object. The perceived surrounding space and its horizon is nothing other than the "correlate" of the kinesthetic total-system at the moment (Claesges, 1964; Husserl, 1973a).

The predictive relationship between current focus (what Husserl calls the null point of bodily orientation) and how the organization of the perceptual field changes with each anticipated kinesthesis is reflected in a study by Duhamel, Colby, and Goldberg (1992). Von Helmholtz (1867) proposed that the brain uses information about intended movement to interpret retinal displacements. In their classic study with monkeys, Duhamel et al. (1992) examined the visual responsiveness of neurons with retinotopic receptive fields in the lateral intraparietal area (LIP) in alert monkeys prior to performing an intended saccade. They found that neurons anticipate the retinal consequences of the intended eye movement: The cortical representation shifts first, and then the eye catches up. After the eye movement, the representation in parietal cortex matches the reafferent visual input and the neuron continues to respond to the stimulus. This process constitutes a remapping of the stimulus from the coordinates of the initial fixation to those of the intended future fixation. The parietal cortex appears to update the position of the stimulus in the new organization of the field before the saccade actually occurs. In Husserl's sense: if I move so, then the world appears so. This suggests that the structure of the field at each moment is determined by the possible movements of attention within that field (where attention need not be conscious as, for example, in the eye-movements while making tea; for unconscious processing of minimal self, see Giersch & Mishara, 2017a).

6. Hallucination in psychosis as failure to "distrust the present"

If we consider Alex, it seems that he is unable to generate hypotheses with regard to the hallucination because there is no relationship between the hallucinatory object (the "rain") and his movements. That is, Alex is unable to generate a new hypothesis about the hidden causes of the stimulus. There is no way to perform the experiment: "If we change the environment or our relationship to it, then sensory input changes" (Friston, 2010, cited above).

The hallucination moves ("wobbles") but independently of the patient's movements. This is similar to a failure of what Hohwy and colleagues (Hohwy, Paton, & Palmer, 2015) describe as "distrusting the present." Resembling Husserl's account, Hohwy and colleagues indicate that as soon as we have settled on one hypothesis it is immediately displaced by a new intervening hypothesis: "… just as the hierarchical system (with informative higher levels) has settled on a rich hypothesis as the best at minimizing prediction error, it then needs to begin looking for a new and better hypothesis… there should be a quite strong anticipation that the currently selected hypothesis will soon decrease its probability. With time, that particular hypothesis should be expected to be less and less efficient in explaining away prediction error. This can be condensed into the idea that as soon as the system settles on a winning hypothesis it should begin to distrust it. Since the winning hypothesis determines what is presently experienced, the system should be in the process of *distrusting the present*" (p. 321). And further: "In perceptual inference, the signature of the distrusted present should be discernable in situations where the sensory input is unchanging but the perceptual inference nevertheless changes. This would indicate that, even though the system reasonably settles on a current winning hypothesis, *h0*, it begins to distrust *h0* in favour of a new hypothesis, *h1*. Crucially, the system should do this even if there is no actual change in the modeled hidden causes: this would indicate that the shift between hypotheses is entirely endogenous, and tied to an expectation of upcoming causal interactions" (p. 324).

Hohwy and colleagues use the example of binocular rivalry. However, it also applies to Alex's inability to distance himself from his hallucination of rain by the failure to generate new hypotheses, i.e., a failure to distrust the present, a distrust which would enable him to change his perspective relative to the hallucination.

Hohwy's "distrusting the present" overlaps with the phenomenological view that by the time the now moment is conscious, it is already becoming past (Mishara, 2010a). In reflection, we do not experience the present moment directly but only its retention because the moment it appears it is already displaced by the next temporal structure of the present, which includes its retention. In Husserl's view, when we are caught up in perceiving or experiencing things, there is a loss of self (*Selbstverlorenheit*), a naïveté about our role in constructing the experience: "Admittedly, the moment I begin to reflect, the naïve perceiving by the self-forgetting I is already past. I am only able to grasp this by reaching back - in the reflecting - into what has 'remained in consciousness' as retention, an immediate memory which *attaches itself backwards* to the original experience" (Husserl, 1959, p. 88, our emphases). That is, we can only reflect on current experience in terms of the just past. The philosopher Klaus Held (1966) cites a manuscript by Husserl: "The stream is always ahead but the I (i.e., the self) is also ahead" (Das Strömen ist immerzu im Voraus; aber auch das Ich ist im Voraus), p. 102. Alex is unable to generate a new hypothesis because no available exploratory movement (kinesthesis in Husserl's sense) provides a new sampling of data that could change his relationship to the hallucination.

In his theory of the perception-action cycle, von Weizsäcker (1933, 1950a, 1950b) influenced a generation of phenomenological psychiatrists and thinkers, including Binswanger, Blankenburg, Conrad, Ey, Gadamer, Straus, Tellenbach, Wyss and others (see Mishara, 2012, for review). Binswanger (1957), for example, described psychosis as failure to transcend (in German sich übersteigen, "step beyond") one's current perspective (see also Conrad, 1958; Mishara, 1997, 2010b). In a related effort, the German social philosopher Plessner (1928) observes that humans are able to position their perspective *outside* themselves, what he calls eccentric positionality. This enables us to imagine how others might see ourselves by being able to take an external viewpoint to one's own body, a form of perspective taking (Mishara, 2009). Heinz (2014) applies Plessner's views to self-disturbances by indicating that in a psychotic state the ability to detect the border between centric and eccentric positions seems to disappear. In view of this very rich history of phenomenology as it is applied to psychosis and self-disturbances, we suggest that hallucinations in schizophrenia involve a disrupted perception-action cycle that underlies the loss of embodied perspective in hallucinations. We examine this problem in the following section.

7. Reflex hallucinations (somatic passivity) and the hallucinating together of the senses: the search for mechanisms

In mid 19th-century, the idea that hallucinations could be multimodal, i.e., involving different sensory modalities, was a viable topic of clinical research. The influential German psychiatrist Kahlbaum (1866) describes the following case:

> "A young female patient repeatedly destroys the spinning wheel, and sewing kits of her mother, and her mother's friends. Each time she yells in genuine anger, "Why do you spin me into that machine?" or "Why do you sew me into your work?" In similar manner, she smashes and disperses the flames in the hearth while saying, "What are you trying to do, burn out my heart?" (p. 35)

Basing his work on contemporary reflex theory, Kahlbaum called these "reflex hallucinations." Here, a stimulus in one sensory modality (in the above cases, visual) becomes connected with a hallucinated stimulus in another modality, i.e., a painful bodily sensation (*schmerzhafte Gemeingefühl*). The visually perceived object (the spinning wheel, sewing kit, fire in the hearth) becomes "*identified*" with one's own body such that *the manipulations of these objects are experienced as manipulations of one's own body*. "Reflex hallucinations are a group of appearances which have in common the succession that a real perception or hallucination is followed with reflex-like speed by a hallucinatory process" (Kahlbaum, 1866, p. 35).

Resembling synaesthesia, the stimulus or perceptual object in the "reflex hallucination" is perceived in one sensory modality but nevertheless provokes hallucination in a second modality. Finding the term "reflex hallucination" outmoded, Mayer-Gross (1928), not withstanding, presents the following case, which resembles Kahlbaum's earlier observations:

> "An older woman with schizophrenia regularly complained that the hospital staff inflicted torture on her body. The cleaning of the floors (above her room), moving furniture, washing silverware in the kitchen, stirring the soup, all take place in her body. If one presses her to go further, she always explains it the same way. She hears these things in her room - such sounds could in fact could be heard in her room - but, at the same time, she feels these activities taking place in her body. The personnel do this deliberately to torture her" (p. 462).

To demonstrate how perspective – as in the above case – may be lost in multimodal hallucinations of patients with schizophrenia, Mayer-Gross provides the counterexample of a delirious patient who sees gold coins on his bed. Once he reaches for the coins and finds that he cannot touch them, he corrects ("transcends," goes beyond) his initial perspective, whereby the gold pieces are no longer visible. Spurious information in the visual modality is corrected by pertinent information processed in the tactile modality. But this is precisely what does not occur in the so-called "reflex hallucinations" of psychosis. *The patients are unable to vary their own perspective by exploring the hallucination or hallucinatory object from other sides or aspects other than the one that currently presents itself*. The patient is unable to do what the delirious patient does, i.e., compare the information from different sensory modalities to produce a more accurate perception. The multimodal information constrains knowledge for the delirious patient, but, in the reflex hallucination, it does the opposite. It leads to a conflagration of hallucinations, expanding across sensory modalities, towards what Mayer-Gross calls a "hallucinating together of the senses" in schizophrenia.

Importantly, the woman who experiences torture inflicted in her body states that the cleaning and stirring "do not at all occur above or below her" (the actual sources of the sound relative to her room) but "entirely in her own body." Far from *integrating* the

input of different sense modalities, as the delirious patient does in updating his perception by comparing sense-modalities, the schizophrenia patient *fuses the different sense modalities*. Here, *auditory stimuli become usurped by bodily experience* in a coenesthetic hallucination of bodily self. Notably, Kahlbaum's patient also experienced the outside events as occurring in her body. In his first rank symptoms Kurt Schneider later identifies this with somatic passivity, influences playing on the body, and "made experiences" imposed by powerful others (Kendler & Mishara, 2019). Sensory modalities become fused such that the patient's body becomes the locus of the torture, no longer troubled by the initial sounds which were merely the instruments of powerful others. For Mayer-Gross and his early Heidelberg school colleagues, there is an atmospheric change of the total experience into something foreign, unfamiliar or uncanny (see also Jaspers, 1913; Binswanger, 1957; Conrad, 1958). For the patient who experiences the household utensils as objects of torture, these objects take on a character that is different than their usual uses. The phenomenological psychiatrist, Raballo (2016) states that hallucinatory voices [but could involve other hallucinations] in schizophrenia involve a global transformation of self and world, where the "felt-naturalness of the psychic field seems changed" (p. 137).

Mayer-Gross observes similar multimodal bodily hallucinatory experiences in the Heidelberg mescaline studies (with psychiatric faculty and medical students as participants) as a model-psychosis of self-disturbances. Mayer-Gross (1928, 1932) cites a participant in the study (reported by Beringer, 1927):

> "One believes one hears sounds and sees faces and yet, I cannot tell whether I am hearing or seeing… I hear scratching, harsh trumpet blasts, which are all a painful gnashing…" (Beringer, 1927, p. 65; emphasis added)

Here, there is confusion between different sense modalities as in the loss of perspective described by Wyss (1973). This also resembles the experiences of the woman who complains that the hospital staff inflicted torture through sounds registered in her body.

One current model for the occurrence of psychotic symptoms is based on a possible failure in multisensory integration (Postmes et al., 2014). According to this model, impaired multisensory integration leads to perceptual incoherence, which may invoke incoherent self-experiences. It has been proposed that subconscious attempts to restore perceptual coherence may induce psychotic symptoms such as hallucinations (Postmes et al., 2014). Indeed, experimentally induced perceptual incoherence can induce altered self-experience (Blanke, 2012; Lopez, Lenggenhager, & Blanke, 2010) in healthy subjects. There is also evidence for deficits in multisensory gain (Ross et al., 2007) and multisensory temporal processing dysfunction (Stevenson et al., 2017) in individuals diagnosed with schizophrenia.

According to models of Bayesian inference and predictive coding, multisensory integration relies on an internal model regarding statistical regularities in the environment. This enables cross-sensory predictions as a mechanism to arbitrate between integration and segregation of signals from different sensory modalities (Noppeney & Lee, 2018). Along these lines, impairments in multisensory integration underlying perceptual incoherence may be accounted for by Bayesian predictive coding theories of schizophrenia, which have proposed a reduced precision of prior beliefs relative to an increased precision in the encoding of the sensory data (Adams et al., 2013; Mishara & Sterzer, 2015; Sterzer et al., 2016, 2018). Perceptual incoherence might reflect differences in the precision of priors in different sensory modalities or an imbalance of priors at different levels of the predictive coding hierarchy (Heinz et al., 2018; Sterzer et al., 2018). For instance, it has been suggested that a relative increase in the weighting of sensory data may render sensations more vivid, but their content harder to resolve, thus leading to an increased reliance on higher-level beliefs, e.g. about speech narratives in the case of auditory verbal hallucinations (Benrimoh, Parr, Vincent, Adams, & Friston, 2018). In other words, uncertainty caused by imprecise priors and relatively increased weighting of sensory evidence at low hierarchical levels may be compensated by a stronger influence of high-level priors. Conceivably, such a mechanism could also facilitate the integration, or rather, the fusing of signals from different sensory modalities in multimodal hallucinations. This would explain the above-mentioned "hallucinating together of the senses" as described by Mayer-Gross.

Albeit speculative, this account is supported by recent work using computational modeling in a Bayesian framework. This shows that in individuals who frequently experience auditory hallucinations, a higher propensity towards conditioned auditory hallucinations induced by concurrent visual stimulation can be explained by an overweighting of priors (Powers, Mathys, & Corlett, 2017). The authors propose that "hallucinations (percepts without external stimulus) may arise when strong priors cause a percept in the absence of input" (p. 1). Similarly, Teufel, Subramaniam, and Dobler (2015) find a shift in information processing in schizophrenia patients which favours prior knowledge over incoming sensory evidence. These are compelling examples of how Bayesian theory and phenomenological accounts are able to inform experimental work in order to improve both the understanding of pathophysiological processes and the possible translation into clinically relevant predictions. Nevertheless, both studies acknowledge that inconsistencies in findings (i.e., whether hallucinations result more from strong priors or conversely, sensory updating) may reflect the hierarchical organization of perception: "Perturbations may affect some levels of the hierarchy and not others" (Powers et al., 2017, p. 1).

In fact, such compensatory measures could "explain away" low-level perceptual anomalies, which otherwise could be very frightening or disruptive. The belief that the world is going to end could be a strong high-level prior. However, it could also reduce the alienation from the perceptual world or self-disturbances arising from low-level perceptual anomalies. Experiences of somatic passivity symptoms could be used to balance frightening or confusing sensory anomalies at lower levels of processing as suggested by Mayer-Gross' 'perceptual anomalies approach' to schizophrenia (Mishara et al., 2015; Sterzer et al., 2016; see also introduction above).

The woman who complains that hospital staff torture her through sounds registered in her body could be explained this way. The proposed imbalance of imprecise low-level priors and overly precise sensory data may result in the vivid sensation of the sounds in

her body, which is explained away by the high-level belief regarding malevolent hospital staff. As Benrimoh et al. (2018) note, "increased sensory precision may give resulting hallucinations their realistic, out-loud quality" (p. 198). The description "out loud" here need not refer to auditory verbal hallucinations, audible thoughts, etc., but also multimodal hallucinations, i.e., in terms of what Jaspers describes as "objectively" present (leibhaftig).[7] It is likely that the self as body is not only tied to multimodal processing (Apps & Tsakiris, 2013) but also with its disruption in the multimodal hallucinations of schizophrenia.

8. Embodiment, metaphor, hallucination: do self-disturbances preserve self during catastrophic conditions?

As stated in the introduction, Kurt Schneider (who later incorporated many self-disturbances in his first rank symptoms) observes that even when the self is characterized bizarrely by the patient, "the previous self is not obliterated; it persists in spite of the transformation and beyond it." While this is an intriguing statement, it is not entirely clear what Schneider means. We propose an explanation which also incorporates Alex's seeing rain.

Alex was at first frightened by the rain or veil, as well as the accompanying multimodal somatic experiences of tickling, pressure on his eyes, "movement" in his brain, and changes of temperature in his hands and legs. While the veil itself "wobbles," it does not disturb the perceptual world beyond the veil, nor for that matter, the self that is presumably looking through the veil. One might say tentatively that the world is stabilized in relation to the self precisely through the veil or rain.

Here, the disturbing aspect is also the one that maintains coherence. Alex cannot step into the rain and it does not change when he moves. There is no opportunity for him to examine the rain or veil from outside his current perspective. He is unable to actively explore it from different sides, aspects, or different sensory modalities, as he is able to do with other objects in his surrounding environment.. He is admittedly hampered by the veil but not incapacitated by it. Acting as metaphor which we believe organizes the experience, the veil helps stabilize the very relationships it interrupts.[8] The patient knows that the outside world is beyond the veil but cannot step beyond or outside the veil to observe and explore the veil itself as hallucinatory object.

Even though the rain may seem to lack substance as transparent "wobbling veil," it is experienced as a "wall" (still another metaphor Alex uses) between Alex and the world. The self-world relationship is preserved (if also disturbed) by the veil. Thus, it would seem that the veil, or rain, has the function of both separating and connecting world and self. It is not that the veil preempts action. The subject can still act in this world separated by the veil. It is rather that Alex, in principle, knows that there is no action he can take to gain perspective on the veil itself, which rather moves with him wherever he moves. Thus, unlike other objects in his surrounding world, he is unable to take distance from the veil by using his movements to explore its different sides or aspects.

In this view, the veil, or rain, preserves self and world in a certain stability that would otherwise be elusive. That is, the veil wobbles, but does not disturb the stable environment beyond the veil. It serves as an example of what von Weizsäcker calls "improvisation" of a self-organizing experiential field. The field maintains coherence by preserving some aspects of the perceptual Gestalt while sacrificing others. During psychosis, transitions may be rapid and ballistic in that each abrupt new organization of the surrounding field *appears* to emerge on its own without precedent in the prior organization (Uhlhaas & Mishara, 2007).

In a certain sense, we might compare this solution with the woman patient described above, who internalizes or absorbs the annoying kitchen and cleaning noises inside her body in a manner that she is apparently no longer bothered by the noises themselves. This is accomplished at great cost, however, because the noises are replaced by the internal bodily suffering she experiences. We require further phenomenological and experimental data to determine whether the disruption fundamentally lies in such cases with low-level sensory processing (Sterzer et al., 2016) or with discrepancies of millisecond timing in perception-action cycle (see Giersch & Mishara, 2017a, 2017b) or other mechanisms (Silverstein & Rosen, 2015; Silverstein, 2016).[9]

As indicated above, we make the tentative claim that the somatic passivity, "made experiences" and the influences playing on the body by powerful others in self-disturbances may have an adaptive role when the self faces catastrophic destruction. When K.

[7] For Jaspers, genuine or true hallucinations are experienced as "objectively" present (*leibhaftig*) in their phenomenal givenness and are experienced alongside real perceptions in external objective space (1911, 1913). In contrast, pseudohallucinations are imaginary (*bildhaftig*), not experienced as concretely real, have the character of subjectivity, and appear in inner subjective space. We refer to Jaspers' term Leibhaftigkeit (referring to the seeming objective presence of the hallucination) not to endorse Jaspers' distinction with pseudhohallucinations, but to concur with Mayer-Gross (1928) that this term does not distinguish so-called pseudohallucinations which may also be experienced as *leibhaftig* (Mishara and Zaytseva, 2019). Alex's "seeing rain" does not qualify as a "pseudohallucination" according to Jaspers' definition. The "rain" is not perceived as part of the world and yet, contra Jaspers, it is also not perceived as part of the self or inner subjective space. Rather we suggest that the "rain" in this case separates world and self in order to "preserve" them as not fusing. The term 'pseudohallucination' has a long, contentious history concerning its definition and clinical usefulness (Berrios & Dening, 1996).

[8] The study of comprehension and production of metaphors in schizophrenia patients has a long history. We suggest here that patients who experience I-paralysis often take their metaphoric images of self literally. For example, Meynert's patient experiences himself as a "mere keyboard upon which others play" (Kendler & Mishara, 2019). Similarly, Binswanger's (1957) patients describe themselves as a "machine," "a computer," or a "registering apparatus whose sole function is to register impressions." In a separate publication, we discuss adaptiveness (albeit limitied) of self-metaphors when taken literally in self-disturbances (see also Mishara, 2010a, and the section on metaphor in Mishara, 2010c).

[9] Vision has the restriction that it directly perceives more or less only what is in front of the subject at the moment. Auditory stimuli, however, can be perceived at any point in the 360° surrounding the subject (Odegaard, Beierholm, Carpenter & Shams, 2019). Recently, Gruters et al. (2018), found that ear drum oscillations associated with eye-movements may actually precede saccades by 10 ms, even in the absence of auditory stimuli. Such visual-auditory interactions may prepare the way for later integration of information from both modalities. Moreover, multimodal processing, as we suggest in this paper, could be particularly sensitive to timing anomalies as those found in schizophrenia.

Schneider's patients identify themselves as another person, a dog or burning Christmas tree, we contend that the self is nevertheless preserved in these transformations by sacrificing fundamental aspects to preserve others in spontaneous "improvisation" to preserve minimal "coherence" of self-world relationship (cf. von Weizsäcker 1933, 1950a, 1950b). The self may have lost its will to powerful others, in that perceptions, movements, feelings, thoughts, etc. are impacted by the external agency of I-paralysis. Precisely by sacrificing the self in such extreme ways, however, other aspects of self may be paradoxically preserved. The bizarre descriptions of self seen in the so-called reflex, or coenesthetic hallucinations, may actually have the paradoxical consequence of preserving self by keeping some part of it (no matter how minimal) unscathed from the bizarre transformations the patient reports. That is, by virtue of making such complaints to others, there is still a self who can maintain minimal distance to formulate and report these putative injustices. Precisely as narrator of these atrocious violations of self, the patient – for the moment – escapes (overcomes, transcends) the loss of self to powerful others (I-paralysis) about whom the patient complains. This is not to say that the patient does not suffer considerably in these experiences. In Alex's case, which is less severe, we suggested that the veil has the function of both separating (protecting) and connecting self and world.

Despite an absence of self-agency, patients with schizophrenia may nevertheless "continue to respond reflexively to the environmental cues…necessary for continued survival… The delusions are not primarily a defensive reaction to protect the self, but involve a 'reorganization' of the patient's experience to maintain behavioral interaction with the environment despite the underlying disruption to perceptual binding processes (Conrad, 1958; Mishara, 2010b). At the Aha-moment (of the delusion), the 'shear pin' breaks, or as Conrad puts it, the patient is unable to shift 'reference-frame' to consider the experience from another perspective. The delusion disables flexible, controlled conscious processing from continuing to monitor the mounting distress of the wanton prediction error during delusional mood and thus deters cascading toxicity. At the same time, automatic habitual responses are preserved, possibly even enhanced." (Mishara and Corlett, 2009, p. 531; see also Bortolotti, 2018; Gunn & Bertolotti, 2018).

In this contribution, we suggest that self-disturbances play an adaptive or compensatory role for the uncoupling of perception and action, and/or other low-level sensory anomalies. They may minimally preserve self in catastrophic changes of neural functioning during psychosis. Referring to K. Schneider's observation cited above: "the previous self is not obliterated; it persists in spite of the transformation and beyond it." We have suggested that such a 'reorganization' (Conrad, 1958; von Weizsaecker, 1933, 1950a, 1950b) of the patient's experience also occurs in self-disorders to preserve some aspects of self by sacrificing others.

9. Conclusions

We presented a case of persisting visual hallucinations with attendant somatosensory features. Visual/multimodal hallucinations in schizophrenia are understudied and therefore, the mechanisms are not well understood. The Early Heidelberg School (Gruhle, Mayer-Gross, Beringer) originated and developed the self-disturbances concept and used mescaline as a psychotomimetic agent to study them.

The Early Heidelberg School suggests that self-disturbances arise from a discrepancy between controlled and automatic processing. Gruhle's description of the two components of self-disturbance involve different relationships to automatic processing. In the first component, the self experiences its own automatic processing as alien to self in a split-off self of doubled-I. In the second, the I-paralysis, the source of disruption to automatic processing in one's daily activities is outside the self in omnipotent agents or forces. These experiences are very disturbing to patients and cause considerable suffering especially early in illness. While perception and action are typically tightly coupled, these processes become detached in persons with schizophrenia and contribute to visual/multimodal hallucinations. This could play a role in self-disturbances where patients feel estranged from their own automatic processing of perception, action, thinking, volition, etc. We require further phenomenological and experimental data to determine whether the disruption lies in such cases with low-level sensory processing (Sterzer et al., 2016) or with discrepancies of millisecond timing, e.g., involving the perception-action cycle (see Giersch & Mishara, 2017a, 2017b), or other mechanisms (Silverstein & Rosen, 2015; Silverstein, 2016).

In acute psychosis, Alex experienced thought insertion, thought broadcasting, as well as experiencing himself as "puppet." However, apart from these acute experiences, the second component - the omnipotence of external agents who control the patient - is absent. There is nevertheless an atmospheric change of the total experience into something foreign, unfamiliar or uncanny (what Gruhle calls basic mood that directly reflects the underlying disease process). Alex is unable to step out into the rain and it does not change when he moves. The patient cannot enter the rain, which, as a "wall" or wobbling "veil", nevertheless serves as a separation between himself and the surrounding environment. The "rain" rather moves with the patient's movements and he is unable to take distance from it. He is unable to explore the object through movement and thus is prevented from gaining perspective in relation to the hallucinatory object. That is, Alex is unable to predict changes of the hallucinatory experience through his own exploratory movements – as there appears to be no relationship between the subject's and the hallucinatory object's movements- but he must somehow make sense of the experience.

The clinical phenomenology is compatible in many respects with hierarchical Bayesian predictive coding. Both approaches acknowledge the importance of the perception-action cycle in their respective hierarchical formalisms. Both emphasize prediction (or, for Husserl, expectation) on different spatial and temporal scales and both describe "unconscious inference." In this contribution, we outlined how self-disturbances may play an adaptive or compensatory role. Alex is unable to actively explore the hallucinatory 'object' from different sides or aspects, as he is able to do with other objects. Acting as metaphor which organizes the experience, the "rain" (alternatively, "veil," or "wall) helps stabilize the very relationship it interrupts. Alex knows that the outside world is beyond the veil but cannot step beyond or outside to observe and explore the veil itself. Rather the rain or veil remains in front of him wherever he looks.

He experiences a diminution of his environment through the rain, which is accompanied by an increase of abnormal somatosensory experiences. This is reminiscent of the older female patient reported by Mayer-Gross who internalizes or absorbs the annoying kitchen and cleaning noises inside her body in a manner that she is apparently no longer bothered by the noises themselves. This is accomplished at great cost, however, because the noises are replaced by the internal bodily suffering she experiences. In Alex's case, we suggested that the rain or veil has the function of both separating and maintaining relationship of world and self.

Author contributions

JK interviewed patient and performed clinical rating. AM conceived the contents and structure of the article. AM provided the translations from German. AM, JK and PS co-wrote the article.

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Declaration of Competing Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

Adams, R., Stephan, K. E., Brown, Frith, C., & Friston, K. (2013). The computational anatomy of psychosis. *Frontiers in Psychiatry/Frontiers Research Foundation, 4*, 47. https://doi.org/10.3389/fpsyt.2013.00047.
Adams, R., Brown, H. R., & Friston, K. J. (2015). Bayesian inference, predictive coding and delusions. *Avant, 3*, 51–88.
Aleman, A., & Larøi, F. (2008). *Hallucinations: The science of idiosyncratic perception.* Washington, DC: American Psychological Association.
Apps, M. A. J., & Tsakiris, M. (2013). The free-energy self: A predictive coding account of self-recognition. *Neuroscience & Biobehavioral Reviews*. https://doi.org/10.1016/j.neubiorev.2013.01.029 PMID: 23416066.
Benrimoh, D., Parr, T., Vincent, P., Adams, R. A., & Friston, K. (2018). Active inference and auditory hallucinations. *Computational Psychiatry, 2*, 183–204.
Beringer, K. (1927). *Der Meskalinrausch: Seine Geschichte und Erscheinungsweise.* Berlin, Germany: Verlag Julius von Springer.
Berrios, G. E., & Dening, T. R. (1996). The enigma of pseudohallucinations: current meanings and usage. *Psychopathology, 29*, 17–34.
Binswanger, L. (1957). *Schizophrenie.* Pfullingen, Germany: Neske.
Blanke, O. (2012). Multisensory brain mechanisms of bodily self-consciousness. *Nature Reviews Neuroscience, 13*(8), 556–571.
Bortolotti, L. (2018). Delusions and the three myths of irrational belief. In L. Bortolotti (Ed.). *Delusions in Context* (pp. 97–116). London: Palgrave Macmillan.
Bracha, H. S., Wolkowitz, O. M., Lohr, J. B., Karson, C. N., & Bigelow, L. B. (1989). High prevalence of visual hallucinations in research subjects with chronic schizophrenia. *The American Journal of Psychiatry, 146*(4), 526–528.
Bruner, J. (1973). *Going beyond the information given.* New York, NY: Norton.
Buytendijk, F. J. J. (1974). *Prolegomena to an Anthropological Physiology, A. I. Orr (trans).* Pittsburgh, PA: Duquesne University Press.
Chadwick, P., & Birchwood, M. (1994). The omnipotence of voices: A cognitive approach to auditory hallucinations. *British Journal of Psychiatry, 164*(2), 190–201. https://doi.org/10.1192/bjp.164.2.190.
Claesges, U. (1964). *Edmund Husserls Theorie der Raumkonstitution.* Dorderecht, Netherlands: Springer.
Conrad, K. (1958). *Die beginnende Schizophrenie.* Versuch einer Gestaltanalyse des Wahns, Stuttgart, Germany: G. Thieme.
Delespaul, P., & van Os, J. (2002). Determinants of occurrence and recovery from hallucinations in daily life. *Social Psychiatry and Psychiatric Epidemiology, 37*(3), 97–104.
Duhamel, J. R., Colby, C., & Goldberg, M. (1992). The updating of the representation of visual space in parietal cortex by intended eye movements. *Science, 255*(5040), 90–92. https://doi.org/10.1126/science:1553535.
Ellinwood, E. H. (1967). Amphetamine psychosis: I. Description of the individuals and process. *Journal of Psychoactive Drugs, 2*(2), 42–51.
Friston, K. (2005). A theory of cortical responses. *Philosophical transactions of the Royal Society of London. Series B, Biological sciences, 360*(1456), 815–836.
Friston, K. (2008). Hierarchical models in the brain. *PLOS Computational Biology, 4*, e1000209.
Friston, K. (2009). The free-energy principle: a rough guide to the brain? *Trends in Cognitive Sciences, 13*(7), 293–301.
Friston, K. (2010). The free-energy principle: a unified brain theory? *Nature Reviews Neuroscience, 11*(2), 127–138.
Friston, K. (2014). Active inference and agency. *Cognitive Neuroscience, 5*, 119–121.
Friston, K., Adams, R. A., Perrinet, L., & Breakspear, M. (2012). Perceptions as hypotheses: saccades as experiments. *Frontiers in Psychology, 3*(May), 1–20.
Fuster, J. M. (2006). The cognit: a network model of cortical representation. *International Journal of Psychophysiology, 60*, 125–132.
Gallagher, S., & Allen, M. (2016). Active inference, enactivism and the hermeneutics of social cognition. *Synthese*. https://doi.org/10.1007/s11229-016-1269-8.
Gauntlett-Gilbert, J., & Kuipers, E. (2003). Phenomenology of visual hallucinations in psychiatric conditions. *The Journal of Nervous and Mental Disease, 191*(3), 203–205.
Giersch, A., & Mishara, A. L. (2017a). Is Schizophrenia a disorder of consciousness? Experimental and phenomenological support for anomalous unconscious processing. *Frontiers in Psychology, 8*, 1659.
Giersch, A., & Mishara, A. L. (2017b). Disrupted continuity of subjective time in the milleseconds range in the self-disturbances of schizophrenia: Convergence of experimental, phenomenological and predictive coding accounts. *Journal of Consciousness Studies, 24*(3-4), 62–87.
Gregory, R. L. (1980). Perceptions as hypotheses. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences, 290*, 181–197.
Grivois, H. (1999). Adolescence, indifferentiation, and the onset of psychosis. *Contagion Journal of Violence Mimesis and Culture, 6*, 104–121.
Gruhle, H. W. (1915). Selbstschilderung und Einfühlung. *Zeitschrift für die gesamte Neurologie und Psychiatrie, 28*, 148–231.
Gruhle, H. W. (1922a). Psychologie des Abnormen. In G. Kafka (Ed.). *Handbuch der vergleichenden Psychologie* (pp. 3–151). München, Germany: Reinhardt.
Gruhle, H. W. (1922b). (1922b) Die Psychologie der Dementia praecox. *Zentralblatt für Neurologie, 78*, 454–471.
Gruhle, H. W. (1929). Psychologie der Schizophrenie. In J. Berze (Ed.). *Psychologie der Schizophrenie* (pp. 73–168). Wien, Austria: Springer.
Gruhle, H. W. (1932). Die Psychopathologie. In O. Bumke (Ed.). *Handbuch der Geisteskrankheiten. Part 5: Die Schizophrenie* (pp. 135–292). Berlin, Germany: Springer.
Gruters, K. G., Murphy, D. L. K., Jenson, C. D., Smith, D. W., Shera, C. A., & Groh, J. M. (2018). The eardrums move when the eyes move: A multisensory effectcon the mechanics of hearing. *Proceedings of the National Academy of Sciences*. https://doi.org/10.1073/pnas.1717948115.

Gunn, R., & Bertolotti, L. (2018). Can delusions play a protective role? *Phenomenology and the Cognitive Sciences, 17*, 813–833. https://doi.org/10.1007/s11097-017-9555-6.
Gurwitsch, A. (1964). *The Field of Consciousness.* Pittsburgh, Pa: Duquesne University Press.
Heilman, M. K. M., & Valenstein, E. (2011). *Clinical neuropsychology.* Oxford, UK: Oxford University Press.
Heinz, A. (2014). *Der Begriff der psychischen Krankheit.* Berlin, Germany: Suhrkamp222–223.
Heinz, A., Murray, G., Schlagenhauf, F., Sterzer, P., Grace, A. A., & Waltz, J. A. (2018). Towards a unifying cognitive, neurophysiological, and computational neuroscience account of schizophrenia. *Schizophrenia Bulletin*. https://doi.org/10.1093/schbul/sby154.
Held, K. (1966). *Lebendige Gegenwart.* Den Haag, Netherlandy: Martinus Nijhoff.
Hermle, L., Oepen, G., & Spitzer, M. (1988). Zur Bedeutung der Modellpsychosen. *Fortschritte Neurologie und Psychiatrie, 56*, 48–58.
Hesselmann, G., Darcy, N., Rothkirch, M., & Sterzer, P. (2018). Investigating masked priming along the "vision-for-perception" and "vision-for-action" dimensions of unconscious processing. *Journal of Experimental Psychology: General, 147*(11), 1641–1659.
Hoffman, R. E. (2007). A social deafferentation hypothesis for induction of active schizophrenia. *Schizophrenia Bulletin, 33*, 1066–1070.
Hohwy, J., Paton, B., & Palmer, C. (2015). Distrusting the present. Available at: *Phenomenology and the Cognitive Sciences,* 1–21. http://link.springer.com/10.1007/s11097-015-9439-6.
Husserl, E. (1959). *Erste Philosophie (1923/24). II. Theorie der Phaenomenologischen Reduktion.* The Haag, Netherlands: Martinus Nijhoff.
Husserl, E. (1966). *Analysen zur passiven Synthesis aus Forschungsmanuscripten 1918–1926.* The Hague: Martinus Nijhoff.
Husserl, E. (1970). The crisis of European sciences and transcendental phenomenology: An introduction to phenomenological philosophy. trans. David Carr Evanston, IL: Northwestern University Press.
Husserl, E. (1973a). Ding und Raum. Vorlesungen 1907. Edited by Ulrich Claesges. Husserliana: Edmund Husserl–Gesammelte Werke, Band 16. The Hague, Netherlands: Martinus Nijhoff.
Husserl, E. (1973b). *Experience and judgment, investigations in a geneology of logic.* Evanston, Ill: Northwestern University Press.
Jardri, R., Duverne, S., Litvinova, A. S., & Denève, S. (2017). Experimental evidence for circular inference in schizophrenia. *Nature Communications, 8*, 14218. https://doi.org/10.1038/ncomms14218.
Jaspers, K. (1910). Eifersuchtswahn. Ein Beitrag zur Frage, Entwicklung einer Persönlichkeit oder Prozess? *Zeitschrift für die gesamte Neurologie und Psychiatrie, 1*, 567–637.
Jaspers, K. (1911). Zur Analyse der Trugwahrnehmungen (Leibhaftigkeit und Realitätsurteil). *Zeitschrift für die gesamte Neurologie und Psychiatrie, 6*, 460–535.
Jaspers, K. (1913). *Allgemeine psychopathologie.* Berlin, Germany: Springer.
Kahlbaum, K. (1866). Die Sinnesdelirien. *Allgemeine Zeitschrift für Psychiatrie und psychischgerichtliche Medizin, 23*, 56–78.
Kendler, K. S., & Mishara, A. L. (2019). The pre-history of Schneider's first-rank delusions: Texts from 1810 to 1932. *Schizophrenia Bulletin,* sbz047. https://doi.org/10.1093/schbul/sbz047.
Kopiske, K. K., Bruno, N., Hesse, C., Schenk, T., & Franz, V. H. (2016). The functional subdivision of the visual brain: Is there a real illusion effect on action? A multi-lab replication study. *Cortex, 79*, 130–152. https://doi.org/10.1016/j.cortex.2016.03.020.
Land, M., Mennie, D., & Rusted, J. (1999). The roles of vision and eye movements in the control of activities of daily living. *Perception, 28*, 1311–1328.
Lee, T. S., & Mumford, D. (2003). Hierarchical Bayesian inference in the visual cortex. *Journal of the Optical Society of America A, Optics, Image Science, and Vision, 20*, 1434–1448. https://doi.org/10.1364/josaa.20.001434.
Lopez, C., Lenggenhager, B., & Blanke, O. (2010). How vestibular stimulation interacts with illusory hand ownership. *Consciousness and Cognition, 19*(1), 33–47.
Ludwig, K., Sterzer, P., Kathmann, N., Franz, V. H., & Hesselmann, G. (2013). Learning to detect but not to grasp suppressed visual stimuli. *Neuropsychologia, 51*(13), 2930–2938.
Mayer-Gross, W. (1928). Psychopathologie und Klinik der Trugwahrnehmungen. In O. Bumke (Ed.). *Handbuch der Geisteskrankheiten. Band I. Allgemeiner Teil I.* Berlin, Germany: Verlag von Julius Springer.
Mayer-Gross, W. (1932). Die Klinik der Schizophrenie. In O. Bumke (Ed.). *Handbuch der Geisteskrankheiten* (pp. 293–578). Berlin, Germanys: Springer.
Mayer-Gross, W., & Stein, H. (1926). Über einige Abänderungen der Sinnestätigkeit im Meskalinrausch. *Zeitschrift für die gesamte Neurologie und Psychiatrie, 101*, 354–386.
Merabet, L. B., Maguire, D., Warde, A., Alterescu, K., Stickgold, R., & Pascual-Leone, A. (2004). Visual hallucinations during prolonged blindfolding in sighted subjects. *Journal of Neuro-Ophthalmology, 24*, 109–113.
Milner, A. D., & Goodale, M. A. (1995). *The visual brain in action.* Oxford, UK: Oxford University Press.
Mishara, A. L. (1990). Husserl and Freud: time, memory and the unconscious. *Husserl Studies, 7*, 29–58. https://doi.org/10.1007/BF00144886.
Mishara, A. L. (1995). Narrative and psychotherapy - The phenomenology of healing. *American Journal of Psychotherapy, 49*(2), 180–195.
Mishara, A. L. (1997). Binswanger's psychiatry. In L. Embree (Ed.). *Encyclopedia of phenomenology* (pp. 62–66). Dordrecht: Kluwer Academic Publishers.
Mishara, A. L. (2005). Body self and its narrative representation in schizophrenia: Does the body schema concept help establish a core deficit? In H. De Preester, & V. Knockaert (Eds.). *Body image and body schema interdisciplinary perspectives on the body* (pp. 127–152). Amsterdam, Netherlands: John Benjamins Publishing Company.
Mishara, A. L. (2007). Is minimal self preserved in schizophrenia? A subcomponents view. *Consciousness and Cognition, 16*, 715–721.
Mishara, A. L. (2009). Human bodily ambivalence: Precondition for social cognition and its disruption in neuropsychiatric disorders. *Philosophy, Psychiatry & Psychology, 16*, 133–137.
Mishara, A. L. (2010a). Kafka, paranoic doubles and the brain: Hypnagogic vs. hyper-reflexive models of disruption of self in neuropsychiatric disorders and anomalous conscious states. *Philosophy, Ethics, and Humanities in Medicine (PEHM), 5*, 13.
Mishara, A. L. (2010b). Klaus Conrad (1905–1961): Delusional mood, psychosis and beginning schizophrenia. Clinical concept translation-feature. *Schizophrenia Bulletin, 36*, 9–13.
Mishara, A. L. (2010c). Autoscopy: Disrupted self in neuropsychiatric disorders and anomalous conscious states. In S. Gallagher, & D. Schmicking (Eds.). *Handbook of phenomenology and cognitive science* (pp. 591–634). Berlin: Springer. http://www.springerlink.com/content/q34127121705712x/.
Mishara, A. L. (2012). The 'unconscious' in paranoid delusional psychosis: Phenomenology, neuroscience, psychoanalysis. In D. Lohmar, & J. Brudzinska (Vol. Eds.), *Founding Psychoanalysis Phenomenologically. Phaenomenologica (Published Under the Auspices of the Husserl-Archives): Vol. 199*, (pp. 169–197). Dordrecht: Springer.
Mishara, A. L., & Corlett, P. (2009). Are delusions biologically adaptive? Salvaging the doxastic shear pin. *Behavioral and Brain Sciences, 32*, 530–531.
Mishara, A. L., & Fusar-Poli, P. (2013). The phenomenology and neurobiology of delusion formation during psychosis onset: Jaspers, truman symptoms, and aberrant salience. *Schizophrenia Bulletin, 39*(2), 278–286.
Mishara, A., Bonoldi, I., Allen, P., Rutigliano, G., Perez, J., Fusar-Poli, P., et al. (2015). Neurobiological models of self-disorders in early schizophrenia. *Schizophrenia Bulletin,* 1–7. http://www.ncbi.nlm.nih.gov/pubmed/26385763.
Mishara, A. L., & Sterzer, P. (2015). Phenomenology is Bayesian in its application to delusions. *World Psychiatry, 14*(2), 185–186. https://doi.org/10.1002/wps.20213.
Mishara, A. L., & Zaytseva, Y. (2019). Hallucinations, a disorder of phenomenal consciousness? In G. Stanghellini, M. Broome, A. Fernandez, & P. Fusar-Poli (Eds.). *Oxford handbook of phenomenological psychopathology*Oxford, UK: Oxford University Press. https://doi.org/10.1093/oxfordhb/9780198803157.013.54 Online Publication Date: Jan 2019. on-line version: https://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780198803157.001.0001/oxfordhb-9780198803157-e-54.
Morton, W. A., & Stockton, G. G. (2000). Methylphenidate abuse and psychiatric side effects. *Primary care Companion to the Journal of Clinical Psychiatry, 2*(5), 159.
Mueser, K. T., Bellack, A. S., & Brady, E. U. (1990). Hallucinations in schizophrenia. *Acta Psychiatrica Scandinavica, 82*(1), 26–29.
Mumford, D. (1992). On the computational architecture of the neocortex. II. The role of cortico-cortical loops. *Biological Cybernetics, 66*, 241–251.
Noppeney, U., & Lee, H. L. (2018). Causal inference and temporal predictions in audiovisual perception of speech and music: Audiovisual perception of speech and music. *Annals of the New York Academy of Sciences, 1423*(1), 102–116. https://doi.org/10.1111/nyas.2018.1423.issue-110.1111/nyas.13615.
Nowak, L. G., & Bullier, J. (1997). The timing of information transfer in the visual system. In K. S. Rockland, J. H. Kaas, & A. Peters (Vol. Eds.), *Extrastriate visual cortex*

in primates: Vol. 12, (pp. 205–241). New York, NY: Plenum Press.
Odegaard, B., Beierholm, U., Carpenter, J., & Shams, l. (2019). Prior expectation of objects in space is dependent on the direction of gaze. *Cognition, 2018*, 220–226. https://doi.org/10.1016/j.cognition.2018.10.011.
Paillard, J. (1991). Knowing where knowing how to get there. In J. Paillard (Ed.). *Brain and space* (pp. 461–481). Oxford, UK: Oxford University Press.
Paillard, J. (2005). Vectorial versus configural encoding of body space: A neural basis for a distinction between body schema and body image. In H. De Preester, & V. Knockaert (Eds.). *Body image, and body schema, interdisciplinary perspectives on the body* (pp. 89–109). Amsterdam, Netherlands: John Benjamins Publishing Company.
Pascual-Leone, A., & Hamilton, R. (2001). The metamodal organization of the brain. *Progress in Brain Research, 134*, 427–445.
Pienkos, E., Giersch, A., Hansen, M., Humpston, C., McCarthy-Jones, S., Mishara, A., Nelson, B., Park, S., Raballo, A., Sharma, J., Thomas, N., & Rosen, C. (2019). Hallucinations beyond voices: A conceptual review of the phenomenology of altered perception in psychosis, Working Group Report, 4th International Consortium on Hallucination Research Meeting. *Schizophrenia Bulletin. 45*(1), S67–S77. https://doi.org/10.1093/schbul/sby057.
Plessner, H. (1928). *Die Stufen des Organischen und der Mensch. Einleitung in die philosophische Anthropologie.* Berlin/New York: De Gruyter.
Postmes, L., Sno, H. N., Goedhart, S., van der Stel, J., Heering, H. D., & de Haan, L. (2014). Schizophrenia as a self-disorder due to perceptual incoherence. *Schizophrenia Research, 152*, 41–50. https://doi.org/10.1016/j.schres.2013.07.027.
Powers, A. R., Mathys, C., & Corlett, P. R. (2017). Pavlovian conditioning–induced hallucinations result from overweighting of perceptual priors. *Science, 357*(6351), 596–600. http://www.sciencemag.org/lookup/doi/10.1126/science:aan3458https://doi.org/10.1126/science:aan3458.
Rao, R. P., & Ballard, D. H. (1999). Predictive coding in the visual cortex: a functional interpretation of some extra-classical receptive-field effects. *Nature Neuroscience, 2*, 79–87.
Raballo, A. (2016). The stream of hallucinatory consciousness: when thoughts become like voices. *Journal of Consciousness Studies, 23*, 132–143.
Ross, L. A., Saint-Amour, D., Leavitt, V. M., Molholm, S., Javitt, D. C., & Foxe, J. J. (2007). Impaired multisensory processing in schizophrenia: deficits in the visual enhancement of speech comprehension under noisy environmental conditions. *Schizophrenia Research, 97*(1–3), 173–183.
Schenk, T., & McIntosh, R. D. (2010). Do we have independent visual streams for perception and action? *Cognitive Neuroscience, 1*(1), 52–62.
Schneider, K. (1939). *Psychischer Befund und psychiatrische Diagnose.* Leipzig, Germany: Thieme.
Schneider, K. (1959). *Clinical Psychopathology.* New York: Grune & Stratton.
Schneider, K. (1980). *Klinische Psychopathologie* (12th ed.). Stuttgart: Thieme.
Silverstein, S. M. (2016). Visual perception disturbances in schizophrenia: A unified model. *Nebraska Symposium on Motivation, 63*, 77–132.
Silverstein, S. M., & Rosen, R. (2015). Schizophrenia and the eye. *Schizophrenia Research: Cognition, 2*, 46–55.
Sterzer, P., Mishara, A. L., Voss, M., & Heinz, A. (2016). Thought insertion as self disturbance (Ichstörung): A combined bayesian predictive coding, phenomenological approach. available at: *Frontiers of Molecular Neuroscience, 10*http://journal.frontiersin.org/article/10.3389/fnhum.2016.00502/abstract.
Sterzer, P., Adams, R. A., Fletcher, P., Frith, C., Lawrie, S. M., Muckli, L., et al. (2018). The predictive coding account of psychosis. *Biological Psychiatry, 1–10*. https://doi.org/10.1016/j.biopsych.2018.05.015.
Stevenson, R. A., Park, S., Cochran, C., McIntosh, L. G., Noel, J.-P., Barense, M. D., et al. (2017). The associations between multisensory temporal processing and symptoms of schizophrenia. *Schizophrenia Research, 179*, 97–103. https://doi.org/10.1016/j.schres.2016.09.035.
Straus, E. (1949). Die Ästhesiologie und ihre Bedeutung für das Verständnis der Halluzinationen. *Archiv für Psychologie und Zeitschrift Neurologie, 182*, 301–332.
Straus, E. (1978). *Vom Sinn der Sinne: ein Beitrag zur Grundlegung der Psychologie* (2nd enl. ed.). Berlin, Germany: Springer Verlag.
Teufel, C., Subramaniam, N., Dobler, V., et al. (2015). Shift toward prior knowledge confers a perceptual advantage in early psychosis and psychosis-prone healthy individuals. *Proceedings of the National Academy of Sciences of the United States of America, 112*, 13401–13406.
Trevarthen, C. B. (1968). Two mechanisms of vision in primates. *Psychologische Forschung, 31*, 299–337.
Uhlhaas, P. J., & Mishara, A. L. (2007). Perceptual anomalies in schizophrenia: integrating phenomenology and cognitive neuroscience. *Schizophrenia Bulletin, 33*, 142–156.
Ungerlieder, L. G., & Mishkin, M. (1992). Two cortical visual systems. In D. J. Ingle, R. J. W. Mansfield, & M. S. Goodale (Eds.). *The analysis of visual behavior* (pp. 549–586). Cambridge: MIT Press.
von Helmholtz, H. (1867). *Handbuch der physiologischen Optik.* Leipzig: Leopold Voss.
von Helmholtz, H. (1878 (1971)). The facts of perception. In R. K. Middletown (Ed.), The selected writings of Hermann von Helmholtz. Connecticut: Wesleyan University Press.
Wang, R. F. (2004). Action, verbal response and spatial reasoning. *Cognition, 94*(2), 185–192.
von Weizsäcker, V. (1933). Körpergeschehen Neurose. Analytische Studie über somatische Symptombildung. *GS, 6*, S.119-238.
von Weizsäcker, V. (1950a). Funktionswandel und Gestaltkreis. *Deutsche Zeitschrift für Nervenheilkunde, 164*, 43–53.
von Weizsäcker, V. (1950b). *Der Gestaltkreis. Theorie der Einheit von Wahrnnehmen und Bewegen* (4. Aufl.). Stuttgart, Germany: Georg Thieme Verlag.
Wyss, D. (1973). *Beziehung und Gestalt.* Goettingen: Vandenhoeck & Ruprecht.