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MSc in Psychology, Neuroscience and Human Sciences**



**UNIVERSITÀ
DI PAVIA**



IUSS

A SHARED DEFINITION OF SOMATOPARAPHRENIA: A SCOPING REVIEW OF THE MISDIAGNOSIS OF SOMATOPARAPHRENIA AND A STATEMENT OF CLEAR DIAGNOSTIC PARAMETERS

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Academic year 2023/2024

*A mia madre Laura,
mi hai insegnato a volere il meglio dalla vita ma a sentirmi sempre più che abbastanza.*

*A mio padre,
sei stato il mio primo professore e rimani ad oggi il mio preferito.*

*A mio fratello,
vivi la vita pienamente e coraggiosamente, spero riuscirò presto a ad imparare da te.*

Index

ABSTRACT.....	05
Chapter 1- INTRODUCTION AND BACKGROUND.....	06
1.1 DISORDERS OF BODILY AWARENESS.....	08
1.1.1 Anosognosia	09
1.1.2 Asomatognosia.....	10
1.2. SOMATOPARAPHRENIA.....	11
1.2.1 Somatoparaphrenia; History.....	11
1.2.3 Somatoparaphrenia; Neuroanatomical Correlates.....	12
1.2.4 Somatoparaphrenia; Diagnostic Complications.....	13
Chapter 2 -SCOPING REVIEW STRUCTURE.....	15
2.1 Aim of the Scoping Review.....	15
2.2 Scoping Review Objectives.....	15
2.3 Scoping Review Questions.....	16
Chapter 3- METHODS.....	17
3.1 Information Sources and Search Strategy.....	17
3.2 Eligibility Criteria.....	17
Chapter 4- RESULTS.....	18
4.1 Data selection and collection.....	19
Chapter 5- DISCUSSION.....	101
5.1 MISDIAGNOSIS.....	101
5.1.1 Somatoparaphrenia and Misdiagnosis.....	101
5.1.2 Disorders misdiagnosed as Somatoparaphrenia.....	102
5.1.3 Insights on the Misdiagnosis Present in the Articles Selected for the Scoping Review.....	105

5.2 Previous Literature on the Topic of Somatoparaphrenia.....	106
5.3 An Overview of the Patients in the Scoping Review.....	108
5.4 Deficits Associated with Somatoparaphrenia.....	108
5.5 Somatoparaphrenia: A Shared Definition.....	110
5.6 Crossed somatoparaphrenia.....	111
5.7 Somatoparaphrenia on a Continuum.....	112
6.0 LIMITATIONS.....	114
6.1 FUTURE DIRECTIONS.....	114
6.2 CONCLUSIONS.....	115
6.3 SIGNIFICANCE STATEMENT.....	115
REFERENCES.....	117

ABSTRACT

Background: Somatoparaphrenia (SP) is a neuropsychological condition, mainly observed in brain-damaged patients, characterized by the delusional belief about the patient's body, that the contralesional limbs belong to someone else. The key feature of SP is, therefore, the presence of an ownership misattribution of the denied limbs. The present scoping review aims to give a proper definition and specific diagnostic criteria for SP, which, due to its nature, has been subjected to many misdiagnoses throughout history and in literature. Moreover, the deficits connected to the disorder are identified in the review, and a discussion on a theoretical categorization of SP is opened.

Methods: The studies in the scoping review were selected by searching keywords in the PubMed portal. The studies included in the review had to be case studies, case reports, or review articles. To meet the inclusion criteria, at least one patient/case study, a disorder label/diagnosis, and a description of the patient's symptoms/ direct transcript of the patient disturb description were needed.

Results: The review included 40 articles, 23 of which contained misdiagnoses. The patient sample consisted of 153 individuals: 42 were correctly diagnosed with SP, 55 were misdiagnosed, and the remaining 56 were diagnosed with other disorders of bodily awareness. The most common misdiagnosis was Delusional misidentification, and the most common deficit was extrapersonal neglect.

Conclusions: The present scoping review contains a new and more unified view of SP. It offers more detailed criteria for a precise diagnosis of SP, defining the main characteristics unique to this disorder. Identifying the deficits connected to SP is relevant to understanding the severity of the illness. Finally, the reasoning behind the idea of the disorders of bodily awareness being placed on a continuum, and among these disorders, if SP itself can belong to said continuum, could have great diagnostic significance.

Chapter 1- INTRODUCTION AND BACKGROUND

The present scoping review will open a discussion on the theme of somatoparaphrenia (SP), a condition characterized by a disturbance in the sense of body ownership, in other words, a disruption of the sensation that our body belongs to us. SP has more elements that distinguish it from other conditions. Still, starting from understanding the meaning of body ownership and its unhealthy manifestation, the disturbed sensation of body ownership (DSO) will help insert SP into a theoretical framework to facilitate global comprehension.

The feeling of body ownership, a constant in the life of a (healthy) human, can be defined as the sensation that a given body part belongs to us. It is often underthought or taken for granted because it is a fundamental aspect of the neural representation of the body and an essential and implicit determinant of any current sensory or motor event. (Romano et al., 2015).

Problems start to arise when this “fundamental aspect” is disrupted, creating disorders that are, by nature, intertwined with the sensation of body ownership.

The sense of body ownership involves many aspects of our cognitive system. Some examples are vision, touch, proprioception, and efferent copies of motor plans, which tend to converge and determine the location of the parts of the body. Naturally, a disturbance involving such essential aspects could drastically affect the healthy belief of ownership toward the body (Tsakiris, 2010; Botvinick & Cohen, 1998; Tsakiris et al., 2006).

Important clues also derive from the study of body ownership in healthy individuals; the data derived from a paradigm developed to temporarily disrupt their body ownership, developed, controlled, and executed in a clinical setting. According to the experiment, if a “mismatch between two or more sensory modalities is artificially introduced, several phenomena of a disturbed body representation also emerge in healthy people, typically together with a misperception of body location” (Romano & Maravita, 2019). The results confirm the hypothesis that a mismatch in sensory modalities can lead to a disturbed sensation of body

ownership, resulting in complications concerning the sense of body location in the space.

In literature, the idea of perception of our body is defined as a coherent blend of numerous sensory impressions; moreover, this “multisensory perception” of one’s own body is thought to derive from a multisensory integration, i.e., various sources of sensory information (e.g., vision, touch, proprioception) are merged to give a coherent experience of the body. The body must be perceived as distinct from the surrounding environment. (Crucianelli et al.,2024). So again (as in 2019), we find vision, touch, perception, and their combination as the pivotal element of the sense of body ownership.

Subsequently, the study will focus on pointing out the neuroanatomical correlation of the sense of body ownership, gaining a deeper understanding of the neural basis implicated, and allowing a causal correlation between damage and effect.

Among all the brain areas, the main ones involved in the sense of body ownership seem to be the cerebellum, the putamen, the amygdala, the thalamus, and the hippocampus.

In neuroimaging studies, the cerebellum was one of the first subcortical areas observed in the sense of body ownership study. It appears to be connected to the detection of multisensory synchrony, multisensory recalibration, and prediction error.

The cerebellum's role is crucial because of its tight connection with multisensory perception, which is essential for generating a sense of body ownership and representing the space near one’s body. The putamen seems to be determinant in the peripersonal space, which is "the multisensory representation of space surrounding the body”.

The amygdala seems to be involved in emotional defense reactions related to body ownership, while the thalamus is implicated in the control of cross-modal attention. Finally, the hippocampus, already known for its close connection to memory systems, is related to “bodily self-location and bodily self in memory”.

In conclusion, disturbances in bodily awareness can be crucial to better understanding the

processes responsible for developing the sense of body ownership (Crucianelli et al., 2024).

The question that spontaneously arises is: What happens after brain damage occurs and disrupts the areas responsible for body awareness? The answer is that damage to the brain can drastically disrupt the sense of body ownership, resulting in disorders of self-awareness. This would inevitably lead to different symptoms, among which “the most striking is somatoparaphrenia” (Romano & Maravita, 2019).

1.1 Disorders of Bodily Awareness

To better understand somatoparaphrenia and facilitate its recognition and distinction from other neurological disorders, it is necessary to have a basic knowledge of all the disorders of bodily awareness, i.e., disorders that follow the disruption of body awareness. These disorders share some similarities with SP but also have prominent differences.

The previous paragraph mentioned the disruption of the sense of body ownership. This disruption can manifest in disorders concerning body awareness, called body awareness disorders (BAD) or disorders of bodily awareness.

These disorders can be found in different contexts, varying from neurological to psychiatric.

Bodily awareness disorders, even though present, are uncommon in neurology. Among the symptoms, the most characteristic is “distorted perception or reduced awareness of parts of the body or an impaired ability to localize them, feelings of strangeness, loss of agency, and illusory feelings of movement or even of having supernumerary limbs”. Moreover, concerning neural correlates, body awareness disorders usually result from parietal lobe lesions, even though they can also arise after lesions located in other brain areas.

Among the most critical disorders of bodily awareness, we can find Anosognosia, Asomatognosia, and Somatoparaphrenia (SP) (Pisella et al., 2019).

1.1.1 Anosognosia

The term Anosognosia first appeared in the literature in 1914 in a publication by Babinski in *Reve Neurologique*. It was a neologism “to designate a puzzling disorder of awareness of paralysis in hemiplegic patients”.

Babinski described his patients with anosognosia as “having intellectual preservation, against a background of clear consciousness, without the presence of either confusion or confabulation and free of hallucinations”.

Babinski, most importantly, isolated anosognosia from general confusion and dementia; this was fundamental to his emphases on the unawareness of the paralyzed limb in anosognosia despite the total preservation of awareness in other areas.

Later, Critchley (1900–1997) “drew a formal distinction between anosognosia and the more pronounced, more psychically “aberrant” denial of illness”. This distinction allowed the beginning of a different categorization of what would later be called bodily awareness disorders. At that time, Babinski’s colleagues had already realized that confronting patients with the deficit or asking for recognition of paralysis was useless in gaining awareness. (Langer & Bogousslavsky, 2024). This example clearly illustrates the level of unawareness that accompanies BADs and defies every logical explanation or evidence.

Today, anosognosia is defined as “the lack of awareness or the underestimation of a specific deficit in sensory, perceptual, motor, affective or cognitive functioning due to a brain lesion. This self-awareness deficit has been studied mainly in stroke hemiplegic patients, who may report no deficit, overestimate their abilities, or deny that they are unable to move a paretic limb” (Orfei et al., 2007).

The present scoping review will address anosognosia for hemianesthesia and hemiplegia. Hemianesthesia is the loss of sensation in the contralesional side of the body, while hemiplegia is a more severe condition defined by the paralysis of one side of the body. Hemiplegia usually

presents itself accompanied by various symptoms, including visual disturbances, sensory loss, and difficulty with speech (Piña-Garza & James, 2013).

The neuroanatomy of the latter deficit seems to be connected with lesions involving different cortico-subcortical structures (Moro et al., 2011).

1.1.2 Asomatognosia

Critchley first coined the term asomatognosia in 1953, describing it as “the subjective sensation as if there existed nothing to the left of the midline of the body”.

Asomatognosia is a unilateral disturbance of body ownership, usually resulting from a right-hemisphere stroke. This condition is characterized by abnormalities regarding the sense of body ownership, such as “the experienced existence, visual self-recognition, and sense of belonging of contralesional body parts”. More specifically, patients with asomatognosia seem not to be able to maintain a continuous sensation and feeling of judgment that the contralesional side of the body, or more specifically, the affected limb, belongs to them. (Jenkinson et al., 2018).

The essential and distinctive part is that patients may not recognize the limb as their own but do not attribute ownership to someone else.

Regarding the neural correlates, asomatognosia seems to follow temporoparietal and medial frontal lesions, which is essential for the feeling of disownership of the limb. (Feinberg et al., 2010).

1.2 Somatoparaphrenia

Somatoparaphrenia (SP), the topic of the present scoping review, is a neuropsychological syndrome that involves the unawareness of ownership of a body part and, in addition, presents productive features such as delusional misidentification and confabulation” (Feinberg & Venneri, 2014).

The term somatoparaphrenia originates from the Greek παρα + φρεν, φρενος means “against the mind,” and σωμα, σωματος refers to the “body”: therefore, somatoparaphrenia is defined as a bodily delusion (Handbook of Clinical Neurology, 2018).

1.2.1 Somatoparaphrenia; History

The term somatoparaphrenia first appeared in a 1942 article by Gerstmann titled " Problem of imperception of disease and impaired body territories with organic lesions - Relation to body scheme and its disorders.”.

In this issue, Gerstmann names three “indirect disorders of the body scheme”; all three are characterized by “an abnormal experience or behavior toward, or verbal statement about a function of a part of the body”.

The first one was anosognosia (a term coined by Babinski in 1914), which is defined as “cases of imperception of disease or defect in function”. The second one would be later named asomatognosia, “cases of imperception of the defective parts or side of the body, with forgetting of their existence or non-recognition of their possession”. The last and third one will be a syndrome that Gerstmann will call Somatoparaphrenia, consisting of a variant of asomatognosia involving delusional beliefs about the contralesional side of the body.

According to Gerstmann, in somatoparaphrenia, the experience of the affected limb's absence is associated with illusional, confabulatory, or delusional ideas of an odd nature (Feinberg et

al., 2014). Here, we start to see the appearance of the confabulation and delusion elements essential in diagnosing SP.

Josef Gerstmann names somatoparaphrenia for the first time as a “florid disturbance that involves denying limb ownership plus misattributing belonging of the paretic limb or side as belonging to another person”. He subsequently adds that “the psychotic quality to this disturbance is reflected in its delusional confabulatory elements.” (Langer & Bogousslavsky, 2024). The latter statement contains the fundamental aspect of the misattribution of the contralesional limb and its attribution to someone else, which is specific only to SP.

Later, in 1955, Critchley added that among the more common features of SP is “personification of the paralyzed limb,” i.e., the contralesional limbs are given different identities and may be attributed to a relative, child, or pet. Critchley also theorizes misoplegia, a disorder characterized by hate toward the limb that could result in abuse or physical attack. (Feinberg & Venneri, 2014).

1.2.2 Somatoparaphrenia; Neuroanatomical Correlates

The neuroanatomical correlates of SP began to be researched, and the result of said research became more precise and defined from 2012 to 2019.

In a 2012 study, Gandola et al. indicated that the brain structures involved were the subcortical white matter of the right hemisphere, the middle and inferior frontal gyri, the right hippocampus, and the amygdala.

In 2014, Romano et al. found that the basal ganglia and the thalamus (together with the areas mentioned in 2012 by Gandola et al.) are associated with SP.

Moro et al., in 2016, underlined the involvement of the right basal ganglia and surrounding white matter, confirming the previous results of the studies mentioned.

More generally, in a 2019 article from Romano e Maravita, SP is stated to usually result from right hemisphere lesions (97.5%). Moreover, SP seems to follow more frequently intraparenchymal stroke (95.5%), even though cases of SP after neoplastic lesions or subdural hematoma have also been reported (Weinstein & Kahn, 1950; Beato et al., 2010; Halloran, 1946).

1.2.3 Somatoparaphrenia; Diagnostic Complications

To complicate the diagnostic process, somatoparaphrenia has a very short duration: in most patients, SP lasts for days or weeks, and it has rarely been reported to persist for months. Two-year persistence of somatoparaphrenic symptoms has been described in only one patient (Nightingale, 1982), who developed SP 4 years after a cerebral lesion; however, the florid psychotic illness was not restricted to the contralesional limbs. (Cogliano et al., 2012), For this reason, the short diagnostic window complicates the study of the syndrome even more.

A key aspect of the diagnosis of somatoparaphrenia is that it is thought to be a rare condition. However, among right brain-damaged patients, it has been reported a 15% of general alterations of body representation. (Baier & Karnath, 2008; Moro et al., 2016). This finding suggests that SP could sometimes be misdiagnosed or unnoticed by clinicians.

Moreover, SP usually co-occurs with other right hemisphere disturbances, representing a diagnostic complication. SP results from massive hemispheric damage, which is frequently associated with other deficits in body awareness and space processing. Among these deficits, the most prominent are anosognosia, unilateral space neglect, and personal neglect. (Gandola

et al., 2012). To conclude, it is hypothesized that the mentioned association could be due to the overlap of anatomical substrates. (Bottini et al., 2009) (Romano & Maravita, 2019).

CHAPTER 2 -SCOPING REVIEW STRUCTURE

2.1 Aim of the Scoping Review

The present scoping review aims to observe the definition and diagnosis of somatoparaphrenia in literature from its discovery until today, focusing on the disorder's incorrect definition and misdiagnosis.

The literature has an unclear and unspoken gap about SP and its borders. The misdiagnoses date back to 1954 and are still present in 2021.

Therefore, finding a shared and accepted definition of SP that contains the parameters for a correct diagnosis and avoids misdiagnosis is imperative.

Finally, the present work will consider the idea of somatoparaphrenia being on a continuum with the previously mentioned disorders of bodily awareness.

2.2 Scoping Review Objectives

The first objective of the scoping review is to focus on the theme of misdiagnoses and to provide a proper, complete, and exhaustive definition of somatoparaphrenia.

From 1935, somatoparaphrenia was misdiagnosed. This misdiagnosis kept repeating over time, leading to a chain of misdiagnoses. So, the definition of the disorder has remained unclear in the literature.

It is crucial in this scoping review to give a proper definition of somatoparaphrenia and point out the cases in which it was misdiagnosed and the most common misdiagnosis, i.e., which pathologies were mistaken for somatoparaphrenia.

Another review objective is to highlight the most frequent deficit associated with SP. The review also sheds light on crossed somatoparaphrenia.

The last goal of the scoping review is to understand whether the bodily awareness disorders family can be placed on a continuum or should be considered separately and among them, and

whether somatoparaphrenia itself could belong to the said continuum or should be considered individually.

2.3 Scoping Review Questions

- Are there misdiagnoses of somatoparaphrenia in the literature? If yes, how many?
- Which disorders were mistaken for somatoparaphrenia?
- Which is the most frequent deficit associated with somatoparaphrenia?
- How can somatoparaphrenia be correctly defined?
- How can crossed somatoparaphrenia be defined?
- Are bodily awareness disorders on a continuum, or should they be considered separately? What about the case of somatoparaphrenia?

CHAPTER 3- METHODS

The present work was conducted following the PRISMA guidelines for Scoping Review (Tricco et al., 2018).

The structure of the review followed four phases:

(1) formulation of the research questions, (2) research of the keywords selected according to the work aim, (3) selection of the relevant studies in the literature, (4) relevant information extraction.

3.1 Information Sources and Search Strategy

The Studies present in the scoping review were selected by searching the nine following keywords in PubMed.

The keywords were asomatognosia, somatoparaphrenia, body ownership disorder, limb disownership, bodily awareness disorder, limb confabulation, limb belonging attribution, limb delusions, and disturbed sensation of limb ownership.

3.2 Eligibility Criteria

The studies included in the present review met the inclusion criteria:

(i) case study/case report/review article type; (ii) presence of at least one patient/case study; (iii) presence of a disorder label/diagnosis; (iv) description of the patient symptoms/ direct transcript of the patient disturb description.

CHAPTER 4 - RESULTS

For the present scoping review, first, research was conducted in the PubMed database using nine keywords, carefully selected to gather all the possible studies involving somatoparaphrenia, even the ones that did not contain the label “somatoparaphrenia.” The nine keywords were asomatognosia, somatoparaphrenia, body ownership disorder, limb disownership, bodily awareness disorder, limb confabulation, limb belonging attribution, limb delusions, and disturbed sensation of limb ownership. This selection was thought to cover thoroughly all the possible disorders with somatoparaphrenic traits.

The initial research identified 321 articles; from this initial gathering, duplicates were removed, and 283 articles were analyzed. After the removal of duplicates procedure, the eligibility criteria mentioned before were applied to 283 articles. A number of 40 articles were considered eligible for the review (*figure 1*).

Of the selected 40 studies, 23 had at least one misdiagnosis of SP.

Being the first eligibility criteria (i) case study/case report/review article type, all the articles selected had to contain at least the data of one patient. The total of patients taken into consideration for the scoping review was 153.

The 153 patients were singularly analyzed, employing, when possible, their direct description of the disorder. After the analysis, 42 patients were correctly diagnosed with SP, and 55 were categorized as misdiagnoses, meaning there could have been an incorrect, incomplete diagnosis or an underdiagnosis. The remaining 56 patients were diagnosed with other bodily awareness disorders, general confabulations, or deficits.

Table 1 provides the analysis of the 40 studies. It indicates the number of patients, the handedness, the presence of SP, the patient description of the disorder, the patient's gender and age, and the presence of the deficits: extrapersonal neglect, personal neglect, hemianopia, hemianesthesia, hemiparesis, and hemiplegia.

4.1 Data selection and collection

Figure 1. The selection process of the articles

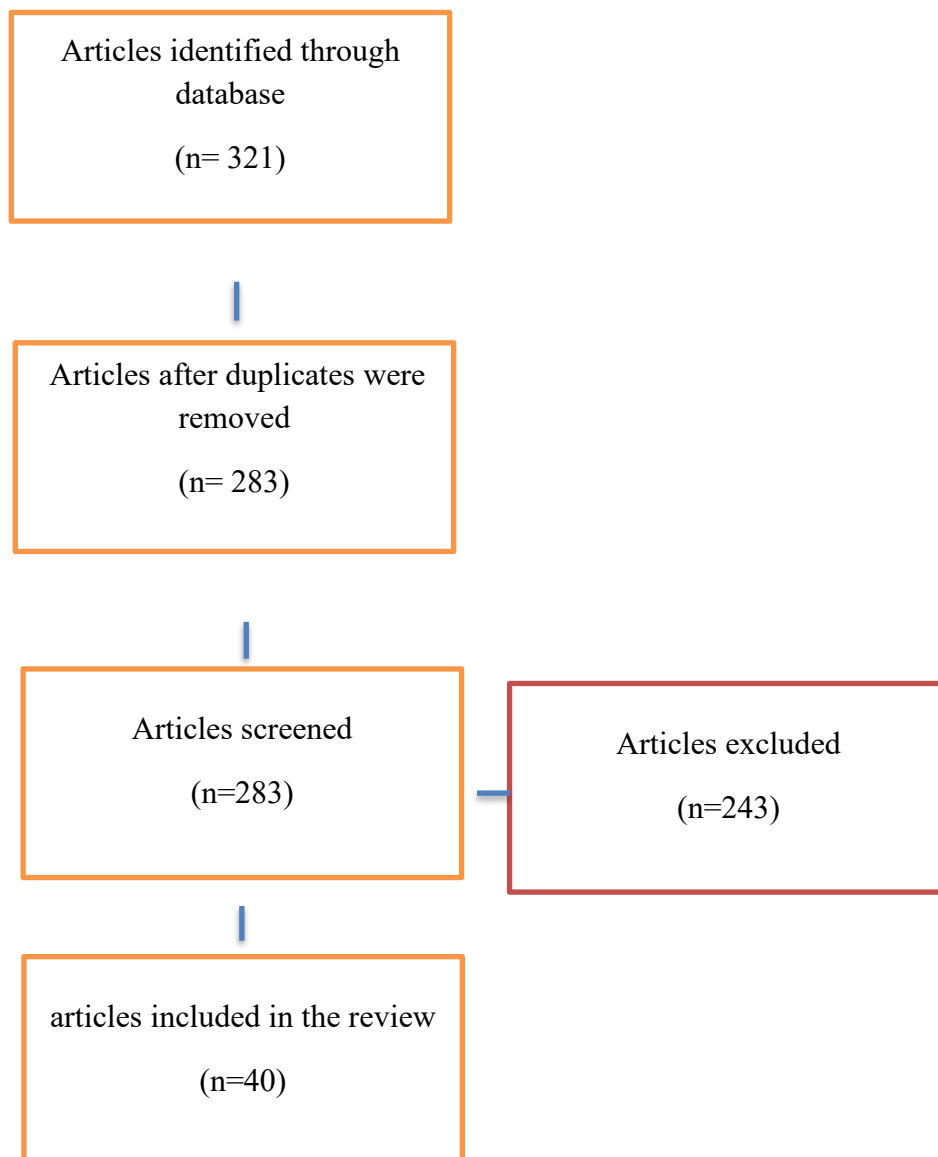


Table 1 studies considered in the scoping review

year of publication, title and Authors	n. P	L/R	lesion side	disturb label	SP	Patient disturb description	patient age/ gender	N extra personal	N personal	hemi anopia	hemi anesthesia	hemi paresis	hemi plegia
1935 The Image and Appearance of the Human Body: Studies in the Constructive Energies of the Psyche Schilder	p1	R	L	right- sided SP (crossed SP)	+		48 F				+		
1938 Gerstmann syndrome: finger agnosia, agraphia, confusion of right and left, and acalculia.	p1	R	L	right- sided SP (crossed SP)	+	"Now that I see that it is my arm it must be, but it does not feel like it. I thought somebody was in bed with me, but I did not	57 F			+	+		+

Table 1 continued

Nielsen JM						know who it was. I wondered if somebody was in bed with me with an arm across me." On questioning, she further explained that she had thought perhaps it was her daughter's arm, that she had come to stay with her but that she had not felt any portion of her daughter's body except the arm. At the							
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Table 1 continued

						time of examination she complained that her arm was water- logged and heavy and that the right leg "gets numb and kind of goes to sleep."							
1954 Delusional reduplication of part of the body E.A. Weinstein, R.L. Kahn, S. Malitz and J. Rozanski	p1		R	SP	-	At times, the patient said she had two left hands, on other occasions, she said that the hand belonged to Mrs. D., a close friend and nurse who visited her daily. Twice, she	57 F	-					

Table 1 continued

						said it was the hand of a doctor.							
1982 Somatoparaphrenia: a case report. Nightingale S.	p1	R	R	schizophr eniform illness and severe and unusual form of SP	-	“The left side of the body, he claimed, had slipped behind the right side so that his right arm and leg, the right side of his trunk and the features of the right side of his face were more prominent than the left. The left side seemed to him evil and controlled by external agents, sometimes the Devil	46 M						

Table 1 continued

						and sometimes his deceased father in collusion with the Devil”.							
1983 Non, je ne suis pas paralysee, c’est la main de mon ’ mari G. Assal	p1	R	R	SP (misiden tification of sentient left hand)	+	(misidentification of sentient left hand) “it’s the hand of my husband”.	86 F	+					
1990 Verbal asomatognosia Feinberg, et al	12 p			asomato gnosia	-	(Sense of disownership, ownership attribution to others not investigated in all							

Table 1 continued

						cases and not distinguished in lesion mapping)							
1990 Anosognosia and major depression in 2 patients with cerebrovascular lesions Starkstein et al	p1	R	R	anosogn oisa		The patient stated that the left arm was “disjointed and separated”; hated it and referred to it as “jerk” delusional misidentification, misoplegia	71 M						
	p2	R	R	anosogn osia	+	The patient claimed left arm was not hers, belonged to a nearby person, disliked it, hit it because it did not	48 F						

Table 1 continued

						obey her, and referred to as “zodoquio” (neologism).							
1991 Remission of somatoparaphrenic delusion through vestibular stimulation, E. Bisiach, M.L. Rusconi and G. Vallar	p1	R	R	SP	+	The patient referred to left arm as “belonging to her mother, found it in her bed, warmer than her own arm”; “She forget it when she was discharged from the hospital.” Later misidentified it as her son's arm.	84 F	+					

Table 1 continued

1991													
The pathogenesis of anosognosia for hemiplegia D N Levine 1, R Calvanio, W E Rinn	p1				+	The patient misidentified her left arm as her husband's.	78 F						
	p2			SP	-	The patient claimed that the paralyzed left arm was a "make- believe leg that his 3- year-old grandson had left in the bed when visiting earlier that day "	60 M						
1992	p1		R	SP	+	The patient repeatedly affirmed that her left	69 F	+	+	+	+		+

Table 1 continued

Partial remission of hemiplegia and somatoparaphrenia through vestibular stimulation in a case of unilateral neglect.						upper limb “was not hers but the examiner's”. patient's left arm was brought in her good visual field and asked whose it was, she answered: "It's not mine. I found it in the bathroom, when I fell. It's not mine because it's too heavy; it should be yours. It can move and do everything; when I feel it too heavy, I put it on my						
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Table 1 continued

						stomach. It doesn't hurt me, it's kind". When asked where her own arm was, she answered: "Behind the door".							
1996 [Somatoparaphrenia caused by the lesion in the dominant cerebral hemisphere--a case report]. Miura N, Takeda A, Terao S, Tanaka H, Ishikawa S, Mitsuma T.	p1	R	L	right-sided SP (crossed SP)	+	Neuropsychologically, there were anosognosia (AG) for hemiplegia and SP. The patient was arguing her hand as doctor's hand.	77 F	+		+	+	+	+

Table 1 continued

1999 Does vestibular stimulation activate thalamocortical mechanisms that reintegrate impaired cortical regions? Schiff ND, Pulver M	P1	R	L	right-sided SP (crossed SP)		When the patient right hand was moved with effort and brought into the left visual hemi-field the patient could not identify the hand as her own. Asked, 'Whose hand is this?', the patient tentatively replied, 'I don't know' and further denied the hand as her own when queried	81 F	+		+			+
2000	p1	R	R	SP	+	The patient claimed that the left hand most	50 M	+					

Table 1 continued

Recognition of self-produced movement in a case of severe neglect						likely belonged to his son.							
Deprati et al													
2000													
Somatoparaphrenie						(misidentification of							
Eine “plusvariante” der						left body) AHP and							
Anosognosie für						described her left side							
Hemiplegie [So- ”						alternatively as her							
matoparaphrenia. A	p1		R	SP		handicapped nephew	85						
“positive-variant” of						and a clumsy cat.	F	-					
anosognosia for						Misidentification of							
hemiplegia]						her daughter also							
M. Paulig, M. Weber						occurred.							
and S. Garbelotto													

Table 1 continued

2002 Feeling touches in someone else's hand Bottini et al	p1	R	R	SP	+	The patient claimed left hand belonged to her niece.	77 F	+	+	+	+		+
2002 Strokes restricted to the insular cortex. Cereda C, Ghika J, Maeder P, Bogousslavsky J.	p4	R	R	SP	+	The patient presented a distortion of body image, not recognizing her own left upper limb and attributing it to a stranger.	75 F						
2008 Tight link between our sense of limb ownership and self-	12 p			SP	-	All the confabulation toward affected limb classified as somatoparaphrenia without specification							

Table 1 continued

awareness of actions. baier and karnath						of the contents of confabulation. General confabulation toward affected limb							
2010 The neuroanatomy of asomatognosia and somatoparaphrenia Feinberg TE, Venneri A, Simone AM, Fan Y, Northoff G.	G1 -1 SP		R	Asomato gnosia+S P	+	The patient told the doctor to “tell his brother to remind him to take his left arm home with him or he will leave it at the hospital”.	52 M	+					+
	G1 -2 SP		R	Asomato gnosia+S P	+	Variably misidentified the left arm as “remote control” “telephone pole” “dummy hand”	75 M	+					+

Table 1 continued

						delusional misidentification, confabulation (display of extensive and refractory confabulatory or delusional content)							
	G1 -3 SP		R	Asomato gnosia+S P	+	The patient Misidentified the hand as belonging to “Miss Mary's my mother-in-laws hand”	62 M	+					+
	G1 -4 SP		R	Asomato gnosia+S P	yes	Variably misidentified the hand as a “stock,” “stock option probably,”	81 F	+					+

Table 1 continued

						“perfume bottle” delusional misidentification (display of extensive and refractory confabulatory or delusional content)						
	G1 -5 SP		R	Asomato gnosia+S P	yes	Claimed the left arm was “a hand that was left on the subway and they brought it here and they put it on me” delusional misidentification, confabulation (display	45 F	+				+

Table 1 continued

						of extensive and refractory confabulatory or delusional content)							
	G1 -6 SP		R	Asomato gnosia+S P	+	The patient stated, “It's supposed to be my arm, but I think it's my brother's arm” He described how “gangsters chopped off his arms and threw them in the river.” It was subsequently attached to him.	53 M	+					+

Table 1 continued

	G1 -7 SP		R	Asomato gnosia+S P	+	The patient called the left arm a “breast” and a “deodorant” She described how her husband who had died left his hands behind. “They used to fall on my chest. I said “got to get rid of them!”. Put them in the garbage....Yes ... two days ago....Still in the garbage ... a black hand, with a plastic cover ... you'll	79 F	+					+
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Table 1 continued

						find them ... Be careful, though ... the nails are very long ... and very sharp!"							
	G1 -8 SA		R	asomato gnosia	-	simple asomato, least confabulatory content	73 M	+					+
	G1 -9 SA		R	asomato gnosia	-	simple asomato, least confabulatory content	82 F	+					+
	G1 -10 SA		R	asomato gnosia	-	simple asomato, least confabulatory content	82 F	+					+

Table 1 continued

	G1 -11 SA		R	asomato gnosia	-	simple asomato, least confabulatory content	82 F	+					+
	G1 -12 SA		R	asomato gnosia	-	simple asomato, least confabulatory content	64 M	+					+
	G1 -13 SA		R	asomato gnosia	-	simple asomato, least confabulatory content	83 F	+					+
	G2 -1		R	non- asomato gnosia + neglect	-	hemiplegia and hemispatial neglect	48 M	+					
	G2 -2		R	non- asomato	-	hemiplegia and hemispatial neglect	57 F	+					

Table 1 continued

			gnosia + neglect										
G2 -3		R	non- asomato gnosia + neglect	-	hemiplegia and hemispatial neglect	76 M	+						
G2 -4		R	non- asomato gnosia + neglect	-	hemiplegia and hemispatial neglect	81 M	+						
G2 -5		R	non- asomato gnosia + neglect	-	hemiplegia and hemispatial neglect	67 M	+						
G2 -6		R	non- asomato	no	hemiplegia and hemispatial neglect	64 F	+						

Table 1 continued

			gnosia + neglect										
G2 -7		R	non- asomato gnosia + neglect	no	hemiplegia and hemispatial neglect	85 M	+						
G3 -1		R	only hemipleg ia	no	simple hemiplegia	68 M	-	-					+
G3 -2		R	only hemipleg ia	no	simple hemiplegia	66 F	-	-					+
G3 -3		R	only hemipleg ia	no	simple hemiplegia	44 F	-	-					+

Table 1 continued

	G3 -4		R	only hemipleg ia	no	simple hemiplegia	37 M	-	-				+
	G3 -5		R	only hemipleg ia	-	simple hemiplegia	40 F	-	-				+
	G3 -6		R	only hemipleg ia	-	simple hemiplegia	50 M	-	-				+
2010 Transitory somatoparaphrenia associated with a left frontoparietal meningioma.	p1	R	L	Transitor y SP	yes	She reported a feeling of strangeness involving her right upper limb and stated that her limb did not belong to her. Additionally, she	62 F						

Table 1 continued

Beato R, Martins W, Nicolato A, Ulhoa TH, Oliveira MM, Avelar IF.						mistook her sister's left upper limb as her own, denying that she was mistaken despite demonstrations proving the contrary.							
2011 Mirror-view reverses somatoparaphrenia: dissociation between first- and third-person perspectives on body ownership. Fotopoulou A, Jenkinson PM, Tsakiris	p1	R	R	SP	+	The patient claimed that her left arm below the level of the shoulder and her left leg belonged to her husband and that her 'own' left hand was not hemiplegic and it was somewhere left of the arm she	65 F		+	+			+

Table 1 continued

M, Haggard P, Rudd A, Kopelman MD						thought was her husband’.							
	p2	R	R	SP	+	The patient had the firm belief that her left arm belonged to her granddaughter.	78 F	+		+			+
2012 My sister's hand is in my bed": a case of somatoparaphrenia. Pugnaghi M, Molinari M, Panzetti P, Nichelli PF, Zamboni G.	p1		R	SP	+	When shown the patient her left arm, she said it was her sister’s arm. She was convinced that this had happened because the day before being admitted to the hospital she had visited her invalid	82 F	+					+

Table 1 continued

						sister (who indeed was in vegetative status) and had touched her unresponsive hand.							
2012 An anatomical account of somatoparaphrenia Gandola M, Invernizzi P, Sedda A, Ferrè ER, Sterzi R, Sberna M, Paulesu E, Bottini G.	P1		R	SP	+	“This hand is cold and sweaty, it’s not mine”. “It’s plump. It’s the hand of my niece Arianna”. “She left it here because she doesn’t care about that”. “I found it there and took it with me, now it stays here as it was mine, it keeps me		+	+	+	+		+

Table 1 continued

						company, please leave it here with me”. “It’s the hand of S.B. (an Italian political leader), it was on his desk, and he left it there, he didn’t need it and gave it to me”.						
	P2		R	SP	+	The patient stated “It’s the hand of a guy. it’s very hairy. my hand is beyond the river Piave”. “You’re still telling me riddles about this hand. it’s the hand of a boxer”.		+	-	+	+	+

Table 1 continued

					“It’s the hand of this stupid man near me”. “My left hand went to Iraq to defend S.H., it has been two years since it went there”.								
	P3		R	SP	+	“No, it’s not my hand.it is yours”. “It occupies a lot of space in this bed, it’s so uncomfortable”. “It is an artificial limb. not mine. it is of the nurse. it is very intrusive; I’ve no more space in this bed!” “Yes, please		+	+	+	+		+

Table 1 continued

					take it away. I don't care about its destiny as it is not mine"							
P4		R	SP	+	"The problem is that this hand is not mine. I've already told it to the other doctor". "How am I supposed to know whose hand is this? It's not mine". "My hand is not like this, this is different, it's too short. I don't know who left it here". "It's of someone that passed by, but I don't		+	-	+	+		+

Table 1 continued

					know who he was exactly". "The problem is this hand that cannot move is not mine"							
P5		R	SP	+	"It's warm. it's my niece's hand". "My hand is there. maybe it has gone on holiday because it was too tired, it always works a lot, poor little." "There was another woman here with me. yes, in the same bed. it should be her hand. maybe		+	+	+	+		+

Table 1 continued

					there were no more beds, and they put her here with me”. “No, it’s not mine because it’s too heavy”.							
P6		R	SP	yes	“Yes, it’s your hand. Who’s other should it be?” “It’s a left hand. I suppose that it should be your left hand”. “Anyway, I’m sure that it could not be mine because my hand is on my stomach. Can’t you see?”		+	+	+	+		+

Table 1 continued

	P7	R	SP	yes	“It’s not my hand. It’s a female hand”. “It’s the hand of that young nurse named Jasmine”. “It’s very strange. terrible. If I have her hand, she should have been wounded and she should have lost it”. “The nurses are joking, someone took my arm away. I couldn’t see because I was eating, and then they replaced it with		+	-	-	+		+
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Table 1 continued

						this one. It's a puppet".							
	P8	?	R	SP	yes	"It's my niece's hand". "She is so kind, she left it here to keep me company." "My niece is so sweet. she's always making me some massages. but she's also very absent minded. look here, she was rushing home and forgot her hand here!"		+	+	+	+		+
	P9		R	SP	+	"Mine or yours? it's a female hand. it could be of the nurse but it		+	+	+	+		+

Table 1 continued

					wears my pyjamas. it's strange." "It really doesn't look like mine. My hand is more thin and dry". "I don't know. I feel nothing. obviously it's not mine. it's yours. if you want it, I'll give it to you as my gift, since I have no need for it. It doesn't work. Maybe you'll be able to get it working". "I woke up last night and called the nurse because there							
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Table 1 continued

					was this hand here and I thought that Nadia forgot it. I wanted to give it back to her. She cannot work without it. Poor Nadia”.						
P1 0		R	SP	+	[Examiner: the experimenter brings the patient left hand in front of her face and asks: “Whose arm is this?”] “It’s your hand. Sure, whose hand is it supposed to be?” [Examiner: where is your left hand?] “My		+	+	-	+	+

Table 1 continued

					hand is on my stomach and it cannot move” (the patient’s hand is not on her stomach but it was brought by the experimenter in the mid-sagittal plane of the patient). It could be yours, I don’t care, take it away if you need it”. “No it’s not mine, I’ve already told you, are you joking? Why should it be mine?” “My hand is different, not so heavy,									
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Table 1 continued

					then maybe it's the hand of the doctor who examined me before. Give it back to him".							
P1 1		R	SP	+	"It's your hand". "No I'm not sure, it's not a female hand". "It's the hand of that handsome guy, the other doctor". "No no, it's not my hand, this is so little. my hand is big as a shovel". "It's the hand of your colleague, the guy that was here with		+	+	+	+		+

Table 1 continued

					you, my hand is on the bed”								
P1 2		R	P without SP	-				+	+	+	+		+
P1 3		R	P without SP	-				+	-	-	+		+
P1 4		R	P without SP	-				+	-	+	+		+
P1 5		R	P without SP	-				+	-	+	+		+

Table 1 continued

	P1 6		R	P without SP	-			+	+	+	+		+
	P1 7		R	P without SP	-			+	-	+	+		+
	P1 8		R	P without SP	-			+	-	-	+		+
	P1 9		R	P without SP	-			+	-	+	+		+
	P2 0		R	P without SP	-			+	-	+	+		+

Table 1 continued

	P2 1		R	P without SP	-			+	-	-	+		+
	P2 2		R	P without SP	-			+	-	-	+		+
	P2 3		R	p without SP e N	-			-	-	-	-		-
	P2 4		R	p without SP e N	-			-	-	-	-		-
	P2 5		R	p without SP e N	-			-	-	-	-		-

Table 1 continued

	P2 6		R	p without SP e N	-			-	-	-	-		-
	P2 7		R	p without SP e N	-			-	-	-	-		-
	P2 8		R	p without SP e N	-			-	-	-	-		-
	P2 9		R	p without SP e N	-			-	-	-	-		-
	P3 0		R	p without SP e N	-			-	-	-	-		-

Table 1 continued

	P3 1		R	p without SP e N	-			-	-	-	-		-
	P3 2		R	p without SP e N	-			-	-	-	-		-
	P3 3		R	p without SP e N	-			-	-	-	-		-
	P3 4		R	p without SP e N	-			-	-	-	-		-
	P3 5		R	p without SP e N	-			-	-	+	-		-

Table 1 continued

	P3 6		R	p without SP e N	-			-	-	-	-		-
	P3 7		R	p without SP e N	-			-	-	-	-		-
2012 Chronic somatoparaphrenia: a follow-up study on two clinical cases Cogliano R, Crisci C, Conson M, Grossi D, Trojano L.	P1	R	R	SP	-	The patient often stated that his left hand was “fake”, “dead”, and that a third hand replaced or was added to the damaged one (While the examiner is touching patient’s left hand)	59 M	left spatial neglect	-				+

Table 1 continued

						“Did you move this one? P: No, that one is not mine. E: Are you sure about that? Look at the hand I’m touching, whose hand is it? P: I don’t know but it’s not mine, it looks sick, I think someone forgot it here.”							
	P2	R	L	SP	-	expressed persistent feelings of strangeness and sometimes reported	74 M	+	-	+			-

Table 1 continued

						that some animals had entered his arm. E: So, can you control that hand? P: No, I can't because it isn't mine; it is just a pain. E: If it isn't yours, whose hand is it? P: I don't really know.						
2013												
The Rubber Hand Illusion in a patient with hand disownership van Stralen HE, van Zandvoort MJ,	p1		R	SP	+	The patient had the delusional belief that her left arm was her father's arm	78 F					

Table 1 continued

Kappelle LJ, Dijkerman HC													
2013													
What is mine? Behavioral and anatomical dissociations between somatoparaphrenia and anosognosia for hemiplegia Invernizzi P, Gandola M, Romano D, Zapparoli L, Bottini G, Paulesu E.	P1	R	R	SP dissociat ed from AHP	+	Complained of a “foreign, strange and short hand” in her bed abandoned by someone else	60 F	+			+		
	P2	R	R	SP dissociat	+	The patient often woke up in the night	69 F	+	+	+	+		+

Table 1 continued

			ed from AHP		calling the nurses, scared for the presence of a foreign hand on her stomach, which she attributed to her niece Nadia, to a nurse or a patient previously admitted to the hospital in the same bed.							
P3		R	SP dissociat ed from AHP	+	The patient, when asked about the ownership of the left plegic hand, he often ascribed it to the examiner, while	71 M	+			+		+

Table 1 continued

						affirming that his “real” left hand was placed on his stomach.							
P4		R	SP dissociat ed from AHP	+		The patient claimed “whose hand is this?”, affirming that the hand shown by the examiner was too fat, puffy and disobedient to her motor commands. Moreover, she asked the examiner to take away that “foreign” hand and replace it	84 F	+		+	+	+	+

Table 1 continued

						with her own “real” one, that someone surely had hidden away.							
P5		R	SP dissociat ed from AHP	+	When presented with three hands (his own one and both the experimenter’s hands), he persisted in attributing all of them to the examiner, in spite of the obvious nonsense of three arms in the same human body.	70 M	+	+	+	+			+

Table 1 continued

2013													
Remission of anosognosia for right hemiplegia and neglect after caloric vestibular stimulation. Ronchi R, Rode G, Cotton F, Farnè A, Rossetti Y, Jacquin- Courtois S	p1	amb idex trou s	L	SP	-	The patient claimed he had only the left hand and, when his right paralyzed hand was put close to the left one, he said that it was “apparently” his hand.	73 M	+	+	+	+		+
2014													
Arousal responses to noxious stimuli in somatoparaphrenia and anosognosia: clues to body awareness.	p1	R	R	SP	+	‘It is your hand (i.e. the neuropsychologist hand), I am sure. My hand is bigger, mine is like a shovel, this is too tiny.’	66 M	+	-	+	+		

Table 1 continued

Romano D, Gandola M, Bottini G, Maravita A.	p2	R	R	SP	+	‘This is my sister’s hand, yes my sister’s hand. My hand is on my belly but I am too fat I cannot see.	82 F	+	+	+	+		
	p3	R	R	SP	+	‘I do not know. It is not mine. It is just the two of us, so I guess it is your hand (i.e. the neuropsychologist hand).’	65 M	+	-	+	+		
	p4	R	R	SP	+	‘This is my niece’s hand. She works here (i.e. in the hospital), I do not know why her	69 F	+	+	+	+		

Table 1 continued

						hand is here, she should be around.'							
	p5	R	R	SP	+	'This is not my hand. I do not know whose hand is this. Maybe someone working here who examined me before left it here.'	84 F	+	+	+	-		
	p6	R	R	anosogn osia for somatose nsory deficit	-		62 M	+	-	+	+		
	p7	R	R	anosogn osia for somatose	-		67 M	+	-	+	+		

Table 1 continued

				nsory deficit									
	p8	R	R	anosogn osia for somatose nsory deficit	-		81 F	-	+	-	+		
	p9	R	R	anosogn osia for somatose nsory deficit	-		77 M	+	-	-	+		
	p1 0	R	R	anosogn osia for somatose	-		72 M	+	-	+	+		

Table 1 continued

				nsory deficit									
	p1 1	R	R	left hemipleg ia without anosogn osia and without SP	-		67 M	-	-	-	-		+
	p1 2	R	R	left hemipleg ia without anosogn osia and	-		63 M	+	-	-	-		+

Table 1 continued

				without SP									
	p1 3	R	R	left hemipleg ia without anosogn osia and without SP	-		65 F	-	-	-	-		+
	p1 4	R	R	left hemipleg ia without anosogn osia and	-		73 M	-	-	-	-		+

Table 1 continued

				without SP									
	p1 5	R	R	left hemipleg ia without anosogn osia and without SP	-		74 F	+	-	-	-		+
2014 Multisensory remission of somatoparaphrenic delusion: My hand is back!	P1	R	R	SP	yes	The patient, spontaneously and repeatedly, stated that her left hand belonged to her son, obdurately denying it was her	97 F	+	+	+	+		+

Table 1 continued

Bolognini N, Ronchi R, Casati C, Fortis P, Vallar G.						own, while ownership of the remaining part of the left upper limb was preserved.							
	P2	R	R	SP	+	firmly reported that it did not belong to him, but he did not know exactly whose it was	72 M	+	+	+	+		+
2014 "Crossed" somatoparaphrenia: an unusual new case and a review of the literature Perren F, Heydrich L, Blanke O, Landis T.	p1	R	L	right- sided SP (crossed SP)	+	He spontaneously complained about having something like “a piece of wood” or “a thing” in his bed. On other occasions, he also claimed that it was “the leg of	72 M	+		+	+	+	

Table 1 continued

					somebody else” that he did not know. Upon questioning, he said that he did not feel it and that the form was somehow changed and that he could not move foot and toes. Inspection of the leg in a mirror did not modify these phenomena. He also was frequently seen hitting his right leg and handled it as he							
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Table 1 continued

						would like to get rid of it (misoplegia)							
2016 The spatial side of somatoparaphrenia: a case study. Salvato G, Gandola M, Veronelli L, Agostoni EC, Sberna M, Corbo M, Bottini G.	p1	R	R	SP	yes	The patient repeatedly affirmed that her left hand belonged to her husband (G), obstinately denying it was her own.	89 F	+	-	+	+		+
2016 Motor versus body awareness: Voxel- based lesion analysis in anosognosia for hemiplegia and	17 p			Impaired sense of ownershi p		Patients selected for the presence of a sense of disownership plus limb attribution to someone else,							

Table 1 continued

somatoparaphrenia following right hemisphere stroke Moro et al						classified as sense of disownership. (somatoparaphrenia is briefly assessed without specification of patients and confabulation description).						
2016 Caloric Vestibular Stimulation Reduces Pain and Somatoparaphrenia in a Severe Chronic Central Post-Stroke Pain Patient: A Case Study.	P1		L	SP with pain	-	The patient reported the following delusions: her right arm was attached to her hip, her right leg had elongated to her neck,	57 F				-	+

Table 1 continued

Spitoni GF, Pireddu G, Galati G, Sulpizio V, Paolucci S, Pizzamiglio L.						her teeth could run inside her mouth and sometimes they were rearranged and reached her right foot, the right side of her face was expanded and heavy. In order to check the size of her face and the presence of the teeth in the mouth, she used to look herself into a big							
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Table 1 continued

						mirror that she kept hidden in her bag. She also reported her symptoms in the following way: “Sometimes I feel my right arm strange, maybe it is not mine anymore.”							
2019 The dynamic nature of the sense of ownership after brain injury. Clues from asomatognosia and somatoparaphrenia.	p1	R	R	SP with preserved voluntary movements	+	The patient attributes the ownership of his left hand to the examiner	66 M	+		+	+		

Table 1 continued

Romano D, Maravita A.	p2	R	R	SP with preserve d tactile and kinesthet ic sensitivit	+	“It could be mine, but I don't really feel like it's mine. No it is not mine. It is swollen and it does not move, I don't feel like it is mine. E: So whose might it be? P2: it could be someone else's hand, but I don't know ... I guess it's yours. P2 (then, after spontaneously touching the left hand with the right one): No no, this is mine,	84 F	+	+	+	+	+
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Table 1 continued

						now I feel it, I recognise it. It's mine!”							
	p3	R	R	SP at specific spatial locations	yes	first assessed limb ownership, the patient recognised his hand resting on the table, as his own. Critically, when the hand was passively moved in front of his face by the examiner, the patient misattributed the hand to the examiner, while searching for his left	74 M	+	+	+	+		+

Table 1 continued

					hand on the table, i.e. at the last position where he acknowledged correct ownership. Surprisingly, if the hand was kept in the new position for a while, he now correctly attributed the hand to himself, but misattributed it to the examiner again, when the hand was moved back on the table. Intriguingly,						
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Table 1 continued

						when the examiner's hand was placed at the position occupied by the patient's hand before passive movement, the patient attributed that hand to himself.							
2019 A case of somatoparaphrenia characterized by very mild somatosensory disturbance and absence of anosognosia	P1	R	R	SP	-	when asked whose hand it was, the woman answered that it was not her hand because she could not move it	75 F	+	-		+		+

Table 1 continued

for hemiplegia and personal neglect. Sakamoto K, Yokoi K, Hirayama K, Yamaguchi J, Shinoda A 2019													
"1.5 Dissociation" of somatoparaphrenia for the upper limb and neglect for the lower limb following a thalamic stroke presenting as flaccid hemiparesis: rehabilitation	P1	?	R		-	"I don't have [that arm]."	75 F	+	+				

Table 1 continued

applications and neuroscience implications. Randev S, Quiroga O, Islam M, Altschuler EL.													
2021 Where in the Brain is "the Other's" Hand? Mapping Dysfunctional Neural Networks in Somatoparaphrenia. Saetta G, Michels L, Brugger P.	p1	R	R	SP without anosognosia for hemiplegia	+	"This is my mum's hand. Here are her fingers -she is dead"	76 M	+			+		+
2021	p1	R	L	SP	-	she firmly maintained that her foot did not	50 F	-	-			+	

Table 1 continued

Rehabilitation of somatoparaphrenia with misoplegia: insights from a single case-pilot study. Maggio MG, Naro A, Calatozzo P, Rosa G, Porcari B, Latella D, Marzullo P, Calabrò RS.						belong to her. Such explanations were elaborate, strange, persistent, and refractory to correction that she had even written stories about “the foot”, separated from her will or the rest of the body.							
2021 Somatoparafrenie bij een patiënt met schizofrenie en verslavingsproblematie	p1	R		SP in a patient with schizoph renia and	-	In addition to the paranoid and agitated state, the patient had a special delirium. He described how his left	43 M						

Table 1 continued

k: 'Die arm is niet van mij, dokter' [Somatoparaphrenia in a patient with schizophrenia and addiction problems: 'That arm is not mine, doctor']. Neven A, Blom JD				addiction problems		forearm was transplanted during a vacation 17.5 years ago. The arm supposedly came from a Spanish girl, who in turn received the patient's arm.						
2023 Can you please find my upper limb? Somatoparaphrenia without personal neglect: a new case report.	P1	R	R	SP	+	When the examiner picked up the patient's left hand, putting it in front of him, and asked whose hand it was,	67 M		-	-		-

Table 1 continued

Mancuso M, Basagni B, Bolognini N, Vallar G, Damora A.						the patient appeared surprised and answered that it did not belong to him and probably belonged to someone else.							
2023 "It's not mine!" First description of somatoparaphrenia possibly reflecting an undergoing ictal epileptic activity. Rinaldi F, Nucera B, Bratti A, Flore D,	P1	R	R	SP	+	The patient was unable to recognize her left arm as her own; instead, she consistently and repeatedly said that it belonged to the visiting physician.	86 F						

Table 1 continued

Ferraiuolo I, Nardone R, Brigo F													
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P patient, L/R handedness, SP somatoparaphrenia, N extrapersonal Extrapersonal neglect, N personal Personal neglect, +/- presence or absence of deficit, misdiagnosis.

In table 1. Are presented all the studies selected for the scoping review. The most important variables taken into consideration where the number of patients, the handedness of the patients, the lesion side, the disturb label, the presence of somatoparaphrenia, the description of the disorder possibly with the direct speech of the patient, gender and age and finally the most salient deficit associated with the disturb.

Table 2. *Misdiagnosis present in the articles selected for the scoping review*

Year, author, title	Misdiagnosis
1. 1954 Delusional reduplication of part of the body E.A. Weinstein, R.L. Kahn, S. Malitz and J. Rozanski	Delusional Supernumerary Phantom limb supernumerary hands (the patient also had somatoparaphrenic symptoms)
2. 1982 Somatoparaphrenia: a case report. Nightingale S.	schizophreniform illness (The left side seemed to him evil and controlled by external agents, sometimes the Devil and sometimes his deceased father in collusion with the Devil)
3. 1990 verbal asomatognosia Feinberg, et al	Asomatognosia Sense of disownership: The ownership attribution to others was not investigated in all cases and was not distinguished in lesion mapping.
4. 1990 Anosognosia and major depression in 2 patients with cerebrovascular lesions Starkstein et al.	Anosognosia 1 case of undiagnosed SP The patient showed confabulation and misattribution of the limb to someone else.
5. 1991 The pathogenesis of anosognosia for hemiplegia	Anosognosia for hemiplegia 1 case of undiagnosed SP 2 case misidentifications

D N Levine 1, R Calvanio, W E Rinn	
6. 1999 Does vestibular stimulation activate thalamocortical mechanisms that reintegrate impaired cortical regions? Schiff ND, Pulver M	Asomatognosia When the patient's right hand was moved with effort and brought into the left visual hemifield the patient could not identify the hand as her own (was labeled as SP)
7. 2000 [Somatoparaphrenia. A “positive-variant” of anosognosia for hemiplegia] M. Paulig, M. Weber and S. Garbelotto	Delusional misidentification Confabulations and delusions but an absence of SP. The patient described her left side alternatively as “her handicapped nephew and a clumsy cat”.
8. 2008 Tight link between our sense of limb ownership and self-awareness of actions Baier and Karnath	General confabulation toward affected limb All the confabulation toward affected limb were classified as somatoparaphrenia without specification of the contents of confabulation.
9. 2010 The neuroanatomy of asomatognosia and somatoparaphrenia Feinberg TE, Venneri A, Simone AM, Fan Y, Northoff G.	General confabulation toward affected limb 3 cases of display of extensive and refractory confabulatory or delusional content, (but not SP).
10. 2010	Delusional misidentification

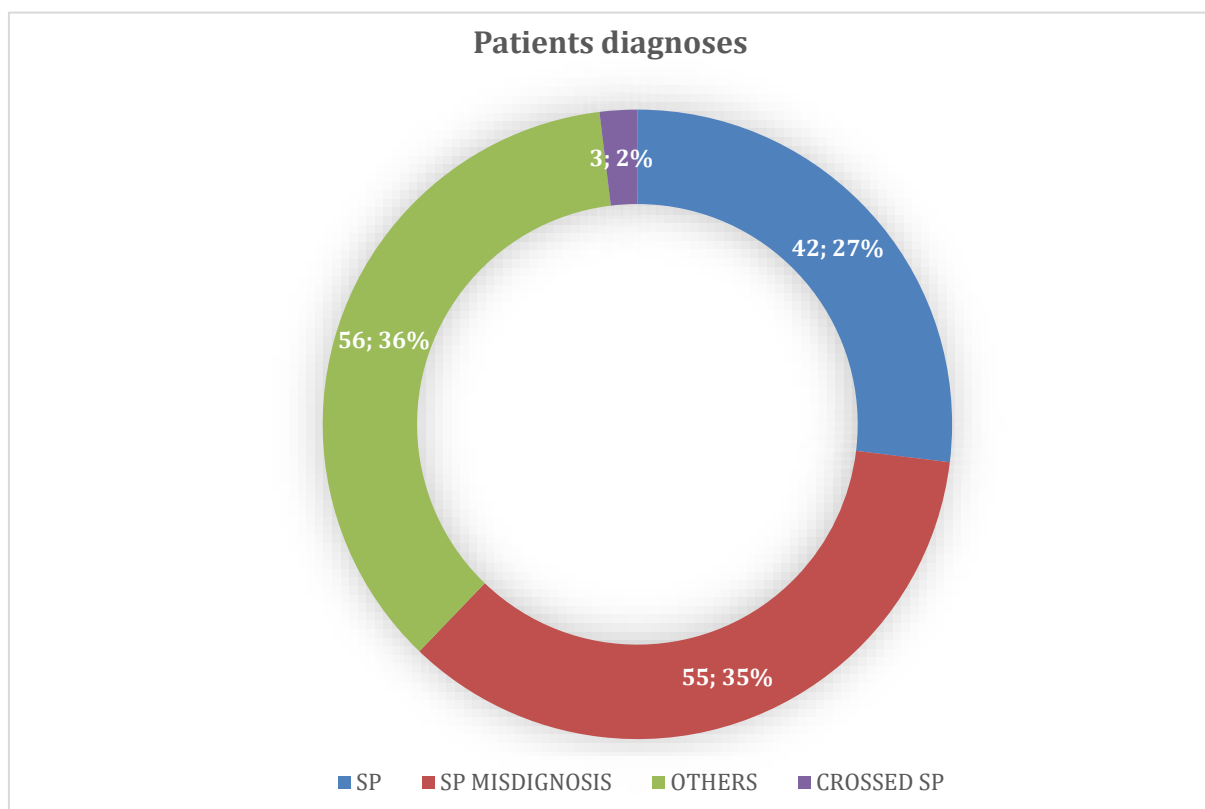
Transitory somatoparaphrenia associated with a left frontoparietal meningioma. Beato R, Martins W, Nicolato A, Ulhoa TH, Oliveira MM, Avelar IF.	Sense of disownership but no clear attribution of the limb to someone else.
11. 2012 An anatomical account of somatoparaphrenia Gandola M, Invernizzi P, Sedda A, Ferrè ER, Sterzi R, Sberna M, Paulesu E, Bottini G.	Delusional misidentification 1 case: Sense of disownership but no clear attribution of the limb to someone else.
12. 2012 Chronic somatoparaphrenia: a follow-up study on two clinical cases Cogliano R, Crisci C, Conson M, Grossi D, Trojano L.	Delusional misidentification feelings of strangeness in the limbs Patient 1: often stated that his left hand was “fake”, “dead”, and that a third hand patient 2: expressed persistent feelings of strangeness and sometimes reported that some animals had entered his arm.
13. 2013 What is mine? Behavioural and anatomical dissociations between somatoparaphrenia and anosognosia for hemiplegia Invernizzi P, Gandola M, Romano D, Zapparoli L, Bottini G, Paulesu E.	Delusional misidentification 2 cases: Sense of disownership but no clear attribution of the limb to someone else.

14. 2013 Remission of anosognosia for right hemiplegia and neglect after caloric vestibular stimulation. Ronchi R, Rode G, Cotton F, Farnè A, Rossetti Y, Jacquin-Courtois S	Anosognosia (Incorrect diagnosis of SP) the patient claimed he had only the left hand and, when his right paralyzed hand was put close to the left one, he said that it was “apparently” his hand.
15. 2014 Multisensory remission of somatoparaphrenic delusion: My hand is back! Bolognini N, Ronchi R, Casati C, Fortis P, Vallar G.	Delusional misidentification Sense of disownership but no clear attribution of the limb to someone else-
16. 2014 "Crossed" somatoparaphrenia: an unusual new case and a review of the literature Perren F, Heydrich L, Blanke O, Landis T.	delusional misidentification and misoplegia “Limb is made of wood”.
17. 2016 Motor versus body awareness: Voxel-based lesion analysis in anosognosia for hemiplegia and somatoparaphrenia following right hemisphere stroke Moro et al	Impaired sense of ownership Patients selected for the presence of a sense of disownership plus limb attribution to someone else, classified as sense of disownership. (somatoparaphrenia is briefly assessed without specification of patients and confabulation description).

	“Sometimes I feel my right arm strange, maybe it is not mine anymore”.
18. 2016 Caloric Vestibular Stimulation Reduces Pain and Somatoparaphrenia in a Severe Chronic Central Post-Stroke Pain Patient: A Case Study. Spitoni GF, Pireddu G, Galati G, Sulpizio V, Paolucci S, Pizzamiglio L.	Delusional misidentification Confabulations and delusions but not SP.
19. 2019 A case of somatoparaphrenia characterized by very mild somatosensory disturbance and absence of anosognosia for hemiplegia and personal neglect. Sakamoto K, Yokoi K, Hirayama K, Yamaguchi J, Shinoda A	Asomatognosia No attribution of the limb to someone else for a SP diagnosis,
20. 2019 "1.5 Dissociation" of somatoparaphrenia for the upper limb and neglect for the lower limb following a thalamic stroke presenting as flaccid hemiparesis: rehabilitation applications and neuroscience implications. Randev S, Quiroga O, Islam M, Altschuler EL.	Neglect for a limb “I don’t have that arm”.

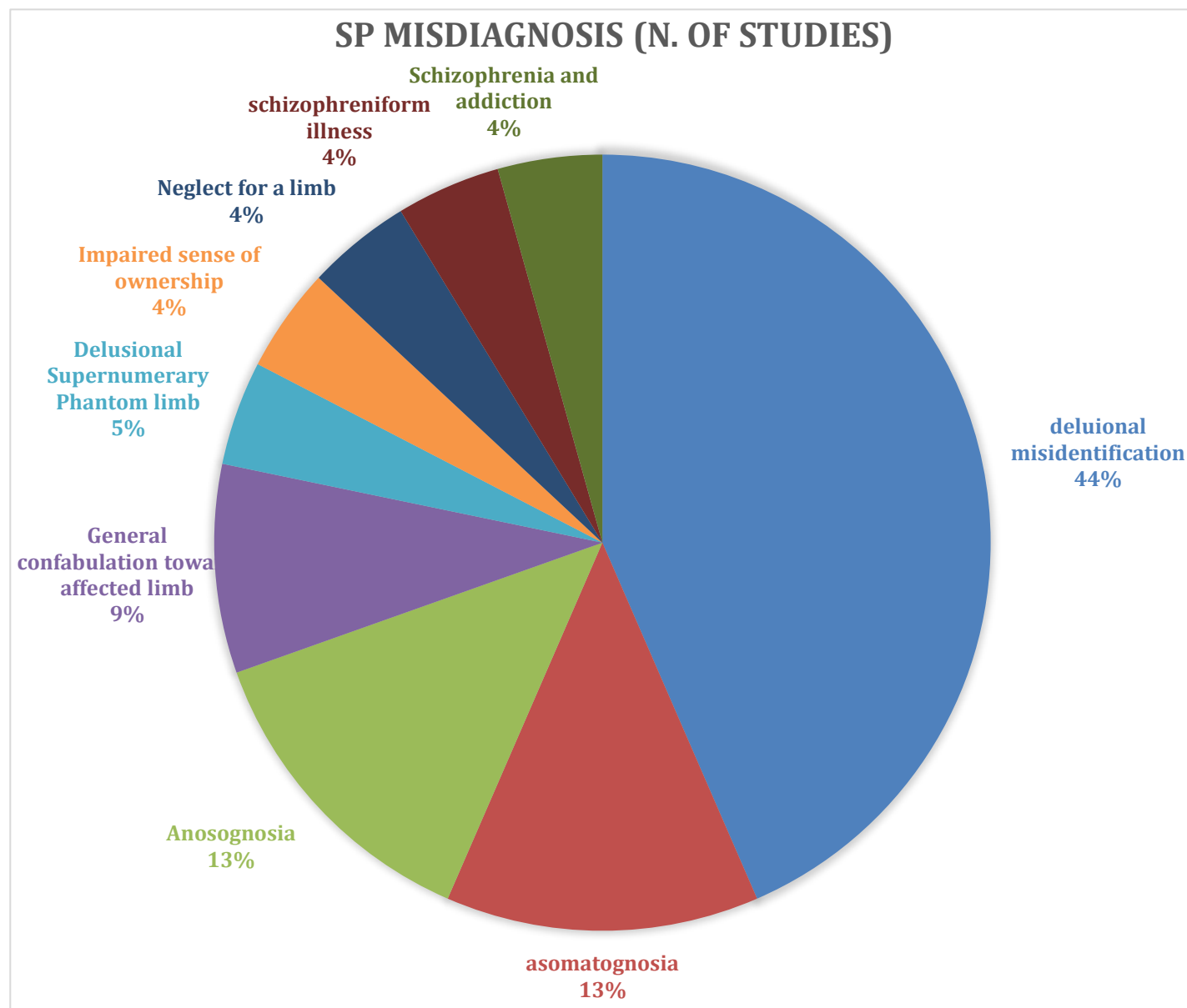
21. 2021 Rehabilitation of somatoparaphrenia with misoplegia: insights from a single case-pilot study. Maggio MG, Naro A, Calatozzo P, Rosa G, Porcari B, Latella D, Marzullo P, Calabrò RS.	Delusional misidentification Confabulation and delusions but no attribution of the limb to someone else.
22. 2021 Somatoparafrenie bij een patiënt met schizofrenie en verslavingsproblematiek: 'Die arm is niet van mij, dokter' [Somatoparaphrenia in a patient with schizophrenia and addiction problems: 'That arm is not mine, doctor']. Neven A, Blom JD	Schizophrenia and addiction
23. 2023 Can you please find my upper limb? Somatoparaphrenia without personal neglect: a new case report. Mancuso M, Basagni B, Bolognini N, Vallar G, Damora A.	Delusional misidentification Lack of attribution of the limb to someone else.

Figure 2. Diagnoses and misdiagnoses of the studies presented in the scoping review



Misdiagnoses (55 patients; 35%), SP diagnoses (42 patients; 27%), other disorders of bodily awareness diagnoses (56 patients; 36%); crossed SP diagnoses (3 patients; 2%)

Figure 3. Graph of the most common misdiagnosis



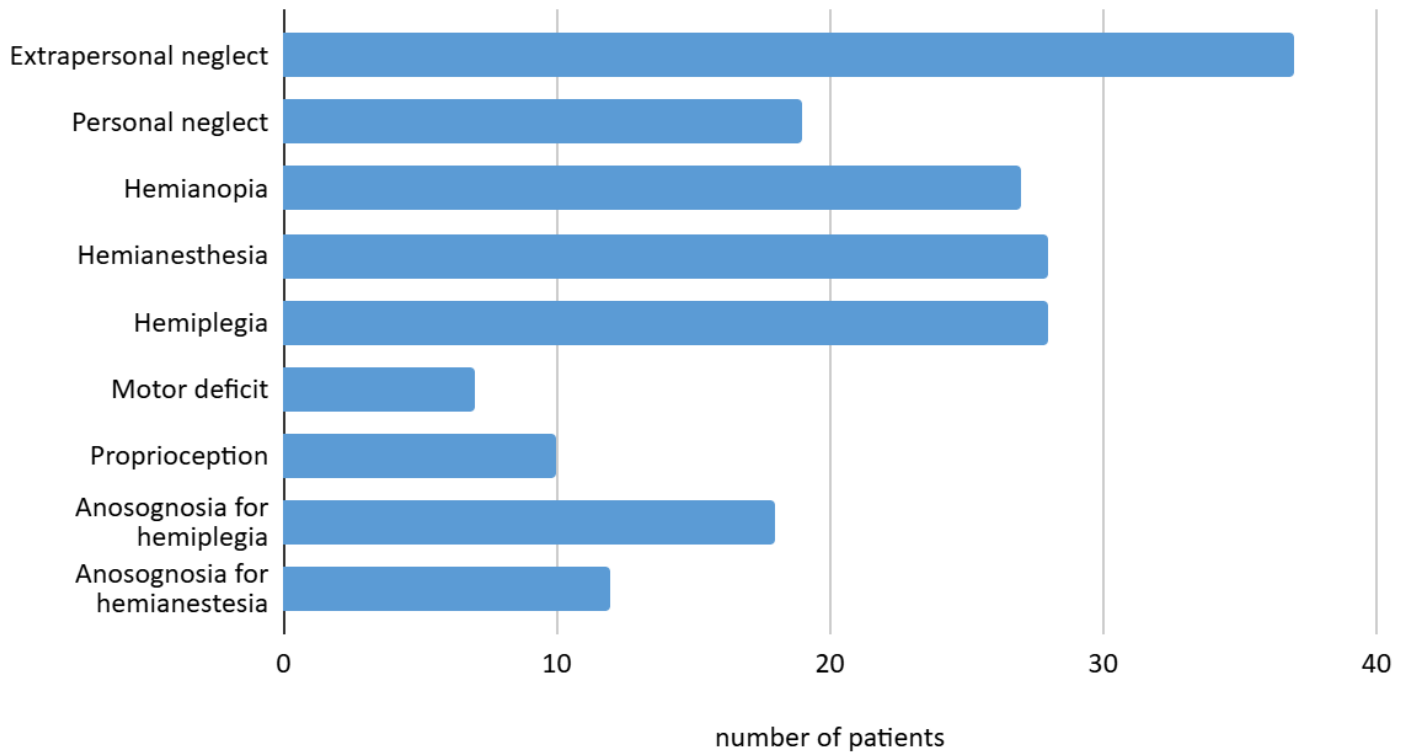
Delusional misidentification (10; 44%); Asomatognosia (3; 13%); Anosognosia (3; 13%).

General confabulation toward affected limb (2; 9%); Delusional Supernumerary Phantom limb (1; 5%); Impaired sense of ownership (1; 4%); Neglect for a limb (1; 4%)

schizophreniform illness (1; 4%); Schizophrenia and addiction (1; 4%).

Figure 4 graph of the most frequent deficit associated with SP

Deficit associated with SP



Extrapersonal neglect (37 p.); Personal neglect (19 p.); Hemianopia (27 p.); Hemianesthesia (28 p.); Hemiplegia (28 p.); Motor deficit (7 p.) Proprioception (10 p.).

Anosognosia for hemiplegia (18p); Anosognosia for hemianesthesia (12 p.).

CHAPTER 5 -DISCUSSION

The present scoping review has as its primary objective the individuation of somatoparaphrenia misdiagnoses; a misdiagnosis could present itself as an incorrect diagnosis of a different disorder being given the label of SP, a case of SP that has been categorized as a distinct disorder or, lastly, cases present in studies in which SP is not even mentioned but the presented patient/s show significant symptoms of SP.

The current review attributes these errors mainly to two causes: the first being unclear and undefined diagnostic parameters and lack of a clear definition, and the second being the source of the first cause, meaning the historical errors occurred in the definition of somatoparaphrenia since its first appearance in the literature in 1935.

For this reason, it is important to identify the exact moments in the literature in which the definition of somatoparaphrenia has been merged with other disorders or classified using the wrong parameters.

5.1 Misdiagnosis

5.1.1 Somatoparaphrenia and Misdiagnosis

From the first appearance of somatoparaphrenia in the literature in 1935, “The Image and Appearance of the Human Body: Studies in the Constructive Energies of the Psyche” (Schilder), 19 years later, in 1954, we find its first misdiagnosis in a study from Weinstein et al. with the title “Delusional reduplication of part of the body.” In the paper, somatoparaphrenia is mistaken for Delusional Supernumerary Phantom limb syndrome. In the cited study, the patient presented somatoparaphrenic symptoms, but the diagnosis was “Delusional reduplication of part of the body”.

Confusion around somatoparaphrenia can also be traced back and attributed to a 1990 study by Feinberg, “verbal asomatognosia,” in which he focuses on the study of the neuroanatomy of

asomatognosia. Still, he committed the error of merging the 2nd and 3rd disorders of Gerstmann classification (*page 9*): asomatognosia and somatoparaphrenia.

This will be the beginning of a series of many misdiagnoses; 23 only in this review accounted for today, to be precise (*table 2*), with the last misdiagnosis in 2023 (Mancuso et al., 2023).

Therefore, it is difficult to consider the time period as the leading cause of misdiagnoses. It is more plausible that the diagnostic criteria were not sufficiently defined, clear, and demarcated.

Searching the keywords “somatoparaphrenia misdiagnoses/is” in the PubMed platform, no precise results or works focus specifically on the misdiagnoses of SP. Therefore, it is essential to this study to provide the most exhaustive and clear explanation and data regarding the phenomenon of misdiagnosis.

5.1.2 Disorders misdiagnosed as Somatoparaphrenia

The 23 misdiagnoses found in the selected studies can be grouped into nine categories (*figure 3*): Delusional misidentification (44%, 10 cases); Asomatognosia (13 %, 3 cases); Anosognosia (13%,3 cases); general confabulation toward affected limb (9%, 2 cases); delusional supernumerary phantom limb (5%; 1 case); Impaired sense of ownership (4%, 1 case); Neglect of a limb (4%, 1 case); Schizophreniform illness (4%, 1 case); Schizophrenia and addiction (4%, 1 case).

Delusional misidentification appears to be the principal diagnosis wrongly attributed to somatoparaphrenia, with a percentage of 44%.

“Delusional misidentification syndromes (DMS) include conditions in which a false belief about the identity of a person, place, or object occurs in the context of psychiatric or neurological disorders” (Roane et al., 2019); in this specific case, the delusional misidentification happens to the affected limb/s. DMS is a broad term that accounts for misidentification without specifying

the characteristics. Being such a broad term sounds reasonable to understand why it was the main misdiagnosis, accounting for 44%, given that one of the main characteristics of SP is misidentification.

Asomatognosia is the second most outstanding misdiagnosis. This data is entirely predictable due to the close nature of asomatognosia and somatoparaphrenia. As previously mentioned, the discovery and definition of the two have always been quite confused, with unclear boundaries that sometimes have merged into each other. It is important to remember with great clearness that the element distinguishing SP from asomatognosia is the presence of a delusional misattribution of the non-recognized limb, which is absent in the latter.

Subsequently, anosognosia counts the same misdiagnosis as asomatognosia, and as previously mentioned, it refers to the active denial of a motor deficit of the affected limb through verbal confabulation. Here, we find again the element of confabulation, which, as previously mentioned, is characteristic of SP. However, the type of confabulation expressed is different in nature from the one in SP. Anosognosia can be found in the form of anosognosia for hemiplegia and anosognosia for hemianesthesia. As stated in this review, both asomatognosia and anosognosia for hemiparesis/hemiplegia have been widely present in the literature as deficit correlated/merged or misdiagnosed as SP, so the result could have been reasonably expected.

Another frequent misdiagnosis found is general confabulation toward the affected limb, which refers to the active production of confabulations involving the affected limb. The term general confabulation is also very broad. We can find confabulation in many disorders, neurological and non. Confabulation is always present in SP, but (sometimes milder) forms can also appear in other deficits or psychiatric disorders.

The supernumerary phantom limb (SPL) was a peculiar and unexpected misdiagnosis. SPL is a rare neuropsychiatric syndrome under which patients perceive more limbs than they anatomically possess (e.g., two instead of only one right arm) (Braun et al.,2020). While it is true that SP is

characterized by confabulation regarding the contralesional limb, the delusion of owning more limbs than the anatomical possessed has never been a trait of SP. Drawing on the literature to have better insight, the phantom limb is a phenomenon characterized by the delusional belief of the presence of a non-existent limb (Cipriani et al., 2011). Therefore, it is possible to attribute the confusion of the misdiagnosis to the delusional nature of the manifestation of this syndrome since SP is known for its confabulatory and delusional elements.

Lower in concentration, we find an impaired sense of ownership, which reflects a sense of disownership of the patient toward the affected limb and neglect of a limb that refers, in this specific case, to the denial of existence and ownership of the affected limb. The feeling of disownership, while on the one hand, is essential for the diagnosis of SP, on the other hand, is not sufficient on its own to classify for an SP diagnosis. The same concept could be applied to neglect of a limb; while present on SP diagnosis, it does not qualify for a complete SP diagnosis on its own.

The last two categories, Schizophreniform illness, and Schizophrenia and addiction are incredibly significant from an empirical point of view. They portray a critical aspect of the difficulty in diagnosing somatoparaphrenia. Somatoparaphrenia, due to its confabulatory component and delusional misattribution of the affected limb to someone else, has been confused for a psychiatric condition such as schizophrenia instead of a neuropsychological condition. It was mentioned that SP was described as having “psychotic qualities”. The confabulations and the delusions of SP patients can reach a level of distance from reality that, even for a scientific mind, could be hard to place as neuropsychological deficits following a brain trauma rather than a psychiatric disorder.

5.1.3 Insights on the Misdiagnosis Present in the Articles Selected for the Scoping Review

As previously mentioned, three of the 23 articles presenting misdiagnoses presented cases of undiagnosed somatoparaphrenia (table 2).

As explained before, somatoparaphrenia is thought to be a rare condition. However, more general alterations of body representation have been reported in up to 15% of right brain damage patients (Baier & Karnath, 2008; Moro et al., 2016). This finding suggests that SP could sometimes be misdiagnosed or unnoticed by clinicians.

This exception of SP being unnoticed by clinicians has been found three times only in the studies considered for the review. Three practical examples of this eventuality will now be given.

In the first case (Weinstein et al., 1954), the patient showed delusional reduplication of part of the body, but she also showed somatoparaphrenic symptoms that were not accounted for. In fact, she declared multiple times that “her hand belonged to the doctor.”

In the second case (Starkstein et al., 1990), the patient was diagnosed only with anosognosia and depression, although she showed confabulation and misattribution of the art to someone else; “The patient claimed left arm was not hers and belonged to a nearby person.”

The third and last case (Levine et al., 1991) was present in the study 1 case of undiagnosed SP: The patient misidentified her left arm as her husband’s.

These are only three examples of the multitude of times in which SP was unnoticed by clinicians; even though this scoping review was conducted as thoroughly as possible, the eventuality of SP being unnoticed will probably account for much higher numbers.

5.2 Previous Literature on the Topic of Somatoparaphrenia

Over the years, several authors proposed different studies on somatoparaphrenia and asomatognosia, focusing attention on various features and elements of the disorders.

The main studies with a peculiar view regarding the topic are reported here. In 2009, Feinberg et al. found a factor of incredible importance in distinguishing between simple asomatognosia and somatoparaphrenia. According to the authors, Asomatognosia follows large lesions involving multiple (including temporoparietal) sectors. The finding of the addition of orbitofrontal dysfunction will be of extreme relevance; according to the authors, it distinguishes somatoparaphrenia from simple asomatognosia. The data indicate the implication of the right medial and orbitofrontal regions in confabulation and self-related systems. Specifically, firstly, all cases of the author's investigation were diagnosed with temporoparietal lesions and hemispatial neglect; secondly, all patients with asomatognosia had medial frontal lesions critical for the disownership of the limb. Finally, and most importantly, the additional right orbitofrontal lesion contributes to the extended and confabulatory responses typical of SP (Feinberg et al., 2010). This first study shows that SP often follows greater and wider lesions than other BADs.

Romano & Maravita, in 2019, investigated through three cases of SP the theoretical framework of this neuropsychological condition. They propose a theoretical account in which the key element responsible for the feeling of disownership of patients with SP could be a defective update of the ongoing dynamic representation of the body finalized to perception and action. Moreover, according to the authors, the delusional misattribution of the contralesional limb would be the direct consequence of the erroneous spatial representation of said limb (Romano & Maravita, 2019). The study's relevance relies on creating a theoretical framework of SP based on a defective update of the dynamic representation of the body, which is essential to perception and action.

In 2018, we can find an extremely innovative take on somatoparaphrenia based on the concept of the vestibular system, which plays a fundamental role in the behavioral and physiological aspects

of body representation. In the study, Salvato et al. found that caloric vestibular stimulation (CVS) of healthy subjects causes body representation distortions, followed by decreased body temperature. Surprisingly, CVS in brain-damaged patients momentarily restores body representation disorders. The authors presented a case of a patient affected by SP who regained the sense of body part ownership after the caloric vestibular stimulation. The idea derived from the results is that physiological signals play a fundamental role in maintaining a coherent mental representation of the body. (Salvato et al., 2018). The groundbreaking aspect of the study is that it has demonstrated that CVS can restore the sense of limb ownership in an SP patient, even for a limited time.

Back to the topic of misdiagnosis derived from literature, a large part of it came from four reviews:

(1) Perren et al. "Crossed" somatoparaphrenia: an unusual new case and a review of the literature, 2015; (2) Braun et al., Psychic tonus, body schema and the parietal lobes: a multiple lesion case analysis, 2007; (3) Giuseppe & Ronchi, Somatoparaphrenia: a body delusion. A review of the neuropsychological literature, 2009 (4) Feinberg & Venneri, Somatoparaphrenia: evolving theories and concepts, 2014.

In these reviews, patients were cataloged respectively as "Eight cases of right-sided somatoparaphrenia (crossed somatoparaphrenia) with left hemispheric lesions"; "Cases of somatoparaphrenia following unilateral parietal lesions," "Demographical, neurological and neuropsychological data of 56 hemisphere-damaged patients with somatoparaphrenia" and "Reported cases of somatoparaphrenia with sufficient clinical data".

The diagnostic criteria used to consider the patients in these four reviews did not follow the previously shared definition of SP. The diagnostic criteria were not as defined as they should be for an SP diagnosis; the crucial element, i.e., attributing the limb to someone else, was not always present and considered for diagnosing the four review cases. For this reason, in this work, every article considered and categorized as SP in the four reviews cited was singularly analyzed, and the

patients were classified according to the declared parameters.

5.3 An Overview of the Patients in the Scoping Review

As mentioned in the result section, the total number of patients eligible for the review was 153. The sample has numerous limitations since patients belong to 40 different studies that do not share the same diagnostic criteria due to the different time periods, authors, and countries. The number of “correct” (following the scoping review parameters) patients’ diagnoses of SP, excluding the diagnosis of other disorders of body awareness, was 42. The number of misdiagnoses was 55 patients. Excluding the different disorders, on a sample of 97 possible cases of SP, 53,35% resulted in misdiagnoses. This means that more than half of the patients in whom SP could have possibly been involved was misdiagnosed. (*Figure 2*).

Moreover, the parameters of age, gender, and handedness will not be considered in the analysis because the majority of articles did not include this information. Even if these data were analyzed, they would not be representative of the sample.

5.4 Deficits Associated with Somatoparaphrenia

Even though the scoping review's main focus is the misdiagnosis of somatoparaphrenia, the data regarding the deficit associated with SP were analyzed. This type of data was relevant to the review's statement that SP usually follows a more severe clinical picture than other BADs and is, therefore, more frequently associated with a more significant number of deficits or deficits with higher severity. *Figure 4* indicates the deficits primarily associated with SP.

Extrapolational neglect was the deficit present in the highest concentration (present in 37 patients). Extrapolational (‘hemispatial’) neglect refers to patients who neglect extrapolational space, named ‘hemispatial neglect,’ and fail to acknowledge environmental stimuli contralateral to the brain

lesion (Adair & Meado, 2014). Personal neglect instead was present but in a lower concentration. It was found in SP 19 patients. Personal neglect consists of impairments in the representation of the contralesional side of the body or a dysfunction of the mental representation of the contralesional space. (Baas et al., 2011).

It is important to report that in a 2019 study by Romano and Maravita, it was underlined that SP usually follows massive hemispheric damages; for this reason, it is associated with other deficits in body awareness and space processing. Among the deficits, we can annoverate anosognosia, unilateral space neglect, and personal neglect. For this reason, the scoping review result of extrapersonal neglect being the most frequent deficit correlated with SP is merely a confirmation.

In 28 cases, the presence of Hemianesthesia and Hemiplegia was registered. As mentioned in the introduction, hemianesthesia is the loss of sensation in the contralesional side of the body. At the same time, hemiplegia is a condition identified by the paralysis of one side of the body, often coupled with symptoms such as visual disturbances, sensory loss, and difficulty with speech (Piña-Garza & James, 2013). These results are under-representative of the two pathologies that, due to the extensive brain damage, are an essential part of SP. Moreover, in the literature, it is possible to find studies that report the frequent association of hemiparesis/hemiplegia and the presence of somatoparaphrenia” (Vallar & Ronchi, 2009; Baier & Karnath, 2008; Perren et al., 2015 Jan).

Anosognosia for hemiplegia (18 patients) and hemianesthesia (12 patients) were found in many cases. Anosognosia for hemiplegia/hemianesthesia is also quite an expected result since, according to previous literature regarding anosognosia for hemiplegia/hemianesthesia, SP has been associated most frequently with anosognosia for hemiplegia (Gandola et al., 2012).

Still high in concentration among deficits, we can find hemianopia, which represents the patients’ failure to adequately respond or report contralesional visual stimuli. Hemianopia can result from lesions in the early visual pathways (Postma & van der Ham, 2017). The deficit is accounted for

in 27 patients. Being a deficit regarding vision on the contralesional side, the high presence of the deficit is very sensible. It can be found in many cases of SP in the literature as an associated deficit. Finally, a deficit in proprioception (10 p.) and a motor deficit (7 p.) were also present but in a lower concentration. The low concentration is almost certainly due to difficulty identifying the symptoms under more specific diagnostic labels. Both a difficulty in proprioception and a motor deficit are umbrella terms that do not allow a precise description of the patient's symptomatology.

5.5 Somatoparaphrenia: A Shared Definition

To answer one of the scoping review's primary objectives, “How can somatoparaphrenia be correctly defined?” it will follow a current definition of the disorder that could be considered exhaustive and extremely useful regarding diagnostic objectives.

According to today's shared definition (Gerstmann, 1942; Vallar & Ronchi, 2009; Feinberg & Venneri, 2014), somatoparaphrenia (SP) is a neuropsychological condition characterized by delusional feelings about the patient's body. The crucial characteristic distinguishing the disorder from the other disorders of bodily awareness is the presence of an ownership misattribution of the denied limbs. The illusory sense of disownership of the patient contralesional limbs is instead shared with disorders such as asomatognosia.

SP is characterized by an intense sense of disownership toward the affected limb (asomatognosia) that has to be coupled with the delusional attribution of the limb to someone else. (Romano & Maravita, 2019).

The attribution of the denied limb must be specific to a person/individual; that could be family members, friends, examiners, medical practitioners, or even strangers. If the patient is asked, “Who does the limb belong to?” and the answer received is “I do not know/I am not sure,” then it does not fully meet the criteria for the diagnosis of somatoparaphrenia.

It is imperative to underline that those beliefs of disownership cannot be attributed to generalized delirium or psychiatric disorder.

Due to this peculiar trait, SP has been misdiagnosed with different disorders of bodily awareness and not since its first appearance in the literature.

5.6 Crossed Somatoparaphrenia

As stated before, there were 42 somatoparaphrenic patients in total; three of these 42 patients were diagnosed with a specific form of somatoparaphrenia, crossed somatoparaphrenia. Even though crossed somatoparaphrenia is extremely rare, it is worth mentioning for scientific and diagnostic purposes.

Somatoparaphrenia is coherent with what is written in the review “has been reported, with a few exceptions, in right-brain-damaged patients, with motor and somatosensory deficits, and the syndrome of unilateral spatial neglect” (Vallar & Ronchi, 2009). The few “exceptions” mentioned refer to the manifestation of SP in left-brain-damaged patients named “crossed somatoparaphrenia.” although very rare, it is clinically interesting and could add to the understanding of the whole disorder.

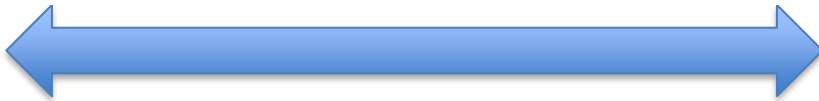
To clarify, crossed-SP is a type of SP following a left-hemisphere lesion. As mentioned before, SP follows almost exclusively lesions of the right hemisphere, which is considered mainly responsible for visuospatial processes. Therefore, to present with a form of somatoparaphrenia after a lesion in the left hemisphere is considered extremely rare.

In literature, we can find a paper on the topic titled "Crossed" somatoparaphrenia: an unusual new case and a review of the literature.” (Perren et al., 2015). The article gives interesting insights on crossed somatoparaphrenia, but the case presented follows the diagnostic criteria of this scoping review and is not a case of SP. The patient denies ownership of the limb but does not attribute

ownership to someone else. So, on the one hand, the study gives crucial diagnostic insight, but on the other hand, it is not entirely accurate in the case study.

5.7 Somatoparaphrenia on a Continuum

Figure 5. idea of a continuum



The word continuum comes from the Latin *continuus*, literally “continuous.” The Cambridge Dictionary defines a continuum as “something that changes in character gradually or in very slight stages without any clear dividing points”. Still, it is also, according to the Oxford Dictionary, “a series of similar items in which each is almost the same as the ones next to it, but the last is very different from the first”.

The word continuum, concerning the disorders of bodily awareness, first appeared in the literature in the 2009 work of Vallar and Ronchi. In it, they place hemi-asomatognosia and feelings of absence on a continuum, affirming that “the continuum between these disorders is apparent.”

The idea of these disorders being placed on a continuum is not as recent. Already in 1953, Critchley wrote that these phenomena (referring to the disorders of body awareness) “are not sharply demarcated. Not infrequently, one condition merges into another or perhaps alternates with another.”

The fact that the disorders of bodily awareness share many similarities, despite the presence of characteristics only specific to one, is evident. Should SP place itself on a continuum with other bodily awareness disorders, or should it be considered separately?

It is extremely important to underline, once again, that somatoparaphrenia has psychotic qualities that do not depend on generalized delirium or psychiatric disorder, has productive features,

presents an ownership misattribution, and has delusional and confabulatory elements that cannot be explained only by lesions.

In the literature, it is specified that somatoparaphrenia appears in patients who have overall larger lesions when compared with patients with only neglect, anosognosia, or those who lack extensive delusions and confabulations (Feinberg et al., 2010) or neglect without somatoparaphrenia (Gandola et al., 2012; Feinberg & Venneri, 2014). This finding again underlines the severity of somatoparaphrenia in its manifestation and the lesion gravity. Finally, the number of deficits associated with SP patients presented in this scoping review was exceptionally high, especially “extrapersonal Neglect”; the reason for this result is previously explained.

In conclusion, it is hard to imagine SP belonging on a continuum with the other cited bodily awareness disorders due to its peculiar and specific characteristics and the severity of brain lesions unique to it. However, finding it hard to picture SP belonging to the continuum does not entirely exclude the possibility of it actually belonging to it. Further research would be needed to confirm this hypothesis's veracity.

6.0 Limitations

The articles considered for the scoping review cover a period of time from 1935 to 2023.

The diagnostic criteria used in the studies varied significantly from study to study. Every article differs in identifying deficits connected to SP and other bodily awareness disorders, and the deficits are often not registered. For this reason, the count of deficits associated with SP is based only on the articles where the information was present, so it is an approximation of the deficit association. Moreover, the parameters age, gender, and handedness were not considered in the analysis because most articles did not include this information.

Finally, many articles were not written in English; therefore, the patient's diagnosis and statements had to be translated. Inevitably, the translation entails a less accurate description of the symptoms and the patients' direct speech.

6.1 Future Directions

Many limitations restrained the present scoping review; for future research, finding a sample of individuals diagnosed using the same diagnostic criteria would be advisable. This would allow a more equal and fair comparison between SP patients. For example, it would allow the data regarding the deficit associated with SP to be more representative. SP being quite rare will allow for a smaller sample. Reflecting on the idea of a continuum between bodily awareness disorders (and SP) could bring important insights into the research and how they are conceptualized.

Finally, for future studies, it is extremely important to report the exact testimony of the SP patient, even with the use of direct speech. Only the patient's description of the disorder and the transcription of the latter will eventually allow mistakes to be corrected in the diagnosis. Furthermore, patients' direct speech helps us better understand their experience.

6.2 CONCLUSIONS

The present scoping review contains a new and more unified view of somatoparaphrenia. It offers more detailed criteria for a precise diagnosis of somatoparaphrenia, defining the main characteristics unique to this disorder. This goal is crucial because of the rarity and the short duration of its manifestation. The misdiagnosis presentation was a means to get a unified view of SP and diagnosis accuracy.

Two points should be followed in future research: It is essential to pay attention to the description of the limb's misattribution; the misattribution must be complete, meaning the limb must be attributed to a known subject. Second, it would be highly recommended to report the patient's experience in their direct words; this would allow more support for the diagnosis and could be a helpful tool for everyone approaching the case report.

Generally speaking, employing a strict diagnostic methodology following the criteria and guidelines presented in the review would allow future studies to obtain a more precise and accurate patient sample that would be more indicative of somatoparaphrenia and its deficits. This would enable more precise mathematical data to investigate the deficit associated with somatoparaphrenia and reach a more thorough understanding of the disorder.

Finally, the reasoning behind the idea of the disorders of bodily awareness being placed on a continuum and among these disorders, if somatoparaphrenia itself can belong on said continuum, could have great diagnostic significance.

6.3 SIGNIFICANCE STATEMENT

In recent years, the research on bodily awareness disorders has reached a more prominent place in the research field. Shedding light on bodily awareness disorders and somatoparaphrenia can allow a more precise understanding and diagnosis according to a better conceptualization of bodily awareness. The present scoping review will possibly be a tool for diagnosing somatoparaphrenia

and will serve as an example of the difficulty in discerning disorders of body awareness. Finally, reading the disorder in the words of the affected patient is thought to help concretize the disorder; otherwise, it is more theoretical than concrete.

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