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Review

Out-of-body experience, heautoscopy, and autoscopic hallucination of neurological origin Implications for neurocognitive mechanisms of corporeal awareness and self consciousness

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Abstract

Autoscopic phenomena (AP) are rare illusory visual experiences during which the subject has the impression of seeing a second own body in extrapersonal space. AP consist of out-of-body experience (OBE), autoscopic hallucination (AH), and heautoscopy (HAS). The present article reviews and statistically analyzes phenomenological, functional, and anatomical variables in AP of neurological origin (n = 41 patients) that have been described over the last 100 years. This was carried out in order to further our understanding of the underlying mechanisms of AP, much as previous research into the neural bases of body part illusions has demystified these latter phenomena. Several variables could be extracted, which distinguish between or are comparable for the three AP providing testable hypotheses for subsequent research. Importantly, we believe that the scientific demystification of AP may be useful for the investigation of the cognitive functions and brain regions that mediate processing of the corporeal awareness and self consciousness under normal conditions.

Theme: Other systems of the Cns
Topic: Association cortex and thalamocortical relations, Cognition

Keywords: Corporeal awareness; Self; Neurology; Brain damage; Vestibular; Multisensory

Contents

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1. Introduction

The self is experienced as distinct from other human conspecifics and may be described as an enduring entity (i.e. the feeling that we are the same person across time) to which certain mental events and actions are ascribed (i.e. the feeling that we are the authors of our thoughts and actions) and which is distinct from the environment [58]. The self has fascinated mankind from time immemorial [94] and its many concepts have been influenced by theology, philosophy, psychology [43,75,77], but also by clinical observations from neurology and psychiatry [41,58,73,74,50,89,90,93]. More recently, cognitive neuroscience has started elucidating some of the cognitive and neural mechanisms of isolated aspects of self processing such as agency [25,37,38], ownership [43], perspective taking [36,85,99], self-other distinction [25,37,38,85–87], and spatial unity between self and body [12]. Yet, as argued by Kircher and Davis [58] the neuroscientific study of the self is in its infancy, as there are currently no established models, very little data, and often not even the vocabulary to describe neuroscientific notions of the self. In addition, with respect to clinical investigations, most studies investigate abnormal self processing in psychiatric conditions such as schizophrenia [42,58], whereas abnormal self processing in neurological conditions has received less attention.

The present article reviews neurological data about complex experiences that are characterized by the visual illusory reduplication of the patient's own body. These phenomena are called autoscopic phenomena (AP) and are generally classified among disorders of somatognosia. Visual disorders of somatognosia include a variety of usually short lasting, illusory experiences about the seen and felt location and position of one's body or body parts in space [11,19,62,63,73,90]. They generally occur in patients with posterior brain damage and are characterized by illusions that only affect a certain body part (visual body-part illusions) or affect the entire body (visual body illusions or autoscopic phenomena [AP]). A variety of visual and non-visual body part illusions such as disconnection, dislocation, movement, and reduplication of, for example, an arm have been described [19,22,50,66,84]. This increased interest in visual body part illusions and especially non-visual body part illusions such as phantom limbs [48,84] led to their neuroscientific investigation and the description of many of their underlying neurocognitive mechanisms. Much less is known about AP, i.e., visual body illusions that affect the entire body. Their scientific study continues to occupy a position between neurobiology and mysticism. Moreover, given the rarity of AP, the widespread neurological literature, and the complex phenomenology of AP they have only recently been classified systematically. The present review analyzes phenomenological, functional, and anatomical similarities and differences of the three main forms of AP: out-of-body experience (OBE), autoscopic hallucination (AH), and heautoscopy (HAS). The separation in three distinct AP was initially developed by Devinsky et al. [32] and subsequently extended by Grüsser and Landis [47], Brugger et al. [18,22], and Blanke et al. [11]. These authors agreed that the combined classification of the well-known phenomenon OBE with the less known phenomena AH and HAS is important since during all three AP the subject has the impression of seeing a second own body in extrapersonal space. It has been speculated that these phenomenological characteristics point to similar as well as distinct neurocognitive mechanisms in the different forms of AP [22,11]. In addition, three other phenomena have previously been classified as AP: internal heautoscopy [50,62,73,93], negative heautoscopy [50,62,73,93], and the feeling of a presence (for recent reviews see [47,22]). During internal heautoscopy, subjects report seeing one or several of their inner organs. During negative heautoscopy, subjects report not seeing their reflection in a reflecting surface. The feeling of a presence is defined as the convincing feeling that there is another person close by without actually seeing that person [21,10] and has been called previously "leibhafte Bewusstheit" [56], "hallucination du compagnon" [62] or "feeling of a presence" [21,10]). We have not included internal and negative heautoscopy in the present analysis because they are extremely rare and there have been, to our knowledge, no reported cases due to focal brain damage. Although several patients with the feeling of a presence due to focal brain damage have been described (for review see [21]), we have not included the feeling of a presence in the present analysis because it is characterized by a *non-visual* body reduplication as opposed to the three main forms of AP which are all characterized by a *visual* body reduplication (see below; for alternative classifications of AP see [22,47,50,62,73,93]).

The present review was carried out in order to better understand the underlying mechanisms of AP, much as previous research into the neural bases of visual body part illusions has demystified these latter phenomena [48,84]. In addition, we believe that the scientific demystification of AP may be useful in defining functions and brain structures that mediate processes of corporeal awareness and self consciousness [75].

2. Autoscopic phenomena

2.1. Classification

OBE: During an OBE people seem to be awake and feel that their "self", or center of awareness, is located outside of the physical body and somewhat elevated. It is from this elevated extrapersonal location that the subjects experience seeing their body and the world [4,11,18,32,54]. The subject's reported perceptions are organized in such a way as to be consistent with this elevated visuo-spatial perspective. The following example from Lunn [66, #1] illustrates what individuals commonly experience during an OBE:

"Suddenly it was as if he saw himself in the bed in front of him. He felt as if he were at the other end of the room, as if he were floating in space below the ceiling in the corner facing the bed from where he could observe his own body in the bed. [. . .] he saw his own completely immobile body in the bed; the eyes were closed."

An OBE can thus be defined as the presence of the following three phenomenological elements: the feeling of being outside one's physical body (or disembodiment); the presence of a distanced and elevated visuo-spatial perspective (or perspective); and the seeing of one's own body (or autoscopy) from this elevated perspective. These three aspects are shown graphically in Fig. 1.

AH: During an AH people experience seeing a double of themselves in extrapersonal space without the experience of leaving one's body (no disembodiment). As compared to OBEs, individuals with AH experience to see the world from their habitual visuo-spatial perspective and experience their "self", or center of awareness inside their physical body (Fig. 1). The following example of an AH is taken from Kölmel [59, #6].

" [. . .] the patient suddenly noticed a seated figure on the left. "It wasn't hard to realize that it was I myself who was sitting there. I looked younger and fresher than I do now. My double smiled at me in a friendly way."

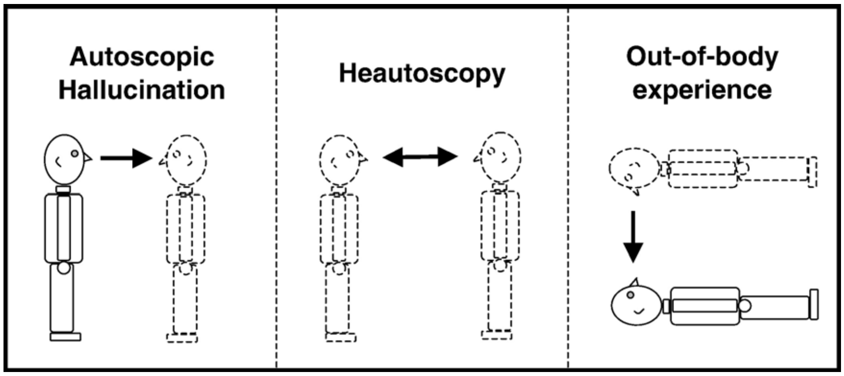

Fig. 1. Phenomenology of autoscopic phenomena. In this figure the phenomenology of AH (left), HAS (middle) and OBE (right) is represented schematically. The experienced position and posture of the physical body for each autoscopic phenomenon is indicated by black lines and the experienced position and posture of the disembodied body (OBE) or autoscopic body (AH, HAS) in dashed lines. The finding that AH and HAS were mainly reported from a sitting/standing position and OBE in a supine position is integrated into the figure. The experienced visuo-spatial perspective during the autoscopic phenomenon is indicated by the arrow pointing away from the location in space from which the patient has the impression to see from (AH: from the physical body; OBE: from a disembodied body or location; HAS: alternating or simultaneous fashion between physical and autoscopic body; modified from Blanke [7]).

HAS: The third form of AP is HAS, which is an intermediate form between AH and OBE. The individual experiencing an HAS also has the experience of seeing a double of himself in extrapersonal space. However, it is difficult for the subject to decide whether he/she is disembodied or not and whether the self is localized within the physical body or in the autoscopic body [11]. In addition, the subjects often report to see in an alternating or simultaneous fashion from different visuo-spatial perspectives (physical body, double's body) as reported by patient 2B in Blanke et al. [11] (Fig. 1).

"[The patient] has the immediate impression as if she were seeing herself from behind herself. She felt as if she were "standing at the foot of my bed and looking down at myself." Yet, [...], the patient also has the impression to "see" from her physical [or bodily] visuo-spatial perspective, which looked at the wall immediately in front of her. Asked at which of these two positions she thinks herself to be, she answered that "I am at both positions at the same time".

To summarize, the three forms of AP differ with respect to the three phenomenological characteristics of disembodiment, perspective, and autoscopy. Whereas there is no disembodiment in AH and always disembodiment in OBEs, subjects with HAS generally do not report clear disembodiment, but are often unable to localize their self. Thus, in some patients with HAS the self is localized either in the physical body, or in the autoscopic body, and sometimes even at multiple positions. Accordingly, the visuo-spatial perspective is body-centered in AH, extracorporal in OBE, and at an extracorporal and body-centered position in HAS. The impression of seeing one's own body is present in all AP (for further details see [11,22]. Only during AH does the subject immediately realize the hallucinatory nature of the experience, whereas HAS and OBEs are generally described as highly realistic experiences [20,11,18].

2.2. Multisensory manifestations and mechanisms

Although, most of the aforementioned authors agree that AP relate to a paroxysmal pathology of own body perception and/or corporeal awareness, it is not known which of the many involved senses are primarily involved in the generation of AP and whether there are differences between the different forms of AP. Some authors postulated a dysfunction of visual processing [40,76]. Visual theories considered AP to be visual or "specular" hallucinations based on the fact that they were experienced and described by most patients spontaneously as visual manifestations [40,76]. In addition, especially AH, may sometimes be lateralized in the visual field and are frequently experienced as visual pseudohallucinations [22,11,18]. However, a number of arguments show that a purely visual explanation cannot account for AP in general. First, although all three forms of AP are described spontaneously as visual, they are frequently experienced as veridical (especially HAS and OBE) and not as pseudohallucinations [11,22,50,73,74]. Secondly, patients and healthy people reported that the impression of reality and self-recognition is preserved even if visual details of the autoscopic body during the AP differ from the patient's actual appearance (such as cloths, age, hair cut, size, coloring of the body ([28,45,54,59,62,67,93]; for discussion see [11]). In some patients, self recognition may even be immediate if the patient only sees his back during the AP [11,32].

These data point to the importance of non-visual, body-related, mechanisms in AP, such as *proprioceptive* and/or *kinaesthetic* processing as already argued by Sollier [93]; for later discussions see also: [11,22,73,62]. In line with phenomenological differences, these authors proposed that the involvement of disturbed processing may differ between the different forms of AP. Sollier [93] for instance differentiated HAS (or "autoscopie dissemblable") from AH (or "autoscopie spéculaire") of previous authors such as Féré [40] suggesting that both AP might relate to different cerebral mechanisms. He postulated the latter to be a mere visual hallucination, whereas he assumed the former to be a proprioceptive-kinaesthetic disturbance associated with a strong psychological affinity between physical and autoscopic body. For proprioceptive-kinaesthetic processing he coined the term cénesthesia (as the body's visceral and deep sensations) stating that AH and HAS are due to different degrees of the "projection of the body's visceral and deep sensations in the space on the outside of the body" [93, pp. 34–44]. Several authors have also highlighted the role of proprioception and kinesthesia in AP by noting that some patients report about shared movements between their physical and autoscopic body (autoscopic echopraxia [22,50,67,73,62]). A further argument in favor of tactile and proprioceptive mechanisms in AP was given by Blanke et al. [11] who reported that the body position of the patient prior to AH/HAS (upright) and OBE (supine) differs suggesting a differential influence of proprioceptive and tactile processing on AP.

Another sensory system, which has been linked to AP, is the *vestibular* system that conveys sensations of the body's orientation in three-dimensional space to the brain. Whereas Bonnier [14] and Skworzoff [92] noted the frequent association of vestibular sensations of either peripheral or central origin with AP, others proposed that a paroxysmal central vestibular dysfunction might be an important mechanism for the actual generation of AP [47,22,73,74]. Menninger-Lerchenthal [73] extended this view and pointed to the importance of vestibular disorders in the generation of visual illusions, visual dysfunctions, as well as AP. Blanke et al. [11] suggested, on clinical grounds, a differential implication of vestibular processing in the different forms of AP. These authors suggested systematic differences in the strength of a vestibular dysfunction in AH, HAS, and OBEs. The role of the vestibular system for AP is also supported by descriptions of vestibular sensations during AP in healthy populations (i.e. [4,28,45,54,75,101]. Blanke et al. [11] suggested that OBEs were associated with a gravitational, otholithic, vestibular disturbance, whereas the vestibular dysfunction in patients with HAS was more variable and often characterized by rotational components, and vestibular dysfunction was absent in patients with AS.

Finally, many patients with AP also experience paroxysmal visual body-part illusions [31,35,50,62,66,53,73] and this has led several authors to argue for a similar or closely related functional and anatomical origin of visual body part illusions and visual illusions of the entire body [22,62,50,53,73,74].

2.3. Etiological and anatomical mechanisms

In comparison with the rich phenomenology of the abovementioned studies, much less information is available about the etiology and especially anatomy of AP, which is partly due to the fact that many cases were reported in the first half of the 20th century. With respect to etiology, AP have been reported in various focal and generalized diseases of the central nervous system. Generalized neurological etiologies include cerebral infections such as meningitis and encephalitis, intoxications, as well as generalized epilepsies [11,22,23,32,31,50,67,62,73]. AP following focal brain damage also emerge from a large variety of etiologies including focal epilepsy [32], traumatic brain damage [96], and migraine [64] as well as vascular brain damage [59] and neoplasia [96].

Regarding their underlying anatomy, AP of focal origin primarily implicate posterior brain regions and with respect to lobar anatomy most studies found the temporal, parietal, or occipital lobe to be involved [8,22,32,50,66,96]. Some of these authors have either suggested a predominance of temporal lobe involvement [32,47], a predominance of parietal lobe involvement [50,73,74], or no brain localization at all [63]. Menninger-Lerchenthal [73] even speculated on different anatomical substrates for the different AP-phenomena, suggesting that AH originate at the junction of the parietal and occipital lobe (junction of Brodmann's areas 21 and 40), HAS from the angular and supramarginal gyrus (Brodmann's areas 40 and 41), and OBEs from the superior parietal lobule (Brodmann's area 7). These anatomical dissociations have been partly confirmed by Blanke et al. [11] showing that AP might be related to damage to the temporo-parietal junction (TPJ). Unfortunately, the number of analyzed patients in this latter study ($n = 6$) did not allow performance of lesion analysis for each of the three forms of AP. Finally, with regard to predominant hemispheric involvement the reported data are quite divergent. Some authors found no hemispheric predominance for AP [31,32,50,41], while others have suggested a right hemispheric predominance for AP [22,47,73,74].

In conclusion, there is to date no comprehensive review of AP of neurological origin that systematically analyses the phenomenological, neurological, and anatomical findings of each reported patient, whose AP were due to focal brain damage. In addition, previous systematic reviews did not differentiate between AH, HAS, and OBE [32] or only analyzed AH and HAS [31]. In both reports, many cases of psychiatric origin (as done by earlier authors: [50,63]) were included, for which neurological or anatomical information was not available. The aim of the present review is the extension of a systematic approach used by Blanke et al. [11] to a larger number of confirmed neurological cases with OBEs, HAS, and AS by systematically analyzing reported medical AP-cases from the English, German, French, and Italian literature. In the following section we will describe inclusion and exclusion criteria as well as critical phenomenological and clinical variables that we used for a statistical comparison between the three AP. In brief, these variables included sensory hallucinations (visual, auditory, tactile, vestibular), illusory body schema disturbances, visual characteristics of the autoscopic body (lateralization, view, partialness, body position, actions), more complex manifestations (sharing of thoughts, words, or actions, bilocation, emotions) as well as associated neurological signs (hemianopia, aphasia, sensorimotor hemisyndrome), diagnosis, etiology, and neuroanatomical data (hemispheric and lobar localization of brain damage).

3. Methods

3.1. Included cases

We found 113 cases with either AH, HAS, or OBE in the medical literature. From this sample, we included cases with focally circumscribed brain lesions as confirmed by magnetic resonance imaging (MRI), computer tomogram (CT), electroencephalogram (EEG), neurosurgical operation, or neuropathological examination. For subsequent statistical analysis, we kept patients, for whom classification as AH, HAS, or OBE were possible from phenomenonological description that was available [11,22]. For instance, we excluded many previously reported cases, who were actually not AP (see also [11,21,31]), but non-visual body schema disturbances such as the convincing feeling that there is another person close by without actually seeing that person. This phenomenon has been called “leibhafte Bewusstheit” [56], “hallucination du compagnon” [62] or “feeling of a presence” [10,21]). Although the visual reduplication of the own body is critical for a case to be classified as an AP, patients, who did not report visual reduplication, have nevertheless been included in previous case collections of AP (i.e. [23, #JB], [50,77,83], [63, #4], [56, #4–#7]). The latter cases were excluded from analysis. Consequently, we also excluded patients, who described experiential phenomena such as scenic visual hallucinations ([100, #2], [50, #1, #2]) or suffered from neurologically or anatomically unspecified psychiatric illness ([66, #A, #B, #C, #D, #E, #F, #G], [63, #1, #2, #6, #7, #8], [31, #1, #2], [51,57,68,71,72,79,91]). Accordingly, we also excluded cases of AP due to migraine, hysteria, narcolepsy, cataplexy, confuso-oniric states, or of hypnagogic origin as well as AP-cases of non-focal or generalized neurological origin ([50, #78], [32, #3, #5, #7]). A further case of subcortical origin has also been excluded [26]. Two reported cases by Penfield were also excluded due to lack of phenomenological detail [81,82].

3.2. Analyzed variables and statistical analysis

According to these inclusion and exclusion criteria, we retained 41 of the 113 reviewed cases, of whom 11 were OBE-patients, 10 HAS-patients, and 20 AS-patients (Table 1). Each of these 41 cases was evaluated by means of a standard protocol including information about the following AP-variables.

3.2.1. Hallucinations

Presence of visual, vestibular, auditory, or tactile hallucinations (*present, not present*).

Table 1
Included cases

OBE	HAS	AH
Daly (1958, #5) [29]	Hoff (1931) [52]	Nouët (1923) [78]
Lunn (1970, #1) [66]	Williams (1956, #24) [100]	Van Bogaert (1934) [97]
Devinsky et al. (1989, #1) [32]	Penfield and Perot (1963, #42) [83]	Genner (1947) [44]
Devinsky et al. (1989, #2) [32]	Ionasescu (1960, #7) [53]	Hécaen and Ajuriaguerra (1952, #84) [50]
Devinsky et al. (1989, #6) [32]	Lunn (1970, #2) [66]	Dewhurst and Pearson (1955, #2) [33]
Devinsky et al. (1989, #3) [32]	Devinsky et al., (1989, #9) [32]	Dewhurst and Pearson (1955, #3) [33]
Devinsky et al., (1989, #10) [32]	Brugger et al. (1994) [20]	Vizioli and Liberati (1964) [98]
Blanke et al. (2003, #1) [10]	Blanke et al. (2003, #2b) [10]	Ionasescu (1960, #8) [53]
Blanke et al. (2003, #2a) [10]	Blanke et al. (2003, #5) [10]	Lunn (1970, #3) [66]
Blanke et al. (2003, #3) [10]	Brugger et al. (in press) [19]	Maximov (1973) [70]
Maillard et al. (2004, #1) [69]		Lance (1976, #1) [60]
		Salati et al. (1983) [88]
		Kölmel (1985, #6) [59]
		Bhaskaran et al. (1990) [3]
		Dening and Berrios (1994, #3) [31]
		Blanke et al. (2003, #6) [10]
		Maillard et al. (2004, #1) [69]
		Maillard et al. (2004, #2) [69]
		Maillard et al. (2004, #3) [69]
		Zamboni et al. (in press) [104]

The table shows all 41 published patients with either autoscopic hallucinations ($n = 20$), heautoscopy ($n = 10$), or an out-of-body experience ($n = 11$) due to circumscribed brain damage that were included and analyzed in the present study.

3.2.2. Body schema disturbances

The patient noted illusory body modifications such as smaller or larger than usual body parts, displaced or unusual limb positions, limb disconnection, absence of a limb, phantom limbs or supernumerary phantom limbs (*present, not present*).

3.2.3. Associated neurological signs

We searched for the presence of 1) hemianopia, 2) aphasia, and 3) sensorimotor hemisyndrome (*present, not present*).

3.2.4. Lateralization

We analyzed whether the autoscopic body was seen in the central visual field (VF) or lateralized to either the right or left VF (*lateralized VF, central VF*).

3.2.5. Partialness

We noted whether the patient saw only certain parts of the autoscopic body or the entire autoscopic body. We evaluated whether trunk, extremities, neck, and head were seen (*partial, whole*).

3.2.6. Position of the autoscopic body

We noted whether the autoscopic body was in upright (standing or sitting) or supine body position. Note that some patients experienced different body positions of the autoscopic body. Thus, when a patient reported that the AP included both a standing and a lying position, one point was allocated for both criteria.

3.2.7. Position of the physical body

We noted whether the patient's physical body was in upright (standing or sitting) or supine body position. In some patients the AP could occur in several different physical body positions. Thus, when the AP only occurred in one body position one point was allocated, when the AP occurred in both the upright and lying position, one point was allocated to both criteria.

3.2.8. View

We analyzed whether the autoscopic body was seen in front-view (as facing the patient), or either in back-view or in side-view (*front-view, non-front-view*).

3.2.9. Actions

Activities of the autoscopic body were noted such as whether the autoscopic body was moving, or was acting, i.e. running, walking, or jumping (*acting, non-acting*).

3.2.10. Sharing of thoughts, words, actions

We searched for more complex forms of interactions between physical and autoscopic body. For instance, whether the patient (1) experienced to have access to or knowledge of the autoscopic body's thoughts or vice versa (here called sharing of thoughts), (2) and whether the autoscopic body communicated verbally with the patient (here called sharing of words), (3) or whether the autoscopic body's actions mimicked the patient's body or actions or vice versa (here called autoscopic echopraxia or sharing of action), (*sharing, non-sharing*).

3.2.11. Bilocation

We noted whether the patient had the impression of being at two or more locations at the same time or in rapid alternation during the AP (*present, non-present*).

3.2.12. Emotions

We analyzed the presence of emotions during the AP *(positive or neutral, negative)*. We noted that emotions could change during a single AP allocating in these instances more than one emotion.

3.2.13. Reality

We noted whether the AP was experienced as real or not (*real, non-real*).

3.2.14. Diagnosis

The diagnosis of the AP was noted.

3.2.15. Etiology

The etiology of the AP was noted.

3.2.16. Lesion side

We analyzed patients with unilateral lesions, i.e., for whom the lesion could either be located to the left or right hemisphere (right hemisphere, left hemisphere) (*present, not present*). Patients with bilateral lesions were excluded for the analysis of this variable.

3.2.17. Lesion site

Localization of the lesion to the temporal, parietal, occipital, or frontal lobe (temporal, parietal, occipital, frontal) was marked. Note that patients with a temporo-parietal lesion, for instance, were allotted to both the temporal and parietal group (*present, not present*).

3.3. Statistical analysis

It was not possible to determine each variable in all patients. Accordingly, we included for the statistical analysis of each variable only the number of patients, for whom sufficient information for that variable was provided. Consequently, the total number of cases for each variable varied with respect to the grand total number of cases that were included for AH (20), HAS (10), and OBE (11; see Table 2).

To account for systematic differences between the three AP groups, we performed frequency comparisons (see also [31]) using Yates' corrected Chi-Square tests. This procedure is an improved approximation of the Chi-square statistic in small frequency tables. It reduces the absolute value of differences between expected and observed frequencies by 0.5 before squaring. This correction, which makes the estimation more conservative, is usually applied when the table contains only small observed frequencies, so that some expected frequencies become less than 10, as is the case in the present study. Moreover, the present study aims to elucidate testable hypothesis about AP, in particular regarding the distinction between the three AP groups, thus, we did not use Bonferroni-corrections given its exploratory nature, but by searching for important features, which could be tested in future studies.

4. Results

Frequencies and percentages of analyzed patients regarding the different variables are presented in Table 2. The number of patients with respect to the total patient

Table 2
Results of the statistical analysis

	AS	HAS	OBE	Yates(chi-square)	*P*-value
Visual hall. (yes)	14/20 (70.0)	3/10 (30.0)	3/11 (27.3)	7.27	0.03
Vestib hall. (yes)	4/20 (20.0)	6/10 (60.0)	6/11 (54.6)	6.21	0.04
Audit hall. (yes)	1/20 (5.0)	2/10 (20.0)	6/11 (54.6)	10.05	0.007
Tact hall. (yes)	4/20 (20.0)	2/10 (20.0)	1/11 (9.1)	0.75	0.69
Body schema (yes)	2/20 (10.0)	4/10 (40.0)	5/11 (45.5)	6.07	0.048
Hemianopia (yes)	11/20 (55.0)	1/10 (10.0)	0/11 (0.0)	15.04	0.0004
Hemi-syndrome (yes)	6/20 (30.0)	4/10 (40.0)	1/11 (9.1)	3.09	0.21
Aphasia (yes)	3/20 (15.0)	3/10 (30.0)	1/11 (9.1)	1.65	0.44
Lateralization (yes)	10/20 (50.0)	3/9 (33.3)	1/10 (10.0)	5.24	0.07
Partial (yes)	9/18 (50.0)	2/10 (20.0)	2/11 (18.2)	4.26	0.12
Autoscopic body-standing/sitting (yes)	14/15 (93.3)	8/9 (88.9)	3/9 (33.3)	11.47	0.003
Autoscopic body-lying (yes)	3/15 (20.0)	2/9 (22.2)	8/9 (88.9)	13.43	0.001
Physical body-standing/sitting (yes)	7/8 (87.5)	7/8 (87.5)	3/7 (42.9)	4.79	0.09
Physical body-lying (yes)	3/8 (37.5)	3/8 (37.5)	6/7 (85.7)	4.93	0.09
View (front)	20/20 (100)	1/9 (11.1)	9/10 (90.0)	29.36	<0.0001
Action (yes)	5/17 (29.4)	8/10 (80.0)	1/9 (11.1)	11.23	0.004
Sharing (yes)	3/14 (21.4)	5/7 (71.4)	1/9 (11.1)	7.45	0.02
Bilocation (yes)	0/20 (0.0)	5/10 (50.0)	0/11 (0.0)	16.54	0.0003
Emotion-pos./neut. (yes)	4/9 (44.4)	1/9 (11.1)	5/10 (50.0)	3.99	0.14
Emotion-neg. (yes)	7/9 (77.8)	9/9 (100.0)	9/10 (90.0)	3.03	0.22
Reality (yes)	3/15 (20.0)	8/8 (100.0)	10/10 (100.0)	28.25	<0.0001
Left hemisphere (yes)	5/19 (26.3)	6/9 (66.7)	2/9 (22.2)	5.08	0.08
Right hemisphere (yes)	11/19 (57.9)	3/9 (33.3)	6/9 (66.7)	2.27	0.32
Temporal lobe (yes)	11/20 (55.0)	8/10 (80.0)	9/11 (81.8)	3.26	0.19
Parietal lobe (yes)	11/20 (55.0)	5/10 (50.0)	5/11 (45.5)	0.27	0.88
Occipital lobe (yes)	12/20 (60.0)	2/10 (20.0)	2/11 (18.2)	7.49	0.02

The table summarizes the results of statistical analysis with respect to the 17 variables. The number (*n*/all patients) of patients per group (autoscopic hallucinations, AH; out-of-body experience, OBE; heautoscopy, HAS) for the different variables is given. Percent values are provided in brackets. Yates' corrected Chi-square values, as well as P-values are presented.

population (n/total) of statistical comparison is also given. In Table 2, we also provide the Yates' corrected Chi-square comparisons (df = 2) including p-values. Percentages of patients are provided in brackets. The main results of statistical analysis are described in the following section (see Table 2 for numerical values).

4.1. Hallucinations

Tactile hallucinations are uncommon in all AP. Visual hallucinations were comparatively frequent in AH, while vestibular hallucinations were comparatively frequent in HAS and OBE (Fig. 2).

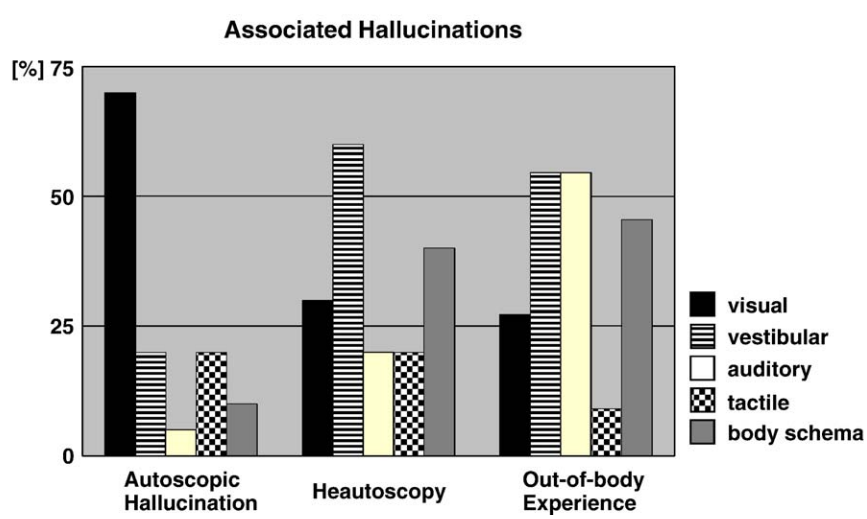

Fig. 2. Hallucinations associated with autoscopic phenomena. The frequency of hallucinations associated with AH (left), HAS (middle), and OBE (right) is given. Visual, vestibular, auditory, tactile hallucinations, and body schema disturbances are indicated. Note the predominance of visual hallucinations in AH, vestibular hallucinations in HAS and vestibular and auditory hallucinations in OBE. In addition, body schema disturbances occurred frequently in HAS and OBE (see text).

4.2. Body schema disturbances

Such disturbances appear more frequent in HAS and OBE, while they are almost absent in AH (Fig. 2).

4.3. Associated neurological signs

Whereas hemianopia was more frequent in AH, it was absent in OBE, and rare in HAS. Sensorimotor syndromes and aphasia were equally rare in all APs.

4.4. Lateralization

In AH, the autoscopic body tended to be more often perceived in the lateral visual fields as compared to the HAS and OBE.

4.5. Partialness

Although a partial autoscopic body was numerically more frequent in AH as compared to HAS and OBE, this difference was not significant. Thus, in either AP, the whole body was more often perceived than only part of the body.

4.6. Position of the autoscopic body

In AH and HAS, the dominant body position was standing or sitting if compared with OBE. For OBE, only about 30% of the patients were in a standing or sitting position. On the other hand, a lying position was dominantly perceived during OBE and only rarely present in AS and HAS.

4.7. Position of the physical body

In AS and HAS, more than 80% of the patients were in a standing or sitting position during the AP. Albeit the comparison only reaching statistical trend level, only about 40% of OBE patients were in a standing or sitting position. The lying position, on the other hand, appears (statistical trend) to be more specific to OBE (more than 80% of patients) than to AS or to HAS (less than 50% of patients).

4.8. View

The autoscopic body was always seen in the front-view in AH and almost always in OBE, but rarely in HAS.

4.9. Actions

Activities of the autoscopic body appear to be specific to HAS (80% of patients), rather uncommon in AH, and almost absent in OBE.

4.10. Sharing of thoughts, words, actions

These phenomena appear to be specific for the HAS group (71%) and were rather rare in AH and OBE.

4.11. Bilocation

This experience is frequently present in HAS, but never in AH and OBE.

4.12. Emotions

Negative emotions are frequent during all AP. Positive and neutral emotional experiences were especially rare in HAS.

4.13. Reality

Whereas OBE and HAS are experienced as highly realistic, AH are experienced as relatively unreal.

4.14. Diagnosis

The main diagnosis for all three forms of AP was epileptic seizure; 14 of 20 patients in AS (70%), 8 of 10 patients in HAS (80%), and 9 of 11 patients in OBE (82%).

4.15. Etiology

Etiologies varied and included idiopathic epilepsy, posttraumatic epilepsy, vascular stroke, neoplasia, dysembryoblastic neuroepithelial tumor, and arteriovenous malformation without any etiology being overrepresented in any of the types of AP.

4.16. Lesion side

The comparisons for the left hemisphere reached statistical trend level suggesting that left hemisphere lesions are relatively common in HAS (>50%), but not in AH or OBE. The comparison for the right hemisphere was not significant (however, when the numerical values are considered, it appears that right hemisphere lesions are more common in AS and OBE; Fig. 3).

4.17. Lesion site

Temporal lesions were present in 55–82% of the patients, while parietal lesions were somewhat less frequent (in approximately 50% of the patients in each group). Occipital lesions, on the other hand, were more common in AH (60%) and relatively uncommon in both HAS and OBE (Fig. 3).

5. Discussion

Our findings show that OBE, HAS, and AH are characterized by different patterns of associated hallucinations and neurological deficits. Vestibular hallucinations and body schema disturbances, as well as the absence of

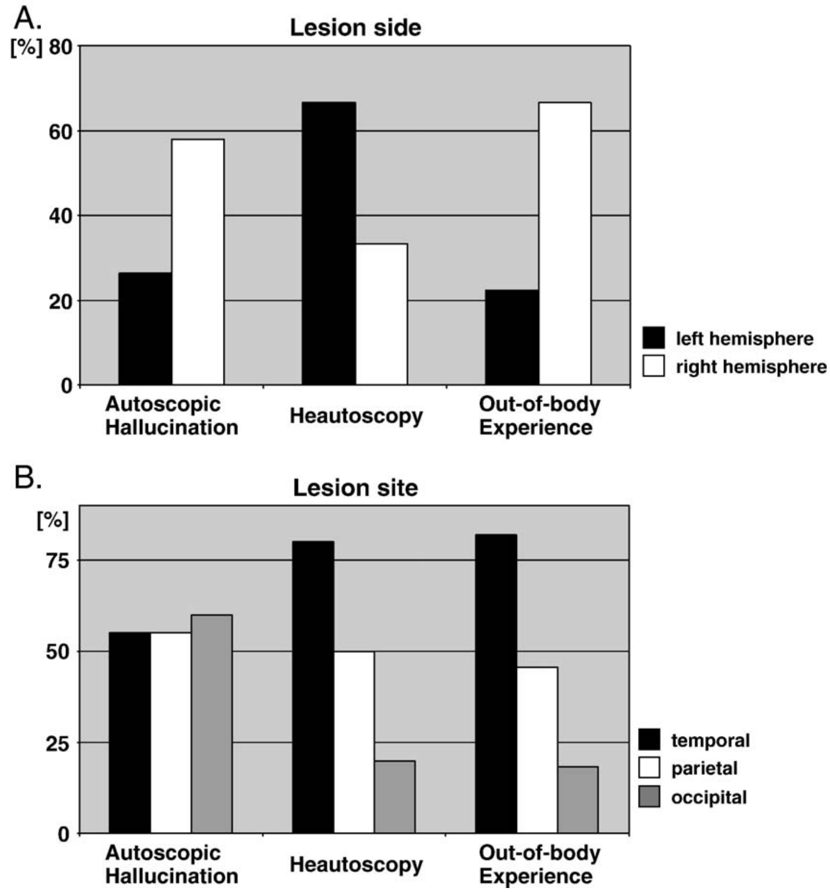

Fig. 3. Anatomy of autoscopic phenomena. Panel A: shows the frequency of left (black columns) and right (white columns) hemispheric brain lesions that were observed in AH (left), HAS (middle), and OBE (right). Our analysis revealed a right hemispheric predominance in OBE-patients (66.7%) and AH-patients (56.6%) and a left hemispheric predominance in HAS-patients (71.4%). Note that the percentages for bilateral cases are not included in this figure. Panel B: plots the frequency of lobar involvement independent of hemisphere in AH (left), HAS (middle), and OBE (right). Percentages are given for the temporal (black), parietal (white), and occipital lobe involvement (grey). In all three forms of AP temporal lobe involvement predominated. In AH-patients, occipital lobe involvement was significantly more frequently (55.6% with respect to 12.5% (HAS) and 18.2% (OBE)).

hemianopia were associated with OBEs and HAS. Yet, lateralized visual hallucinations and hemianopia without vestibular hallucinations and body schema disturbances were associated with AH. Auditory hallucinations were mainly observed in patients with OBEs. Tactile hallucinations, aphasia, and sensorimotor deficits were infrequent in all AP. In addition, the visual hallucinations of AH-patients were significantly lateralized to the side of hemianopia. Based on this pattern of associated hallucinations and neurological deficits, it is possible to differentiate the pseudohallucinatory, mainly visual AHs from both OBE and HAS. The present differentiations confirm earlier case descriptions of AH as a visual or “specular” hallucination or pseudohallucination [40,76]. The present analysis also provides evidence for a vestibular and body schema pathology not for all AP in general, but specifically for HAS and OBEs. Although such has been suggested previously, the patient samples from these prior reports were small, included neurological patients without verified brain damage, psychiatric patients, without statistical comparisons [11,22,73,74]. Our study does have important limitations. The data were gathered retrospectively, from a range of sources, with variable amounts of information. The analysis therefore had to content with missing data. Given the nature of the data, statistical techniques have been used at the limits of their legitimacy.

In the following we will discuss additional characteristics of the autoscopic body that allow to differentiate AH from HAS and OBEs. Although, several authors have reported that AH-, and HAS-patients often only see the autoscopic body partially ([44,70,78]; for discussion see [18]) and that OBE-patients generally see their entire body [4,11,52], partialness of the autoscopic body was generally infrequent in the present patient sample and appeared to be unrelated to any particular form of AP. Yet, 88% of the patients who saw the autoscopic body partially were AH- (63%) or HAS-patients (25%). In addition, all of these latter patients experienced seeing only the upper body of the autoscopic body, while some OBE patients also saw their lower body [9]. In fact, when we analyzed only the patients who saw their body partially, 71% of the AH patients (5 out of 7), 29% of the HAS patients (2 out of 7), and none of the OBE patients (0 out of 7) experienced seeing their upper body partially (Chi-square = 9.98, P = 0.007). A partially seen upper autoscopic body in these AH- and HAS-patients included head, neck, and upper trunk. Arms were often missing. Legs and lower trunk were always missing. With respect to the position of the autoscopic body in the visual field, we found that the position of the autoscopic body was frequently lateralized to the side of visual hallucinations and hemianopia in AH [21], whereas the autoscopic body in HAS and OBE tended to be seen more frequently in the central visual field (see Table 2). Our analysis thus did not confirm earlier observations by Green [45] and Brugger et al. [21] who observed the frequent lateralization of the autoscopic body also for OBEs. This might be due to several reasons. Green [45] carried out her study in healthy subjects and we only investigated neurological patients with confirmed brain damage that was mostly unilateral. As Brugger et al. [21] included psychiatric and neurological patients, and also included neurological patients with non-focal brain damage as well as neurological patients without confirmed brain damage differences in patient selection might explain the phenomenological differences between the different studies. Another interesting phenomenological characteristic is our observation that the autoscopic body is seen as standing or sitting in AH and HAS, whereas it is in supine position in OBEs [11]. This grouping tended to be also found for the actual body position of the patient prior to the AP suggesting that the position in which the patient experiences seeing the autoscopic body directly reflects the patient's own body position prior to and during OBE, HAS, and AH. A supine body position was also found by Green [45] in 75% of her OBE-subjects and, interestingly, most techniques that are used to voluntarily induce OBEs propose that subjects use a supine and relaxed position [4,54]. On the contrary, the mainly upright body position in AH- and HAS-patients of the present study confirms results by Dening and Berrios [31], who reviewed a large number of AH- and HAS-patients. These data suggest that at least partially due to the patient's different body positions, pathological proprioceptive and tactile processing and its pathological integration with other modalities (visual and vestibular) differ for the different forms of AP.

Whereas the above described variables allow to differentiate AH from HAS and OBE, our analysis suggests that the following five phenomenological characteristics of the autoscopic body allow to distinguish OBE and HAS. First, whereas OBE- and AH-patients experience to see the autoscopic body in front-view, HAS often see the autoscopic body in side- or back-views. Ionacescu's patient [53, #7], who was a hairdresser experienced rotating around his customer (while cutting his hair) and then saw his autoscopic body from the side. Blanke et al.'s patient [11, #2b] saw herself from behind as did Devinsky et al.'s patient [32, #9]. Brugger et al. [20] describe a patient who saw the autoscopic body in many different views. Second, this variability of views of the autoscopic body in HAS is also reflected in the motor actions that the latter is experienced to perform. Thus, HAS-patients report that the autoscopic body walks, runs, sits down, even shouts at the patient, and beats him with his fists (for the very vivid description of a patient's experience see [20]). On the contrary, the autsocopic body during OBE and AS does not move or act. Third, HAS is often associated with the experience of sharing of thoughts, words, or actions (71%), which are less frequent in OBE- (11%) and AH-patients (21%). Thus, HAS-patients experienced to hear the autoscopic body talk to them [20] or that both bodies communicated by thought [11, #5]. Others stated that the autoscopic body is performing the actions they were supposed to do [32, #9] or fights with other people that could be of potential danger to the patient [11, #5]. Fourth, whereas the visuo-spatial perspective was unambiguously localized and experienced as unitary by all AH- and OBE-patients (as was used to classify both phenomena), HAS-patients frequently experienced seeing from several different visuo-spatial perspectives [18,11]. Thus, patients 2b, 4, and 5 of Blanke et al. [11] experienced to see from two different physical positions as did Brugger et al.'s patient [20]. Finally, HAS-patients frequently reported to "be split into two parts or selfs" or as if "I were two persons" [80]. Others reported that they were localized at two places at the same time (bilocation; [11, #2b and 5]). In Brugger et al.'s patient [20] bilocation occurred in rapid succession between the autoscopic and physical body and Lunn's patient [66] describes himself (during HAS) as a "split personality". The latter five variables of the autoscopic double (1, views; 2, actions; 3, sharing of thoughts, words, or actions; 4, multiple visuo-spatial perspectives; 5, bilocation or splitting of the self) were all associated with HAS. Thus, although OBE and HAS share many associated hallucinations and some aspects of the autoscopic body, they significantly differ in these latter five, more complex, variables suggesting that they are caused by different central mechanisms.

With respect to lesion side, our data analysis suggests that all three AP may be due to either right or left hemispheric brain lesions. Yet, we also found differences with respect to primarily involved hemisphere and brain region. OBEs (67%) were mostly due to right hemispheric brain damage, whereas more frequent left hemispheric brain damage was found for HAS-patients (67%). The fact that previous studies have analyzed the lesion location for all AP together, might thus explain why some authors reported no hemispheric predominance [32,31,41,50]. Our data would point to a right hemispheric predominance for AH and OBE as suggested only for AH by previous authors [22,47,73,74]. The predominant involvement of the left hemisphere in HAS as found by the present data has not been suggested previously. Regarding the lesion site of AP our data statistically corroborate older literature [31,32,47] in finding a high predominance of temporal lobe involvement in all APs (55–82%; Table 2). The parietal lobe was also found frequently and was equally often involved in all forms of AP (45–55%; Table 2). Only AH-patients had significantly more often involvement of the occipital lobe. This observation is concordant with the above described association with visual hallucinations and hemianopia as already suggested previously based on the fact of frequent bright coloring of the autoscopic body in AH that contrasted with the colorless, pale, and misty appearance of the autoscopic body in HAS [22]. Based on this we suggest that patients with AH might have more posterior brain damage in occipito-parietal and occipito-temporal cortex with less involvement of the TPJ, whereas patients with HAS and OBE have less occipital involvement and more temporo-parietal lesions including the TPJ (see below). To summarize our anatomical findings, AH seem to primarily involve the right temporo-occipital and right parieto-occipital junction, whereas HAS involve the left TPJ and OBEs the right TPJ.

5.1. Multi-sensory disintegration in body and self processing

The present analysis allows to propose a distinct phenomenology and anatomy for each AP. In addition, the present data are in accordance with the proposition that AP, at the dysfunctional level, result from multisensory disintegration. Thus, Blanke et al. [11] proposed that AP result from a disintegration in personal space (due to conflicting tactil, proprioceptive, kinesthetic, and visual information) and a second disintegration between personal and extrapersonal space (due to conflicting visual and vestibular information). These authors proposed that, while disintegration in personal space was present in all three forms of AP, differences between the different forms of AP were mainly due to differences in strength and type of the vestibular dysfunction. Thus, Blanke et al. [11] suggested that OBEs were associated with a strong vestibular disturbance, whereas HAS were associated with a moderate and more variable vestibular disturbance and AH only by a mild or even absent vestibular disturbance. The present phenomenological, neurological, and anatomical analysis confirms the importance of a vestibular dysfunction and body schema disturbance in HAS and OBE and suggests that a vestibular dysfunction is absent or only weakly present in AH. Moreover, the high frequency of visual hallucinations and of hemianopia in AH suggests that deficient visual processing rather than vestibular processing is the main causing factor for disintegration in personal space and/or extrapersonal space in AH. Nevertheless, the frequent parietal lobe involvement does not exclude a weaker interference with vestibular processing that is not experienced in form of abnormal vestibular sensations. This is also in agreement with the anatomical findings in the present study showing that AH-patients have significantly more occipital lobe involvement as compared to HAS- or OBE-patients.

The phenomenological differences between HAS and OBE suggest that they rely on different neurocognitive mechanisms. These more complex phenomenological differences were found despite the highly similar sensory hallucinations and neurological deficits that were associated with HAS and OBE. Thus in contrast to OBEs, HAS were associated with the presence of many different views of the autoscopic body, many actions, the sharing of thoughts, words, and agency, multiple visuo-spatial perspectives, and bilocation of the self. We therefore suggest, that the association of greater phenomenological variability of the autoscopic body (with respect to views and actions) with the increased frequency of shared thoughts, voices, and agency between autoscopic and (the patient's) physical body (i.e. echopraxia) might be due to a greater (or more variable) implication of abnormal kinesthetic/proprioceptive information processing in HAS. This is contrasted in OBE by the silent and static autoscopic body, the disembodiment, the 180° inversion and the elevated and distanced visuo-spatial perspective of the observer (with respect to the extracorporeal environment) that are probably related to vestibular disturbances [11]. Thus, it seems to the subject with an OBE that (1) his body position and visuo-spatial perspective is distanced (about 2–3 meters) and rotated (by 180°) with respect to the actual physical position (Fig. 1). In addition, during HAS, the sharing of thoughts, voices, and agency might make it difficult for the patient to decide where the physical agent ("the thinking, speaking, and acting person"; [30,43] is localized: Am I in the physical body or in the autoscopic body?). These difficulties of the HAS-patient are increased by two visuo-spatial perspectives that either alternate or are simultaneously present between autoscopic and physical body. This situation makes it almost impossible for the HAS-patient to decide where the observing self is localized and might lead to the experience of two "observing" selfs [11, #2B]. It might thus be argued that, HAS is not only an experience characterized by the reduplification of one's *body*, but also by a reduplification of one's *self*. As strikingly reported by Brugger et al. [20] the high risk of suicide during this terrifying experience cannot be overstated as some of these HAS-patients try by all means to reestablish their unitary self. On an affective level of the experience, these differences between HAS and OBEs are also reinforced by the absence of positive emotions in HAS which are quite common in OBEs, as well as differences in the underlying anatomy in HAS and OBEs (see below).

5.2. Body and self processing at the temporo-parietal junction

The above model of AP has been based on phenomenological, neurological, and anatomical findings in neurological patients with AH, HAS, and OBE. It is hoped that these clinical findings and the above described model may help to demystify AP and facilitate a formulation of precise research hypotheses about the sensory and cognitive underpinnings. In the following section, we review neuroimaging studies that have investigated the role of the TPJ in several aspects of processing with respect to corporeal awareness and self consciousness and link these results to illusionary body and self experiences such as AP.

Neuroimaging studies support the role of the TPJ in vestibular processing, multisensory integration as well as the perception of human bodies or body parts [8]. The core region of the human vestibular cortex [16,39,65] is situated at the TPJ including the posterior insula. Brain damage in this area has been associated with graviceptive vestibular sensations and dysfunctions [15,95]. Several neuropsychological and neuroimaging studies suggest the implication of the TPJ and cortical areas along the intraparietal sulcus in combining tactile, proprioceptive, and visual information in a coordinated reference frame [17,24]. Interestingly, Leube et al. [61] have shown that the TPJ codes multisensory conflict or disintegration between visual and proprioceptive information about one's arm position. Thus, the presence of vestibular and multisensory processing at the lesion site in patients with HAS and OBEs is concordant with the above proposed model of a double disintegration at the TPJ in AP. Neuroimaging studies also support the role of the TPJ in processes of visual perception that can be directly linked to AP. Thus, the TPJ was found to be involved in the perception of several visual aspects of the human body such as the perception of body parts [13], of the entire body (in the extrastriate body area [1,34], and of biological motion [2,46]. Importantly, Astafiev et al. [1] have shown that activity in the extrastriate body area is not only modulated in a selective fashion by pictures of human bodies or body parts, but also by modifications of a subject's own limb position suggesting their role in multisensory own body perception and integration. Moreover, mental imagery with respect to one's own body [5,27,55,64] has recently been shown to activate the TPJ [12,102]. This activation was dissociated from activation due to the mental imagery of extrapersonal objects [12,103] and was shown to correlate with phenomenological variables of AP such as illusory self dislocation and visuo-spatial perspective [12]. In addition, Blanke et al. [12] demonstrated that transcranial magnetic stimulation over the TPJ interrupted mental imagery with respect to one's own body but not other objects. In summary, these data show that in addition to processing at the multisensory level, several areas that are implicated in the visual and cognitive analysis of the entire body of others and of oneself are located at the TPJ.

Finally, the TPJ has also been involved in functions of self processing such as egocentric visuo-spatial perspective taking, agency (the feeling of being the agent of one's actions and thoughts), as well as self-other distinction (the capacity by which one distinguishes between oneself and other conspecifics). For instance, the TPJ is the classical lesion site in patients with visuo-spatial neglect [49], a clinical condition, which has been shown to disturb the patient's egocentric spatial relationship with extrapersonal space and visuo-spatial perspective taking. Neuroimaging studies in healthy observers have also revealed activation of the TPJ during egocentric visuo-spatial perspective changes in healthy subjects [85,99]. The pathological visuo-spatial perspectives in OBEs and HAS might thus be related to the functional systems at the TPJ that are involved in the constant updating and calculation of one's visuo-spatial perspective. Our observation that no visuo-spatial perspective changes are reported by subjects with AH might accordingly be due to the fact that there is less or no TPJ involvement. Another role of the TPJ for mental activities such as agency [25,37,38] and self-other distinction [30] was reported from neuroimaging studies. Discussing OBEs from a philosophical point of view, Metzinger [75] has argued that during OBEs the sense of agency is pathological as the feeling of being the agent of one's actions and thoughts is not localized at the position of the physical body, but at the location where the disembodied self is experienced to be. The present analysis suggests that agency is not only pathological in OBEs, but also during HAS, whereas it is normal and body-centered in AH. Although the capacity by which one distinguishes between oneself and other conspecifics might be considered to be unaffected in patients with AP, we argue that this is not the case: In AH the subject experiences seeing from one's habitual (first person) perspective an image of one*self* in the position of an*other* person (as an autoscopic body or double). In OBEs, the body of one*self* is seen as if from a position of an*other* person's (third person) perspective. In HAS, subjects either alternate between or simultaneously experience seeing their body from first- and third person perspectives. It is important to acknowledge that many other cortical areas such as prefrontal cortex, anterior cingulate, postcentral gyrus, precuneus, occipito-temporal junction, insula, and superior parietal lobule [2,30,46,59,84,100] have been shown to play an important role in self processing (as would have been expected for such a complex phenomenon). Yet, the confrontation of the present clinical data on AP (and thus disorders of corporeal awareness and self consciousness) with the reviewed neuroimaging data on body and self processing highlights the role of the TPJ and corroborates previous evidence that the TPJ is a key neural locus for self processing.

6. Conclusion

Based on the reviewed findings we propose a neurocognitive model for each of the three forms of AP that extends previous models [11,18]. We suggest that OBEs are related to pathological activity patterns that are primarily localized at the right TPJ. This would be concordant with the frequent vestibular and body schema disturbances in OBE-patients as well as the absence of visual hallucinations and visual deficits. Deficits in self processing (as defined above) are important in OBEs and also support the implication of the TPJ. Although a double is seen (as in AH) the primary sensation of the OBE-patient is that of being disembodied and of the self being displaced to a position in extrapersonal space. It is from this third-person perspective (or better alter ego perspective [18]) from which the OBE-patient experiences to see. The fact that the present lesion analysis suggests a predominant implication of the right hemisphere in OBE-patients (Table 2), that third person (as compared to first person) perspective taking in healthy subjects activates the right more than the left TPJ [85], and that pathological egocentric perspective taking is also linked to the right TPJ [49] is in agreement with our model.

With respect to HAS, we suggest that they are related to pathological activity patterns that are primarily localized at the left TPJ. This would account for the frequent vestibular and body schema disturbances in OBE-patients as well as the absence of visual hallucinations and visual deficits. Deficits in self processing are important in HAS and support the implication of the TPJ. As in all AP a double is seen. Yet, the primary sensation of the HAS-patients is not of seeing a double in extrapersonal space (AH) or of being disembodied (OBE), but of not knowing where the self is. The patient experiences seeing from multiple visuo-spatial perspectives, and often of being split into two selfs (bilocation and reduplification of one's self). The fact that the present lesion analysis suggests a predominant implication of the left hemisphere in HAS-patients (Table 2) and that first person (as compared to third person) perspective taking in healthy subjects activate the left more than the right TPJ [85] is in agreement with this model. Alternatively, based on the instable visuo-spatial perspective an instable or variable implication of both TPJs also seems possible as well as the additional implication of brain structures outside the TPJ that are involved in kinesthetic, proprioceptive, or motor processing. Finally, the association of echopraxia and shared speech and thoughts in HAS-patients may be related to similar mechanisms as pathological agency of movements and speech in psychiatric subjects [6,42].

We suggest that AH relate to pathological activity patterns distinct from the TPJ. These may be primarily localized in the extrastriate body area [1,34] or its vicinity of either hemisphere and thus at the occipito-temporal junction. This would account for the pseudohallucinatory visual character of the autoscopic body in AH as well as the associated visual hallucinations and hemianopia due to extrastriate (or occipito-temporal) interference (Table 2). This would also agree with the frequent lateralization of the autoscopic body and other visual hallucinations to the contralesional hemifield. Following this model, AH do not primarily impair the TPJ and deficits in self processing (agency, visuo-spatial perspective, self-other distinction) are thus absent or only minor.

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