

## Hallucinatory Experiences in Extreme-Altitude Climbers

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**Objective:** This study attempted a systematic investigation of incidence, type, and circumstances of anomalous perceptual experiences in a highly specialized group of healthy subjects, extreme-altitude climbers. **Background:** There is anecdotal evidence for a high incidence of anomalous perceptual experiences during mountain climbing at high altitudes. **Method:** In a structured interview, we asked eight world-class climbers, each of whom has reached altitudes above 8500 m without supplementary oxygen, about hallucinatory experiences during mountain climbing at various altitudes. A comprehensive neuropsychological, electroencephalographic, and magnetic resonance imaging evaluation was performed within a week of the interview (8). **Results:** All but one subject reported somesthetic illusions (distortions of body scheme) as well as visual and auditory pseudohallucinations (in this order of frequency of occurrence). A disproportionately large number of experiences above 6000 m as compared to below 6000 m were reported (relative to the total time spent at these different altitudes). Solo climbing and (in the case of somesthetic illusions) life-threatening danger were identified as probable triggers for anomalous perceptual experiences. No relationship between the number of reported experiences and neuropsychological impairment was found. Abnormalities in electroencephalographic (3 climbers) and magnetic resonance imaging (2 climbers) findings were likewise unrelated to the frequency of reported hallucinatory experiences. **Conclusions:** The results confirm earlier anecdotal evidence for a considerable incidence of hallucinatory experiences during climbing at high altitudes. Apart from hypoxia, social deprivation and acute stress seem to play a role in the genesis of these experiences. (NNBN 1999; 12:67-71)

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There is anecdotal evidence (1-3), partially in the form of first-hand accounts of world-class climbers (4,5), for a variety of anomalous perceptual experiences during climbing both at moderate and extreme altitudes. We attempted a systematic investigation of the incidence and quality of such experiences in a group of world-class mountaineers who had all reached altitudes of at least 8500 m without supplementary oxygen. As physiologic studies have revealed an altitude of 6000 m as critical for the appearance of the first signs of cerebral hypoxia in trained

climbers (6), we were particularly interested whether climbing above 6000 m (defined as "extreme" altitude [7]) would be accompanied by an especially high frequency of anomalous experiences. We thought that our study might reveal important insights into the mechanisms leading to hallucinations in both healthy and psychiatric populations.

### METHOD

#### Subjects

Eight world-class mountaineers (1 woman, 7 men; mean age, 35.9 years; age range shown in Table 1) were contacted by one of us (O.O.) and asked to volunteer for the present study. All had reached summits higher than 8500 m (e.g., Mount Everest, K2, Kangchenjunga, Lhotse) without bottled oxygen. None of them had a history of neuro-

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logic or psychiatric disease; in particular, none of them had ever suffered from serious head injury. All climbers were right-handed. No other subjects meeting the above criteria were approached.

### Procedure

During the course of a comprehensive physiologic, neurologic, and neuropsychological evaluation (6,8,9), we asked subjects to report any "extraordinary mental phenomena" that they had experienced during climbing and to indicate as accurately as possible the altitude at which such an experience had occurred. They were then given a structured interview on the phenomenologic details of every reported hallucinatory incidence (hallucination defined as a perception without stimulus) as well as on their physical and psychological status at the time of the experience(s). Visual and auditory illusions (i.e., mere misinterpretations of existing stimuli) were not further considered, as high-altitude environments are a particularly rich source of unstructured and ambiguous stimulation (e.g., fog, unusual snow formations, winds). In the somesthetic modality, however, the term *hallucination* is inappropriate per the definition used in this study, because "proprioception without stimulus" is not possible. We therefore refer to anomalous experiences with respect to one's own body as "somesthetic illusions." These comprise distortions of body scheme (alterations in the shape, size, or weight of one's own body), including feelings of reduplication of and separation from one's own body (10). Simple paraesthesias were not considered to be somesthetic illusions.

Neuropsychological tests have been described in detail elsewhere (8). They included assessment of a wide range of functions reportedly affected by acute hypoxia (e.g., short-term memory, visuomotor coordination, cognitive flexibility).

All subjects were tested and interviewed in their native language (i.e., German, French, or Polish).

### RESULTS

In view of the small number of subjects questioned, no statistical treatment of the data was planned, and we report our findings mainly in descriptive terms (see Table and Fig. 1). Post-hoc analyses have been suggested by peer review and are communicated as well (nonparametric Spearman rank correlations).

All but one climber reported hallucinatory experiences, and 46 instances were collected from the group as a whole (see Table). Subject age was related to the total number of reported experiences ( $\rho = 0.78$ ,  $p < 0.04$ ) and to the number of visual hallucinations ( $\rho = 0.81$ ,  $p < 0.04$ ) but not to the number of auditory hallucinations ( $\rho = 0.26$ ,  $p > 0.4$ ) or to the number of somesthetic illusions ( $\rho = 0.69$ ,  $p = 0.07$ ), although the latter were slightly more frequently

reported by the older subjects. The climber who reported the most experiences (18 [39%]) also had a long cumulative exposure to extreme altitude. Statistically, however, there was no association between total exposure to high altitude and the number of reported experiences in any modality ( $|\rho| \leq 0.39$ ,  $p \geq 0.7$ ). Also, there was no correlation between the number of months since the last exposure to high altitude and the number of experiences ( $\rho \leq 0.60$ ,  $p \geq 0.1$ ). Frequency of visual and auditory hallucinations was clearly not related to ranked severity of neuropsychological impairment ( $\rho = 0.50$ ,  $p > 0.6$ ; and  $\rho = -0.22$ ,  $p > 0.8$ , respectively) (8), but there was a trend for the more impaired subjects to report more somesthetic illusions ( $\rho = -0.68$ ,  $p = 0.06$ ). The number of anomalous experiences was not dependent on the presence or absence of abnormalities as revealed by electroencephalography (i.e., bitemporal irritative potentials in subjects 1 and 4, enhanced beta activity in subject 6) (8) or magnetic resonance imaging (i.e., discrete bifrontal cortical atrophy in subject 6, multiple hyperintense periventricular and subcortical white matter lesions 2–12 mm in size in subject 2) (9).

With respect to the modality of reported abnormal perceptual experiences, most (28 [61%]) belonged to the category of somesthetic illusions (i.e., misperceptions of one's own body or of its position in space). Simple body scheme distortions (5 cases), diffuse vestibular illusions of floating (3 cases), or the depersonalization-like experience of one's own body moving like an automaton (3 cases) were less frequent than complex bodily reduplications, mostly in the form of a feeling of the presence of an imaginary person close to one's own body (9 cases) or of separation from one's body (6 cases, 5 of which occurred during acute life-threatening danger). Some illustrative accounts follow.

"During the last few minutes [before the ascent had to be given up], I had the feeling that another person was climbing with me. He [although I 'knew' he was a man, I had no idea who he could have been] was always approximately 5 m behind me, and although I clearly saw that nobody was there, I continued to look over my shoulder again and again. The stronger I felt his being there, the stronger I noticed an 'empty feeling,' a distinct 'hollowness' of my body" (subject 5, climbing behind two companions at an altitude of 8300 m; exhausted but not in danger).

"For several minutes, it seemed to me as if the tent were at least five times as large as I knew it to be. The strangest thing, however, was that my own body felt five times as large as well, although as judged by my eyes, I could not make out any changes, neither concerning my own body nor concerning my environment" (subject 1, bivouacking alone at an altitude of 7500 m).

"I felt myself projected from the rock where I was standing and flying several meters through the air. It was more than mere imagination or daydreaming; the feeling of being

**TABLE 1.** Subject variables of eight mountaineers and incidence of hallucinatory experiences during climbing

Modality of experience	Subject number*								Total incidences per modality
	1	2	3	4	5	6	7	8	
Visual	5	3	2	—	1	—	—	—	11
Auditory	4	—	2	1	—	—	—	—	7
Somaesthetic	9	4	2	5	3	3	2	—	28
Total experiences	18	7	6	6	4	3	2	0	46
Age of subject (years)	43	44	37	31	39	38	28	27	
Total hours spent above 8000m	231	48	62	50	358	74	88	62	
Time since last exposure to high altitude (months)	10.5	9	6	8.5	2	9	9	2	
Ranked neuropsychological impairment††	2	6.5	8	1	3.5	3.5	5	6.5	
EEG findings‡	p	n	n	p	n	p	n	n	
MRI findings‡	n	p	n	n	n	p	ne	n	

\* In decreasing order of number of reported experiences.

†1 = most impaired.

‡From Regard et al. (8).

§From Oelz et al. (9). n, normal; ne, not examined; p, pathological.

up there was as real as the simultaneous feeling of standing on this rock and holding the rope” (subject 6, while watching his companion’s fall at an altitude of approximately 3000 m).

“I could no longer feel myself walking. Instead, I felt my body floating up and down to the rhythm of the waves meeting the shore”(subject 1, after a walk of 80 km at an altitude of approximately 5000 m).

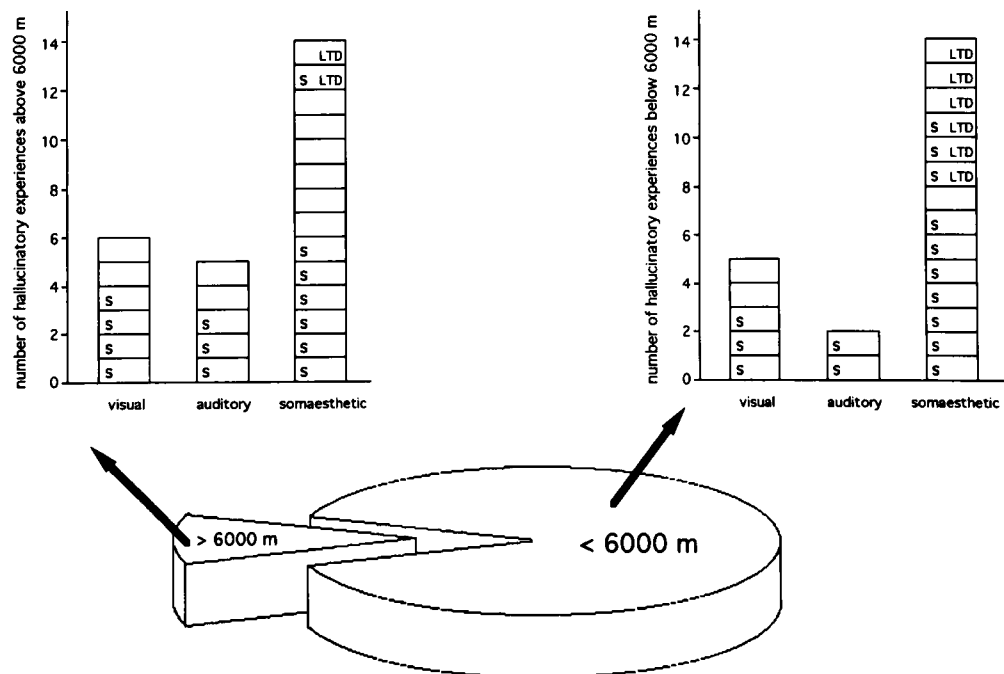
Visual hallucinations were reported by four subjects. They were comprised of simple photisms (2 instances),

the visualization of animals or human figures (8 instances), and the visualization of a complex scene (1 instance).

“Despite the fog, I clearly saw these people. [...] I could make out individual faces and decided that I had never seen them before in my life” (subject 2, during a solo climb at an altitude between 5000 and 6000 m).

“First I saw two horses, later on, just one horse but this time with a rider on its back. In this person, I recognized a remote acquaintance” (subject 1, describing an experience at an altitude of 4500 m).

**FIG. 1.** Incidence of different types of hallucinatory experiences above (top left) and below (top right) 6000 m. Note that for each mountaineer, the time spent at altitudes above 6000 m is only a small percentage (<5%) of the time spent below 6000 m. LTD, experience during acute life-threatening danger; S, experience during solo climb.



Three subjects described auditory hallucinations. There were three instances of ringing bells or more complex musical hallucinations and four instances of human voices.

"I heard someone speaking French. The voice seemed to emanate from within my own body, and I heard myself responding. It was in French too—amazing, if you consider that I do not speak French at all..." (subject 1, solo climb below 6000 m).

"For a few minutes, I heard some friends talk about technical problems or issues relating to our present situation. The voices were quite normal in loudness and intelligibility. I did not try to take part in the conversation" (subject 3, while resting at an altitude of approximately 7500 m).

No tactile, olfactory, or gustatory hallucinations were reported by our subjects. Among the anomalous perceptual experiences spontaneously mentioned but not listed in the Table or Figure were a distorted perception of time (4 instances), transient deafness (3 instances), and one episode of prosopagnosia (the latter at an altitude of approximately 8000 m).

Although an overproportionately large number of hallucinations were experienced during solo climbs, irrespective of modality, situations of life-threatening danger specifically seemed to trigger misperceptions in somesthetic modality (see Fig. 1).

Figure 1 juxtaposes those experiences that took place above 6000 m to those taking place below 6000 m. The absolute number of reported experiences was virtually the same at both extreme and more moderate altitudes. Nevertheless, as illustrated in the Figure, since the time spent at extreme altitudes (i.e., those above 6000 m [7]) is, by conservative estimation, less than 5% of the time spent at lower altitudes, hallucinatory experiences were clearly overproportionately represented at higher altitudes. Altitude did not seem to differentially affect the number of abnormal perceptions in visual, auditory, or somesthetic modalities, although a somewhat greater number of somesthetic illusions occurring outside of life-threatening situations were reported at extreme altitudes. Insight into the hallucinatory character of the reported experiences was preserved throughout.

## DISCUSSION

The types of abnormal perceptions reported by the present group of eight world-class mountaineers correspond to those usually described in the clinical and alpine literature (1–5). The especially high incidence of somesthetic illusions is in accordance with previous accounts (2,5). Occurring most frequently were autoscopic phenomena (i.e., illusory reduplications of one's own body) (10). These manifested themselves mainly as the feeling that an imaginary person accompanied the climber. This "feeling of a presence," which is abundant in mountaineers' reports of

strange experiences (2,3–5,11,12), is also observed in patients with neurologic disease, predominantly in those with lesions in temporoparietal areas of the brain (13). It has been interpreted as a projection of the body scheme into peripersonal space (13). Five of our subjects reported this experience and indicated that it lasted between a few seconds and 12 hours. Another variant of autoscopic reduplication is "out-of-body experiences," (i.e., the feeling of being separated from one's own body and observing it from the outside) (10), which was reported by five of our subjects. In accordance with the literature (5,14,15), this experience was particularly frequent in situations of life-threatening danger (3 of 6 reported instances occurred during falls and 2 more occurred during threatening situations caused by avalanches). Accordingly, its duration was reported to be brief, mostly in the range of seconds. Situations during which subjects had been facing death specifically triggered somesthetic (rather than visual or auditory) perceptual anomalies. This observation may be accounted for by the subject's strong emotional involvement, possibly accompanied by transient limbic hyperactivation, which is known to facilitate the occurrence of autoscopic phenomena of the out-of-body type in normal subjects (10,16).

There seems to be an above-chance association between hallucinatory experiences and solo climbing (see Fig.) in the present sample. This observation is consistent with the notion of social deprivation as a predisposing factor to hallucinations in neurologically normal individuals (17,18), including explorers and mountaineers (12). Although, the feeling of a presence may optimally alleviate psychological suffering due to loneliness, it is interesting to note that human elements (familiar figures and voices) also abounded in the visual and auditory modalities.

Although our study suggests a higher relative incidence of hallucinatory experiences at altitudes above 6000 m as compared to below 6000 m, extreme altitude does not necessarily imply that central hypoxia is the main, or only, causative factor in the genesis of perceptual aberrations (i.e., the absence of correlations between total exposure to high altitude and the number of reported anomalous experiences should also be noted). Although it is known that hypoxia can have hallucinogenic effects (19), the potential influence of factors other than low oxygen concentration must be considered. Typically associated with extreme-altitude climbing are extraordinary physical exhaustion, hypothermia, food deprivation leading to hypoglycemia and ketosis, dehydration, and lack of sleep (7). Each of our eight subjects, while climbing above 6000 m, had to struggle with one or more of these conditions, a fact that may well have increased the propensity for perceptual distortions. Lower resistance to these forms of stress with increasing age may account for the correlations found between the age of the subject and number of reported anomalous experiences. In the context of stressful and highly emo-

tional events, the endorphins may be mentioned, whose hallucinogenic properties are a matter of controversy (16,20). Endorphins are known to lower the threshold for temporal lobe epileptic seizures (21) and could thus contribute indirectly to the rich phenomenology of hallucinatory experiences during times of intense stress (22).

In conclusion, the results of our inquiry re-emphasize the fact that anomalous perceptual experiences can occur outside of the context of psychiatric or neurologic disease. They corroborate previous but more anecdotal reports of a considerable incidence of hallucinatory experiences (especially of somesthetic illusions) in professional mountaineers, which are more numerous at extreme altitudes, at least among those climbers who renounce the use of supplementary oxygen. Our findings also corroborate the fact that the frequency and quality of anomalous perceptions are modified by a diversity of situational factors such as social deprivation and acute life-threatening danger.

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