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CASE REPORT

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Time moving 100-fold slower: time distortion as a diagnostic clue in anti-NMDA receptor encephalitis

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Abstract

Background The primary symptoms in the early stages of anti-NMDA receptor encephalitis are psychiatric manifestations, making it difficult to distinguish from psychiatric disorders. While anti-NMDA receptor encephalitis requires a completely different treatment approach, the specific psychiatric features of the condition remain poorly identified. Although previous studies have suggested that altered perceptions may be characteristic, few case reports focus on altered perceptions of time or time distortion, a phenomenon closely linked to NMDA receptor dysfunction as seen in individuals using NMDA receptor inhibitors like ketamine and phencyclidine. In this report, we describe two cases of anti-NMDA receptor encephalitis manifesting pronounced time distortion in its early stages, which may serve as diagnostic clues for the early diagnosis and treatment of this potentially lethal condition.

Case presentations Two cases of Anti-NMDA receptor encephalitis, both marked by significant time distortion in the early stages and showing near-complete recovery with immunotherapy, are presented in detail. In both cases, time distortion was the predominant symptom among the psychiatric manifestations. Case 1: A middle-aged man experienced a pronounced perception of time moving 100 times slower in the early stages, accompanied by feelings of detachment and auditory abnormalities. This time distortion persisted for over a year, even after other symptoms had fully resolved. Case 2: A young woman reported that time seemed to move two to three times slower in the early stages. Although she did not initially mention time distortion, she confirmed it when specifically questioned.

Conclusions Our report suggests that time distortion, particularly the perception of time moving slowly, can be a distinguishing feature in the early stages of anti-NMDA receptor encephalitis. This unique characteristic, especially when occurring independently of other symptoms, is rare as a primary and isolated symptom in other conditions, making it useful for differentiation from time distortion in other psychiatric disorders. Additionally, since some patients may not spontaneously report time distortion, actively assessing this symptom during early evaluation could help improve diagnostic accuracy.

Keywords Anti-NMDA receptor encephalitis, Time distortion, Altered sense of time, Altered perception, Slow-motion perception

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Background

Anti-NMDA receptor encephalitis is a serious, life-threatening disease, with 29% of patients reportedly admitted to the ICU [1] and 5–11% dying from the condition [2–4]. The prognosis of autoimmune encephalitis largely depends on rapid diagnosis and the early initiation of therapy. Early immunotherapy results in substantial recovery in 70–80% of the patients [1, 5–7]. However, rapidly differentiating anti-NMDA receptor encephalitis from psychiatric disorders, particularly schizophrenia spectrum disorders, can be challenging. This is because anti-NMDA receptor encephalitis often presents with psychiatric symptoms in the early stages, without obvious neurological findings [5, 8–12]. Reports indicate that 87% of patients with anti-NMDA receptor encephalitis experience acute behavioral changes, and 59% initially present with psychiatric symptoms. Among those with psychiatric symptoms, as many as 87% meet criteria for cycloid psychosis [13], which resembles both schizoaffective disorder and brief psychotic disorder. Specifically, 23% meet criteria for acute schizoaffective disorder [12], and 40% experience visual or auditory hallucinations [12]. The similarity of these psychiatric symptoms to common psychiatric disorders, such as schizophrenia spectrum disorders, often leads to misdiagnosis in the early stages of anti-NMDA receptor encephalitis [14–16]. As a result, up to 77% of patients first visit a psychiatrist [9], and 31% are initially admitted to psychiatric wards [2, 3]. In addition, laboratory findings, such as magnetic resonance imaging (MRI), often show no abnormalities in up to 70% of affected individuals [13], and even after spinal fluid testing is performed, the definitive diagnosis cannot be made immediately because it takes some time before the spinal fluid is positive for anti-NMDA receptor antibodies [17]. Despite the significant challenges in diagnosis, a good prognosis in anti-NMDA receptor encephalitis depends on early treatment [3, 18–21]. What is needed are specific psychiatric symptoms that differentiate anti-NMDA receptor encephalitis from other psychiatric disorders, which could significantly improve the prognosis, particularly when neurological symptoms are absent and laboratory findings are either unavailable or inconclusive in the early stages.

While previous studies have suggested that altered perception is a characteristic symptom of anti-NMDA receptor encephalitis [5, 22], the specific types of these alterations remain unclear. Time distortions, in particular, may be linked to this encephalitis, as drugs that inhibit NMDA receptor function, like ketamine and phencyclidine [23–26], commonly cause prominent time distortion among other perceptual disturbances. In fact, time distortion is one of the most consistently reported effects of these drugs [23–26]. A study found that 11 out of 15 healthy volunteers using ketamine complained of time distortion, mostly in slow-motion perceptions [26]. Since antibodies inhibit NMDA receptor function in anti-NMDA receptor encephalitis, this may lead to similar symptoms [27, 28]. Despite these potentially significant connections, only one case report has mentioned time distortion, describing it as an additional feature among various types of perceptual alterations in this condition [29].

We report two patients with anti-NMDA receptor encephalitis who exhibited pronounced time distortion, a novel finding as it emerged as a characteristic symptom during the acute phase. We tracked the progression of this symptom throughout the course of the encephalitis and compared it to time distortion in other psychiatric disorders as well as in other types of encephalitis. Our observations offer new insights into the psychiatric features of anti-NMDA receptor encephalitis and may aid in its early diagnosis, even when detailed examinations such as MRI or cerebrospinal fluid analysis are unavailable, particularly in psychiatric outpatient settings. This can be achieved at no additional cost and may lead to timely treatment of this life-threatening but often difficult-to-diagnose condition.

Case presentations

Ethical aspects of this study were reviewed and approved by the Osaka Red Cross Hospital Human Research Ethics Committee. Between June 2023 and June 2024, two patients with anti-NMDAR encephalitis were admitted to the psychiatry unit of Osaka Red Cross Hospital. Both patients experienced time distortion, prompting this report. The patients and their family members granted informed consent in accordance with the Declaration of Helsinki. The definitive diagnosis of the two patients was based on diagnostic criteria for anti-NMDA receptor encephalitis [17] and the presence of anti-human IgG anti-GluN1 antibodies in cerebrospinal fluid as assessed with enzyme-linked immuno-sorbent assays. Both patients were primarily treated by psychiatrists and neurologists and were followed until full recovery in our psychiatry unit. This setting allowed for a thorough assessment of psychiatric symptoms, which might not have been as feasible in a neurology unit. In both cases, a psychiatrist with more than 35 years of clinical psychiatric experience and several younger psychiatrists worked together in the treatment of the patients. Nursing care was provided by psychiatric nurses, and rehabilitation was performed by an occupational therapist specialized in psychiatry. During the inpatient treatment period, the psychiatrist inquired in detail at least once a week about the patients' time distortion, including any associated abnormalities in modalities such as visual or auditory perception. In Case 1, post-discharge outpatient visits

were held once a month, with the psychiatrist checking for the time distortion on each visit.

Case 1

Case 1 is a 40-year-old man with a history of depression triggered by interpersonal relationship problems at work two times, at 26 and 35 years of age. Forty-three days before admission, he developed a headache and a fever of around 38 °C, which subsided on its own, though a mild fever persisted. Three days before admission, he developed altered perceptions and related symptoms, including a distorted sense of time, a perception of the world in sepia tones, and a feeling of disconnection from reality. As these symptoms intensified, he developed suicidal thoughts and started sleeping only about one hour per night. His sense of time moving slowly gradually worsened. One day before admission, this sensation intensified tenfold, along with a rise in anxiety. On the day of admission, his perception of time felt as it had slowed by up to 100-fold. He made an emergency visit to the neurology department of our hospital. He was admitted to our inpatient psychiatry unit, which provides a more secure environment for individuals with suicidal ideation. Neurological signs observed upon admission included involuntary movements in both upper limbs and altered consciousness, with a Glasgow Coma Scale score of E4, V4, and M6 [30].

He was diagnosed with autoimmune encephalitis, including anti-NMDAR encephalitis, based on preceding fever, psychiatric symptoms atypical for psychiatric conditions such as schizophrenia, altered consciousness, cerebrospinal fluid analysis showing 154 cells/μL with 97% monocytes, and a faint high signal in the left temporal-occipital-parietal cortex on the Fluid Attenuated Inversion Recovery (FLAIR) MRI. His electroencephalogram (EEG) revealed no abnormalities and contrast-enhanced computed tomography (CT) of his trunk showed no findings suggestive of a seminoma or other tumors in the testis. The diagnosis of anti-NMDA receptor encephalitis was confirmed when elevated anti-human IgG anti-GluN1 antibodies were subsequently detected in his cerebrospinal fluid.

In his clinical course, the peak occurred approximately two weeks after admission, marked by worsening neurological and autonomic nervous signs. By hospital day 12, his muscle stiffness and involuntary movements in both upper limbs intensified, accompanied by increased sweating and tachycardia, eventually leading to unresponsiveness with a GMS score of E2, V2, and M4. Central hypoventilation was not observed. He was treated with intensive immunotherapy, including four cycles of steroid pulse therapy (1000 mg of methylprednisolone per day for 3–5, 22–24, 29–31, and 36–38 hospital days after admission), intravenous immunoglobulin once (400 mg/kg of human immunoglobulin, 8–12 hospital days after admission), and intravenous cyclophosphamide twice (1500 mg on hospital days 16 and 43). After hospital day 18, his consciousness gradually improved, with a GMS score of E4, V4, and M6. Around one month post-admission, his involuntary movements, sweating, and tachycardia resolved, and his consciousness further improved.

For his psychiatric symptoms, he exhibited a strong desire to die and significant agitation upon admission, prompting the initiation of antipsychotic risperidone at 3 mg, which was gradually increased to 8 mg by the end of the day. On hospital day 4, his behavior became increasingly chaotic; he violently banged on his room door and repeatedly said, "there is someone else in me." He was additionally prescribed the mood stabilizer valproic acid at 400 mg and the antipsychotic zotepine at 100 mg. Despite these interventions, around hospital day 10, he remained markedly disoriented and chaotic, incorrectly identifying his location as "bank" and his age as "1020 years old." He also experienced time distortion, describing time as moving extremely slowly, and reported auditory perception abnormalities, such as hearing nurses speak slowly. However, this time distortion was not accompanied by visual or kinesthetic perception abnormalities.

When his consciousness became alert again during the recovery phase after passing the peak of his clinical course, he became agitated again, exhibiting aggressive behaviors such as hitting nurses and attempting to strangle himself with the intravenous line. Around one month post-admission, his agitation and aggressiveness resolved, allowing him to engage in simple conversations. However, he continued to experience cognitive dysfunctions, such as difficulty tying shoelaces, performing simple addition, and recalling the content of the previous day's conversation. From around hospital day 35, he regained orientation and no longer reported thoughts of death. He also regained the ability to perform calculations. The sensation of time moving slowly improved from a severe 1000-fold distortion to a 2-fold distortion. By hospital day 60, the abnormal sense of time had diminished, and he only experienced significant time distortion during periods of excess free time. He was discharged with normalized cognitive function, as indicated by a Mini-Mental State Examination score of 29 [31], on hospital day 74. The amount of psychotropics was reduced after the peak of the disease and discontinued shortly after discharge. He returned to his clerical job 9 months after discharge, with a Modified Rankin Scale score of 1, indicating no significant disability [32, 33]. However, 10 months post-discharge, he still reported that time seemed to slow down to twice its usual rate when he felt stressed.

Case 2

Case 2 features a 28-year-old office worker with no prior history of psychotic disorders or family mental health issues. She had not encountered any notable stressors before the onset of her symptoms. Twenty-six days before her admission to our hospital, she began experiencing auditory disturbances, describing strange sounds in her ears, distant voices, and difficulty comprehending speech during a social outing in a flower viewing festival. The following day, she independently visited a neurology clinic, but no abnormalities were detected. Nineteen days before admission, she experienced panic over a strange taste in her food, and her condition progressively worsened. She became unable to hold coherent conversations, wandered aimlessly around the house, crawled on all fours in circles, and her thoughts, speech, and actions became increasingly chaotic. Nine days before her admission to our hospital, she was admitted to a psychiatric hospital with suspected psychiatric condition, when she became unresponsive to external stimuli. After her admission to the psychiatric hospital, she developed a fever of approximately 38 °C, which gradually subsided. However, there was no improvement in her psychiatric symptoms despite treatment with an 80 mg antipsychotic blonanserin patch. Nine days after her initial psychiatric admission, she was referred to our department to investigate the possibility of an underlying neurologic condition.

Upon arrival, she was catatonic and uncommunicative, with frequent involuntary movements in both upper limbs. Her EEG showed an extreme delta brush, although screening laboratory tests, brain MRI, and abdominal MRI (for detecting an ovarian teratoma) revealed no abnormalities. The cerebrospinal fluid cell count was slightly elevated at 10 cells/μL, with 90% of these cells being monocytes. Given her sudden onset of psychiatric symptoms without a prior psychiatric history or identifiable stressors, significant involuntary movements, slow waves on the EEG, and cerebrospinal fluid findings, she was diagnosed with autoimmune encephalitis, including anti-NMDA receptor encephalitis. The diagnosis of anti-NMDA receptor encephalitis was confirmed when elevated anti-human IgG anti-GluN1 antibodies were detected in her cerebrospinal fluid. She received steroid pulse therapy twice: 1000 mg of methylprednisolone per day, administered on 2–6 and 13–17 hospital days. By hospital day 5, she began responding to calls with nodding and was able to eat steadily. The involuntary movements in her upper limbs gradually subsided.

Around hospital day 10, her disorientation improved. She reported, 'Before I was hospitalized in the psychiatric facility, my sense of time felt about 2 or 3 times slower, but now it's back to normal.' This suggested that during the initial phase, when she experienced auditory distortions and taste abnormalities, she was also experiencing time distortion, specifically perceiving time in slow motion. Her altered sense of time was not accompanied by visual or kinesthetic sensory abnormalities. Additionally, she had memory impairment, such as difficulty recalling the lyrics to a song she was previously familiar with, but this improved over time. By discharge on hospital day 29, the only remaining symptom was mild insomnia, and she had a Modified Rankin Scale score of 1, indicating no significant disability.

Discussion and conclusions

We report, for the first time, two cases in which time distortion was a pronounced symptom in the early stages of anti-NMDA receptor encephalitis. This finding aligns with effects observed in drugs that inhibit NMDA receptor function, such as ketamine and phencyclidine [23–26], and may help differentiate this condition from other psychiatric disorders. In Case 1, time distortion remained the primary symptom throughout the initial and residual phases, lasting nearly one year. In Case 2, although time distortion appeared in the early stages, the patient was confused and presumably unable to convey her experience clearly. These findings suggest that clinicians should actively assess for time distortion, especially when patients with anti-NMDA receptor encephalitis are confused and unable to articulate their specific symptoms due to prominent psychiatric disturbances.

We review the characteristics of time distortion based on our two cases and two additional cases from a previous report on altered perception in anti-NMDA receptor encephalitis [29]. The most striking feature is that, in three of the four cases with time distortion (75%), patients experienced the sensation of time moving slowly. Additionally, out of the four cases, two featured altered perceptions in visual and auditory modalities, respectively.

Although time distortion occurs in other conditions, including schizophrenia and other forms of encephalitis [34, 35], slow-motion perception is less common. A previous study of 84 patients with time distortion, regardless of their underlying condition, found that 29 (34.5%) experienced slow-motion perception [34, 35]. Another study reported that, out of 301 patients with schizophrenia, 109 experienced time distortion, but only 12 (4.0%) reported perceiving the sensation of time moving slowly [36]. In schizophrenia, time distortion is often characterized by a fragmented sense of time, such as viewing the world "like a series of photographs," and is associated with disorganization, which is a hallmark of the disorder [36–38]. This abnormality is also described as bizarre alterations in time perception rather than slow-motion perception [39, 40]. In contrast, none of the four cases of anti-NMDA receptor encephalitis showed the time fragmentation typical of schizophrenia. Furthermore,

Case 1 of anti-NMDA receptor encephalitis reported extreme symptoms, including perceiving time as moving 100 times slower, a phenomenon rarely observed in schizophrenia.

We also compare the time distortion of anti-NMDA receptor encephalitis with that of other types of encephalitis. Most of the reported cases of time distortion in other types of encephalitis are associated with Alice in Wonderland Syndrome (AIWS), which is a perceptual disorder characterized by distortions of visual perception, the body schema, and time [41]. However, in most types of encephalitis with AIWS, distortions of visual perception and the body schema are common and time distortion is rare [42]. For example, among Epstein-Barr virus (EBV) encephalitis, which is the most common disease that causes AIWS, only two cases have been reported with time distortion, and even in both of those case, metamorphopsia, a defect of vision in which objects appear to be distorted, was more prominent than time distortion [43, 44]. In other encephalitis, one case of slow-motion perception has been reported in influenza encephalitis, which was also prominent with metamorphopsia [45]. In summary, other encephalitis is often accompanied by altered perceptions, particularly metamorphopsia, and time distortion is rarely complained of almost independently, as in cases with anti-NMDA receptor encephalitis.

Altered perceptions have been found to be more common in patients with autoimmune encephalitis, including anti-NMDA receptor encephalitis, than those in schizophrenia spectrum disorders [22]. Our findings go further, suggesting that among these altered perceptions, time distortion—particularly the sensation of time moving slowly—may be a key differentiating factor between anti-NMDA encephalitis and psychiatric conditions such as schizophrenia, as well as possibly other forms of encephalitis. Confirming the presence of this symptom is straightforward and can be done even when detailed examinations such as MRI or cerebrospinal fluid analysis are unavailable, particularly in psychiatric outpatient settings. Even in cases where MRI findings are inconclusive, this symptom can serve as a suggestive sign, prompting further investigation, such as cerebrospinal fluid analysis. This approach incurs no additional cost and may facilitate the timely treatment of this life-threatening but often challenging-to-diagnose condition.

Limitation

Time distortion as a diagnostic marker in anti-NMDA receptor encephalitis remains speculative due to several limitations. First, while our discussion compares schizophrenia and anti-NMDA receptor encephalitis, recent studies suggest a continuum between anti-NMDA receptor encephalitis and psychiatric disorders associated with NMDA receptor antibodies [46, 47]. The prevalence of time distortion symptoms, particularly in NMDA receptor antibody-positive schizophrenia, has not been thoroughly investigated. Moreover, it remains unclear at which stage of this continuum time distortion symptoms emerge. Second, the number of cases was too small to generalize the results, and our cases are subject to bias, as they involve patients admitted to a psychiatric hospital. Therefore, it is necessary to examine time distortion, particularly the experience of slow-motion perception, across all cases of anti-NMDA receptor encephalitis to accurately determine its prevalence.

Conclusion

Our report suggests that time distortion, especially slow-motion perception, is a characteristic symptom of anti-NMDA receptor encephalitis, occurring even in the early stages. Unlike schizophrenia or other forms of encephalitis, slow-motion perception is more commonly reported as a primary complaint in patients with anti-NMDA receptor encephalitis. Therefore, assessing this symptom is important, as it may help in early diagnosis and improve prognosis.

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Author contributions
RH drafted the initial version of the case report manuscript. MF contributed to the conceptualization of the report and provided critical revisions to the manuscript. HW served as the lead clinician for these cases and reviewed the report. KY monitored the patients from admission through to their outpatient follow-ups. YS, HM, and YI contributed to the clinical evaluation of the patients during admission and to the writing of the manuscript. All authors contributed to the article and approved the submitted version.

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Data availability
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Declarations

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Consent for publication
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Competing interests
The authors declare no competing interests.

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