

Theory of Mind Is Independent of Episodic Memory

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As humans, we are intrigued by who we are and how we differ from other creatures of evolution. Among the capacities thought to be uniquely human are autoeonic consciousness, the aspect of self-awareness that allows us to imagine our own experiences in different places at other times, and theory of mind (ToM), which allows us to infer other people's current mental states. The idea that ToM is closely related to, and that it may depend on, episodic memory and autoeonic consciousness seems perfectly natural: that in order to imagine and make sense of other people's thoughts, feelings, intentions, and actions, we must rely on our autobiographical recollections (1). The ability to consciously recollect past personal happenings has been shown to be necessary for imagining coherent and detailed personal happenings in the future (2, 3). Both episodic memory and ToM emerge close in time in ontogenetic development (4). The neural substrate on which the two abilities rely is in many ways strikingly similar (1).

In order to test the hypothesis that ToM requires autoeonic consciousness, it is necessary to administer objective ToM tests to participants without autoeonic abilities. Such tests are

available, but individuals without autoeonic consciousness are rare. Here, we describe the result of an investigation of the matter with the help of two such rare participants, K. C. and M. L., who, as a result of severe traumatic brain injury (fig. S1), lost their ability to consciously recollect personal happenings from their own lives (5, 6). In both, this loss stands in stark contrast to their preserved ability to think of personal and public facts learned before they suffered brain damage (table S1). Casual observations, especially of K. C.'s clear appreciation of humor and sarcasm (5), suggest that ToM does not require autoeonic consciousness, but in the absence of more extensive, objective evidence the matter has remained unclear.

A variety of the most widely used tests known to be sensitive to perspective-taking and ToM impairment (7) was administered to assess systematically the extent to which K. C., M. L., and 14 control participants can reason about other people's thoughts and feelings (8). K. C.'s and M. L.'s performance was indistinguishable from that of controls on all measures (Table 1).

The current findings are at variance with the idea that the ability to simulate or reconstruct one's

own past mental states is necessary to imagine the contents of other people's minds (1, 2). Both K. C. and M. L. suffer from severe difficulties in consciously (autoeonic) recollecting any events from any period of their lives. Yet they have no apparent difficulty in taking other persons' perspectives and inferring other people's thoughts, feelings, and intentions, as revealed by the ToM tests. The findings imply that K. C.'s and M. L.'s ToM ability may depend on semantic memory and general knowledge abilities that are largely preserved in both cases (5, 6).

Cases such as those of K. C. and M. L. allow for the study of ToM in isolation of autoeonic consciousness. Because these cases are rare, the relevant literature on the topic is sparse. The only other related piece of evidence of which we are aware is a report of a participant with a large medial prefrontal lesion who nonetheless performed well on several of the ToM tests used here. However, the extent to which his autobiographical memory impairment reflects a tendency to confabulate is unclear (7).

Our two cases do not shed any light on the extent to which fully functioning autoeonic ability is necessary for the development of ToM, because both K. C. and M. L. may have acquired ToM ability premorbidly. Our findings do, however, allow the conclusion that an existing severe impairment of episodic memory and autoeonic consciousness does not compromise the expression of ToM abilities. The dissociation we report here is important both theoretically and practically.

References and Notes

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8. Materials and methods are available on Science Online.
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Supporting Online Material

www.sciencemag.org/cgi/content/full/318/5854/1257/DC1

Materials and Methods

Fig. S1

Table S1

References

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Table 1. Performance of all participants on theory of mind (ToM) tests (8). Numbers in parentheses in left-hand column indicate maximum scores for each section.

	K. C.	M. L.	Controls [mean (SD)]
<i>False belief</i>			
First-order (/10)	10	10	10 (0)
Second-order (/10)	10	10	8.79 (1.05)
<i>Faux pas</i> (/30)	29	29	23 (4.67)
<i>Reading the mind in the eyes</i> (/36)	26	31	26.07 (3.77)
<i>Animations</i>			
Random appropriateness (/3)	3	3	2.64 (0.46)
Random intentionality (/5)	0	0	0.48 (0.58)
Goal-directed appropriateness (/3)	3	2.75	2.36 (0.41)
Goal-directed intentionality (/5)	2.75	2.5	2.64 (0.29)
ToM appropriateness (/3)	3	2.5	2.2 (0.5)
ToM intentionality (/5)	4.5	4.5	3.66 (0.7)
<i>Sarcasm and empathy</i>			
First-order (/12)	12	11	11 (1.24)
Second-order (/12)	12	12	10.86 (0.95)
<i>Visual perspective-taking/deception</i>			
Transfer of inference (/6)	6	6	5.93 (0.27)
Deception (first trial of five consecutive correct)	7	6	6.5 (5.44)
<i>Emotional situations</i>			
Self (/8)	7	8	7.64 (0.5)
Other (/8)	8	8	7.93 (0.27)