

NEUROPSYCHOLOGY OF PALINOPSIC HALLUCINATIONS

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SUMMARY

Background. *The continued visual appearance of an object after its removal, for either an intermittent or noticeably sustained period of time, is known as palinopsia. Two types of palinopsic hallucinations are identified: Type 1 hallucinations demonstrate size constancy and the newly proposed principle of semantic matching; Type 2 hallucinations obey Emmert's Law, as does afterimagery.*

Case report. *The palinopsic hallucination and neuropsychological test results of a man who sustained a penetrating injury in the right temporo-parietal area are presented.*

Conclusion. *A theory is outlined in which semantic matching in Type 1 hallucinations is mediated by the right temporal lobe, and the perseverative palinopsic effect in both types of hallucination is attributed to the reciprocal influence of cortical release and abnormal patterns of synchrony within thalamo-cortical visual pathways.*

INTRODUCTION

The sustained visual appearance of an object after its removal is known as palinopsia [Critchley 1951, Kinsbourne & Warrington 1963]. In the first reported case, Pötzl [1988] described a patient with characteristic symptoms. Visiting the courthouse, he "saw a number 67 [above a certain door] and subsequently the same number 67 over all doors" (p. 287). He also saw a man wearing a hat made of chamois cloth and later perceived "all other people with a chamois hair hat" (p. 287). In the neurology clinic "he was examined by doctors, one of whom was bald; he now saw all the people around him with bald heads, including a black-haired woman" (p. 287). Unlike this man's

hallucinations, which replicated objects seen during daily life, palinopsic imagery may also be imaginary and not based on previously perceived physical objects. For example, the perseverative visual effect of palinopsia has been noted in simple hallucinations associated with encephalitis [Mize 1997] and drug toxicity [Kluver 1966].

Palinopsia is usually a transient symptom associated with the progressive or subacute stage of the responsible neurological process [Ardila et al. 1987, Lazaro 1983]. The hallucinated imagery often occurs exclusively within the area of a visual field defect [Feldman & Bender 1970]. In palinopsic patients with a focal lesion, localization usually involves the posterior areas, particularly the occipital and temporo-occipital areas of the right cerebral hemisphere [Vaphiades et al. 1996]. Complicating its diagnostic significance, palinopsic hallucinations are not invariably associated with a postgeniculate lesion. Disease of the eye, the optic nerve, or the optic tract may produce spontaneous visual phenomena, including palinopsia [Jacome 1985, Lepore 1990]. Furthermore, palinopsic hallucinations in epilepsy may differ clinically from comparable symptoms in focal brain damage and lack equally definite localizing significance [Swash 1979, Cummings et al. 1982]. In psychiatric cases without previously identified neurological disease, palinopsia occurs very rarely [Marneros & Korner 1993]; in neurological cases without prior psychiatric disturbance, the confusion and emotional burden of experiencing palinopsia have induced a psychiatric reaction [Gates et al. 1988].

Palinopsic hallucinations appear either intermittently or for a noticeably sustained period of time. The intermittently occurring variety, known as polyopia, is viewed as an instance of the broader category of palinopsia [Critchley 1951]. In palinopsic imagery of previously perceived physical objects, the temporal delay between first seeing the object and its later hallucination varies in length. Such imagery tends to appear within moments, seconds, or minutes [e.g. Bender et al. 1968], although delays of several hours have been described [Cummings et al. 1982], and in one instance a delay of 8-10 years [Feldman & Bender 1970]. The varied temporal delays suggest that palinopsia may draw on remote memory and does not rely exclusively on iconic memory or the recursive processing of working memory.

Palinopsia may be likened to three additional types of preservative abnormality [Critchley 1951, Jacobs et al. 1973]:

- palisomesthesia, involving a sustained sensation of touch;
- palipraxia, when motor activity is experienced despite have ceased;
- palinacousia, in which sound is heard over time, or recurs, despite the absence of acoustic stimulation.

Similarly, palinopsia has occurred in association with two, relatively complex reduplicative abnormalities whose content is emotional and influential for the sense of personal identity: the Capgras syndrome and the experience of subjective doubles [Joseph 1986]. These varied examples suggest an underlying and broadly influential disinhibitory abnormality.

Surveys of the incidence of visual disturbance indicate that palinopsia as an isolated symptom is rare, occurring in 3-4% of cases examined [Gloning et al. 1968, Lepore 1990]. However, palinopsic hallucinations are usually associated with other types of visual symptoms [Bender et al. 1968, Vaphiades et al. 1996], such as porropsia (during which the imagery recedes into the distance) and macropsia (in which it increases in size), and in this context the incidence of palinopsia may be as high as 20% [Lepore 1990].

Three broad explanations of palinopsia have been proposed. Developing an hypothesis introduced by Critchley [1953], Kinsbourne and Warrington [1963] concluded that palinopsia "is not a phenomenon sui generis, but represents a pathological enhancement of normal physiological processes relating to visual after-sensations [afterimagery] and shows similar regularities even in its abnormal setting" (p. 475). Michel and Troost [1980] attributed palinopsia to "defective visual information processing in the occipital lobe ... resulting from disordered temporal synthesis of observed visual information", and spoke in general terms of "abnormal cortical and subcortical control of visual synthesis" (p. 889). Recent explanations [Lance 1986, Cummings et al. 1982, Vaphiades et al. 1996] identify palinopsic hallucinations (as well as other types of visual hallucinations of non-migrainous and non-epileptic origin) as "release phenomena caused by spontaneous activity in the visual association cortex deprived of its normal afferent flow" [Lepore 1990, p. 444].

This study identifies two types of palinopsic hallucinations based on an analysis of 33 individually reported cases and an additional group of 17 cases discussed in aggregate and only in terms of generalizations. Type 1 hallucinations demonstrate size constancy and the newly proposed principle of semantic matching, which is meant to account for the selection of the hallucination's projection site in external space. Type 2 hallucinations obey Emmert's law, as does afterimagery, and on this basis are subject to a change in size depending on the apparent distance of the hallucinated imagery. The second section is a case study of a man who sustained a gunshot wound in the posterior area of the right cerebral hemisphere and subsequently experienced Type 2 hallucinations. Test results from administration of an expanded Halstead-Reitan Neuropsychological Test Battery are reported. The third section proposes a theory in which semantic matching in Type 2 hallucinations is mediated by the right temporal lobe, and the specifically perseverative effect of palinopsia in both types of hallucinations is attributed to the combined influence of cortical release and abnormal patterns of synchrony within thalamo-cortical visual pathways.

PALINOPSIC HALLUCINATIONS

Type 1 hallucinations

The projection site of some palinopsic hallucinations conveys a similar meaning as the physical object which forms the basis of the hallucination.

Pötzl [1988] made a comparable observation when he defined palinopsia as "an iterative reaction in which a constantly positive image was projected in correspondence with the place of other visual objects, their direction and their order" (p.287). For example, a man perceived his wife rubbing her face with both hands immediately after watching an actress on television rub her own face with both hands [Bender et al. 1968]. Another person, the day after she attended a Christmas party where one guest wore a Santa Claus costume, saw multiple actual pedestrians wearing caps and coats like those of the costumed Santa [Meadows & Munro 1977]. Another woman, after watching a familiar actor on television, walked into the next room, where she saw this actor's face superimposed on the faces of her actual dinner guests [Michel & Troost 1980]. In each instance, the palinopsic hallucination supplants or supplements certain features of the projection site, forming a new, composite image whose meaning is comparable to that of the original visual stimulus. The selection of the specific projection site of the hallucination has apparently been constrained by the meaning of the original stimulus, suggesting an abstract or categorical factor that operates spontaneously in the selection of the projection site. In the first example, the wife, like the actress, was perceived rubbing her face, not some other part of her body. Similarly, Santa's cap and coat appeared on the bodies of pedestrians and were not projected on a storefront window or some other surface; and the actor's face was positioned appropriately on the faces of the dinner guests, the palinopsic imagery substituting for their actual faces. Such examples suggest that some palinopsic hallucinations entail a comparison of the meaning of the original visual stimulus and the potential projection sites for the subsequent hallucination. A suitable term for this effect is semantic matching.

One feature of palinopsic hallucinations that show semantic matching is comparable evidence of size constancy in the original visual perception and the subsequent hallucination. In this sense, the hallucination is normally proportioned relative to the projection site and does not show metamorphopsic distortion of its size or shape. In the earlier examples, Santa's cap and coat fit the pedestrians' bodies, as did the cap and coat of the costumed Santa at the Christmas party; the wife's hallucinated hands were proportioned normally, as were the hands of the television actress who served as the prototype for the subsequent hallucination.

The factors contributing to size constancy in normal perception are presumably also operative during this type of palinopsic hallucination. These include distance cues, the physical background or setting of the perceived object, and, most significant in the present context, the object's familiarity [Schiffman, 1976; for discussion of the central origin of size constancy, see Wyke 1960]. An object's familiarity is based on its meaning, which also influences the perception and interpretation of the related distance cues and setting. Similarly, semantic matching concerns the conceptual likeness, or shared meaning, of a particular physical object and the corresponding internal

image which takes form as the palinopsic hallucination. In this sense, meaning, or semantic value, may be viewed as a conceptual factor necessary for size constancy in the palinopsic hallucination, as it is for size constancy in normal visual perception. The comparable role of size constancy in visual perception and this type of hallucination draws general support from the observation that overlapping structures and related cognitive processes subserve both visual perception and imaginary imagery [Farah 1996].

Type 2 hallucinations

Emmert's Law is a well known but not fully understood perceptual principle that has been studied most extensively in the context of afterimagery [Schiffman 1976, Gregory 1987]. Briefly stated, the perceived size of an object, viewed as an afterimage, is directly related to the apparent distance of the site where the image is projected. The projection site of the afterimage is not necessarily a physical surface, but may instead be determined by the focus of attention, in which case the apparent distance of the image is determined by the distance of the focal point of attention. Furthermore, foveation and attentional focus may be independent [Posner 1996], indicating the possibility of a projection site other than the surface to which the eyes are directed.

Palinopsic hallucinations that demonstrate metamorphopsic distortion tend to obey Emmert's Law, meanwhile contravening size constancy. For example, a human eyeball seen originally during a television program assumed much larger proportions when hallucinated on a nearby wall, "being six feet big and covering an entire wall" [Bender et al. 1968, p. 329]. Similarly, the hallucinated images of printed words, seen originally in a newspaper held at arm's length, expanded, becoming "about a foot high" (p. 329), as their projection sites receded. And a giraffe, rather than conveying the animal's large size, was perceived as "small ... [when hallucinated] standing beside a [nearby] lamp-post" [Critchley 1951, p. 273].

DISTRIBUTION OF PALINOPSIC HALLUCINATIONS

Of 33 individually reported cases of palinopsia, 12 (36%) demonstrate semantic matching and size constancy; 4 (12%) demonstrate Emmert's Law, but not semantic matching; 15 (45%) case reports provide too little information to make a determination of their type; and 2 (6%) include clinical information inconsistent with the criteria for either type of hallucination [Bender 1945, Bender et al. 1968, Bender & Sobin 1963, Critchley 1951, Cummings et al. 1982, Feldman & Bender 1970, Kinsbourne & Warrington 1963, Meadows & Munro 1977, Michel & Troost 1980, Pötzl 1988]. An additional study refers to 17 cases, an unspecified number of which appear to be identical to cases reported individually in the other reports, and the remainder are discussed in aggregate and only in terms of generalizations [Feldman & Bender 1970].

The palinopsic hallucinations in these 17 cases were identified generally as obeying Emmert's Law. Of case reports with detailed information, Type 1 hallucinations, showing semantic matching and size constancy, are the most common.

CASE REPORT

MN was a thirty-three-year-old, right-handed man, who had been shot above the right ear with a .22 caliber rifle at age 15. Surgery for removal of bullet fragments was followed by an uneventful recovery, and the medical history otherwise was unremarkable. A history of seizures was denied, and none had been observed by family members or hospital staff. MN had not received psychiatric treatment before onset of psychosis three years before the present hospitalization. Family members denied mental illness in members of the family of origin. MN earned the Graduate Equivalency Diploma after completing the 11th grade and had been gainfully employed for six years. More recently he had lived as a social isolate, whose basic needs were met through federal assistance. He denied drug use and reported drinking three beers per week.

His neurological examination was normal. A CT scan showed evidence of a right parieto-temporal craniotomy with underlying parenchymal damage. His EEG did not show epileptiform activity but did suggest a structural lesion in the posterior region of the right cerebral hemisphere. Audiometry demonstrated both high- and low-frequency losses for the left ear. Laboratory findings, including urine toxicology screening, were unremarkable. He was diagnosed with an organic mood disorder with manic features and treated with Cogentin 2mg bid, Lithobid 600 mg bid, and Prolixin 5 mg am and 10 mg qhs. His lithium level at the time of neuropsychological evaluation was 96 mEq/liter.

PALINOPSIC HALLUCINATION

MN described his hallucination of the geometric figure of a cube that had recurred over several months preceding hospitalization. The cubical form was defined by exceedingly thin lines that did not occlude nearby objects, and receded into the distance, meanwhile expanding in size. The cube surrounded MN, who was situated at its center. His hallucination, in other words, was palinopsic in its perseverative appearance, macropsic in its expansion, porropsic in its recession; and extracampine in its envisioned extension beyond his visual field. He denied a concurrent change in consciousness or associated motor, tactile, olfactory, gustatory, and auditory symptoms. The cube did not have a hemianopic bias in the sense of appearing to one side of the visual field or only within its defective area. He did not recall having seen in the past a similarly shaped physical or imaginary object, nor did he convey surprise or doubt about its extracampine extension. He felt the hallucination had religious significance, and this was apparent from the sense of awe and elation he conveyed while describing it.

The hallucination's form and definition by thin lines, and also MN's emotional experience of elation and religious significance, are similar to personal accounts of the broad class of geometrically-shaped visual hallucinations identified as hallucinatory form-constants [Kluver 1966, Siegel & Jarvik 1975]. Of particular interest, its expansion and recession, coupled with stability of form, indicate that the cube retained a constant visual angle with respect to MN. In this sense, the hallucination obeyed Emmert's Law.

TEST RESULTS

MN was administered an expanded Halstead-Reitan Neuropsychological Test Battery [Reitan & Wolfson 1985, Bradford 1992]. Of particular interest is the pattern of test results from sensory-perceptual, constructional, visual-spatial, and memory tests, indicating a focal lesion in the parieto-temporal area of the right cerebral hemisphere. These results include:

- a left-inferior quadrantanopia;
- left-sided suppression of stimuli in the superior and mid-field area during double-simultaneous visual stimulation;
- left-sided suppression during double-simultaneous auditory stimulation;
- the attribution of left-sided stimuli to the right side of the body during unilateral tactile stimulation ("alloesthesia");
- grossly dyspraxic block designs;
- profoundly impaired figural memory.

His doubling the designs of the figural memory stimulus indicated preservation, and the comparable deficit of confabulation was evident from his superfluous additions to the prose passage during verbal memory assessment [Russell 1988]. His ability to recognize unfamiliar faces was within the average range, as was his accuracy in judging line orientation [Benton et al. 1994]. Color perception, naming, and matching were fully intact.

COMPARABLE CASES OF PALINOPSIA

Two of the reviewed cases with damage in the right posterior area include results from neuropsychological tests. One report provides too little information to determine the type of hallucination [Meadows & Munro 1977, pp. 7f.]; the other shows size constancy [Cummings et al. 1982]. The test results in both cases are like MN's in showing severely impaired figural memory, implicating the probable contribution of impaired functioning of the right temporal lobe in palinopsic hallucinations.

THEORETICAL ASPECTS OF PALINOPSIA

Type 1 hallucinations: the right temporal lobe in semantic matching

Semantic matching may be interpreted as a visually mediated scanning process that seeks a meaningful association between a physical object and

the internal image that surfaces in conscious awareness as the palinopsic hallucination. Hallucinations occur spontaneously, thus the scanning process must occur subliminally and largely outside of voluntary control. Its two steps are, first, the registration of a semantic match between a physical object and an internal image; and second, the engagement of the strictly perceptual aspect of the scanning process concerned with establishing size constancy in the palinopsic imagery. The occurrence of a match marks the inception of the process and, in this sense, determines the moment of the hallucination's occurrence.

Semantic matching is like other clinical phenomena that demonstrate an abstract organizational factor. For example, the imagery of categorical hallucinations is limited to a particular class of objects, such as animals [Lance & McLeod 1981]. In deep dyslexia, paraphasic responses illustrate the selective deterioration of relatively independent semantic networks [Brown 1981]. Both semantic paraphasia [Benson 1979] and category-specific memory impairment [Warrington & Shallice 1984] reflect the organization of mnemonic and language-related processes along lines consistent with semantic determination. These several sets of symptoms reflect temporal lobe involvement, though not exclusively. Similarly, for MN (and the two noted cases with test data) markedly impaired figural memory suggests the contribution of right-temporal lobe dysfunction in palinopsia.

Granted that palinopsia, like other complex visual symptoms, reflects abnormal activity within widely distributed visual systems, what is the specific contribution of the right temporal lobe? This area, particularly its medial structures, provides access to the fund of visually mediated memories that emerge on the basis of comparison with the physical objects that represent potential projection sites of the palinopsic hallucination. Support for this view comes from studies of retrograde amnesia, which "suggest that at the time of the learning the medial temporal region establishes a functional relationship with memory storage sites, especially in neocortex" [Squire 1987, p. 209; see Koslyn 1994, whose associative memory module is localized in part in the temporal lobe]. Additional anecdotal support comes from reports that palinopsic "recurrence seemed to be initiated by recalling [*italics added*] the stimulus object" [Cummings et al. 1982, p. 445].

One test of the temporal-lobe hypothesis of semantic matching would involve distinguishing cases of palinopsia on the basis of their demonstrating either semantic matching or Emmert's Law. If the medial structures of the right temporal lobe are essential for semantic matching, Type 1 palinopsic hallucinations should not occur in persons with serious structural damage in this area. On the other hand, such persons may experience Type 2 hallucinations, as may persons with focal lesions outside the medial temporal lobe. MN is a case in point.

SUBCORTICAL FACTORS IN PALINOPSIA

Palinopsic hallucinations have been explained in a general way as cortical release phenomena. Focusing specifically on the perseverative effect of palinopsia, Michel and Troost [1980] refer to the "disordered temporal syntheses" of visual information, which they attribute to "abnormal cortical and subcortical control of visual syntheses" (p. 889). The present theory, drawing on both interpretations, explains palinopsia in terms of release hallucinations originating in the occipital lobe which have been altered in a palinopsic manner by abnormal thalamic influences. An analysis of MN's visual field defect illustrates this view in greater detail.

MN's left-inferior quadrantanopia resulted from damage to the superior aspect of the geniculo-striatal pathway in the right cerebral hemisphere, of which one result would be diminished or absent downstream flow to the corresponding areas of the occipital cortex. On this basis, conditions were met for abnormal activity within deafferented striatal and circumstriatal areas and the emergence of release hallucinations, which would be subject to additional shape processing as such abnormal occipital activity is transmitted along ventral pathways of the cortical visual system [Ullman 1996]. In this manner, abnormalities within the geniculo-striatal system provide the visual imagery which is later subject to the perseverative palinopsic effect, which itself is supplementary to such imagery and not a necessary feature of the release hallucination. The palinopsic effect is attributed to activity within the reciprocally related geniculo-striatal and tecto-thalamo-extrastriate visual systems. These two systems, one cortical and the other predominantly subcortical, are richly interconnected [Creutzfeldt 1988, Mesulum 1985, Uttal 1978]. The pulvinar receives input from Area 17, either directly or by way of the superior colliculus; and the visual association cortex is influenced by thalamo-cortical loops originating in the pulvinar. Pathways from Area 17 to the pulvinar bridge the two systems, promoting top-down communication originating in the occipital cortex.

This broadly encompassing cortico-thalamic visual network forms the basis of the communication of abnormal occipitally-based effects to the pulvinar and the associated disturbance of the thalamic mechanisms that influence higher-order processing in the visual association areas. The pulvinar plays "a central role for the functional organization of extrastriate visual areas" [Creutzfeldt 1988, p. 309], and does so by generating rhythmic activity that "encompasses discrete thalamo-cortical zones ... [and] controls restricted parts of the cortex" [Rougeul-Buser et al. 1978, p. 217]. In this sense, the pulvinar is a complex timing mechanism composed of multiple subsystems (thalamo-cortical zones) that influence the appearance, duration, and cessation of visual imagery. Absent normal patterns of synchrony among these subsystems, cortically-based hallucinations acquire the additional feature of palinopsic preservation. Briefly stated, disturbed thalamic functioning, derivative of cortical release, is the specific cause of the palinopsic effect.

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Neuropsychology is a branch of psychology that is concerned with how a person's cognition and behavior are related to the brain and the rest of the nervous system. Professionals in this branch of psychology often focus on how injuries or illnesses of the brain affect cognitive and behavioral functions. It is both an experimental and clinical field of psychology, thus aiming to understand how behavior and cognition are influenced by brain function and concerned with the diagnosis and treatment of... Hallucinations are a psychopathological phenomenon with neuropsychological, neuroanatomical and pathophysiological correlates in specific brain areas. They can affect any of the senses, but auditory and visual hallucinations pre-dominate. Verbal hallucinations reveal no gross organic lesions while visual hallucinations are connected to defined brain lesions. Functional neuroimaging shows impairments in modality specific sensory systems with the hyperactivity of the surrounding cerebral cortex. Disinhibition and expansion of the inner speech was noted with impaired internal monitoring in auditory verbal hallucinations. The subcortical areas and modal-specific associative cortex and cingulate cortex are essential for the occurrence of hallucinations. Neuropsychology of palinopsic hallucinations. Authors: David Bradford. Year: 2003, Volume: 1, Number: 2. The palinopsic hallucinations and neuropsychological test results of a man who sustained a penetrating injury in the right temporo-parietal area are presented. Conclusion. A theory is outlined in which semantic matchng in Type 1 hallucinations is mediated by the right temporal lobe, and the perseverative palinopsic effect in both types of halluciantion is attributed to the reciprocal influence of cortical release and abnormal patterns of synchrony within thalamo-cortical visual pathways. Keywords: Hallucinations, palinopsia, cortical release. 25. A neurolinguistic classification of aphasia. Neuropsychology of palinopsic hallucinations. Acta Neuropsychologica, 1(2), 97-107. In 1989, while actively hallucinating, he suffered a mild TBI in a pedestrian accident. Despite findings of organic dysfunction, he did not receive full neuropsychological diagnosis and treatment until four years later, when he presented with symptoms of perseveration, hemispatial neglect, and disturbances of working memory.