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Research report

Speech errors of amnesic H.M.: Unlike everyday slips-of-the-tongue

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ARTICLE INFO

Article history:

Received 1 July 2009

Reviewed 23 November 2009

Revised 1 March 2010

Accepted 15 May 2010

Action editor Art Shimamura

Published online 11 June 2010

Keywords:

Speech errors

Amnesic H.M.

Language production

Comprehensibility

Grammaticality

ABSTRACT

Three language production studies indicate that amnesic H.M. produces speech errors unlike everyday slips-of-the-tongue. Study 1 was a naturalistic task: H.M. and six controls closely matched for age, education, background and IQ described what makes captioned cartoons funny. Nine judges rated the descriptions blind to speaker identity and gave reliably more negative ratings for coherence, vagueness, comprehensibility, grammaticality, and adequacy of humor-description for H.M. than the controls. Study 2 examined “major errors”, a novel type of speech error that is uncorrected and reduces the coherence, grammaticality, accuracy and/or comprehensibility of an utterance. The results indicated that H.M. produced seven types of major errors reliably more often than controls: substitutions, omissions, additions, transpositions, reading errors, free associations, and accuracy errors. These results contradict recent claims that H.M. retains unconscious or implicit language abilities and produces spoken discourse that is “sophisticated,” “intact” and “without major errors.” Study 3 examined whether three classical types of errors (omissions, additions, and substitutions of words and phrases) differed for H.M. versus controls in basic nature and relative frequency by error type. The results indicated that omissions, and especially multi-word omissions, were relatively more common for H.M. than the controls; and substitutions violated the syntactic class regularity (whereby, e.g., nouns substitute with nouns but not verbs) relatively more often for H.M. than the controls. These results suggest that H.M.’s medial temporal lobe damage impaired his ability to rapidly form new connections between units in the cortex, a process necessary to form complete and coherent internal representations for novel sentence-level plans. In short, different brain mechanisms underlie H.M.’s major errors (which reflect incomplete and incoherent sentence-level plans) versus everyday slips-of-the tongue (which reflect errors in activating pre-planned units in fully intact sentence-level plans). Implications of the results of Studies 1–3 are discussed for systems theory, binding theory and relational memory theories.

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doi:10.1016/j.cortex.2010.05.009

Thousands of people have heard the famous amnesic H.M. produces error-free sentences on National Public Radio (NPR; Newhouse, 2007). These and many other people have the impression that H.M.'s language production is normal, intact, artful, "sophisticated" (Kolb and Whishaw, 2003, p. 500) and "without major errors" (Skotko et al., 2005, p. 406). The present paper reports experimental data that contradict this impression and indicate that H.M. produces new types of speech errors unlike normal, everyday slips-of-the tongue.

First some background information. Following a highly localized medial temporal lobe (MTL) lesion in 1953, H.M. has exhibited selective memory deficits, with impaired recall of new or never-previously-encountered semantic and episodic information, but spared recall of semantic information that H.M. encountered frequently before and after 1953 (see e.g., Gabrieli et al., 1988; James and MacKay, 2001). Under a hypothesis that has profoundly influenced theories in psychology and the brain sciences over the past 50 years (see e.g., MacKay et al., 1998a), H.M.'s selective memory deficits reflect separate systems for storing new information (damaged in H.M.) versus retrieving already-stored information (undamaged in H.M.).

Milner et al. (1968) proposed a related hypothesis with equally profound impact on current theories of the relation between language and memory. Under this Milner et al. hypothesis, language-linked processes are intact and normal in H.M. If correct, this "intact language hypothesis" indicates dissociations between memory storage systems (damaged in H.M.) and the systems for comprehending and producing sentences (by hypothesis undamaged in H.M.). These hypothesized dissociations have motivated the independent modules for processing memory versus language in current systems theories: under these theories, a language comprehension system processes words and sentences, and transmits the products of comprehension to an entirely separate system for long term memory storage. A retrieval system later retrieves these stored memories for transmission to a language production system for verbally expressing the retrieved memory (see e.g., MacKay et al., 2007).

1. The present research: Studies 1–3

The present research followed the standard convention of describing differences between patient and controls that exceed two standard deviations (SDs) as deficits and characterizing indefinitely large differences (as can occur when a control group outperforms a patient with $SD = 0$) as 6 SD deficits. The research consisted of three studies. Studies 1–2 compared language production in H.M. and memory-normal controls matched as closely as possible with H.M. on five dimensions: age, education, IQ, background and native language. The task was to describe captioned cartoons so that a listener could understand what made them funny, with no constraints on description length or duration. This task can be considered naturalistic and ecologically valid (see Benuzzi et al., 2006; and Giora, 2003), involving implicit (but not explicit) production of coherent, easy-to-understand, and grammatical sentences, an important feature because H.M. may retain unconscious, implicit or on-line language abilities

(see Knott and Marslen-Wilson, 2001), but not conscious, explicit or off-line language abilities (see Caplan and Waters, 2006, for an analogous phenomenon in aphasic patients).

Cartoon description requires two everyday skills: the ability to comprehend and appreciate the humor in cartoons, and the ability to effectively communicate that comprehension and appreciation. Reports in the literature suggest that H.M.'s ability to comprehend and appreciate humor is intact: According to Carlson (2004, p. 452; see also Kolb and Whishaw, 2003, p. 447), H.M. both comprehends and enjoys humor, laughing "endlessly... at the same jokes, finding them fresh and new each time." Studies 1–2 therefore addressed the second skill: Can H.M. describe captioned cartoons and communicate why they are funny as readily as controls?

The only currently available data on H.M.'s ability to explain cartoon humor appears in Marslen-Wilson (1970). Marslen-Wilson showed H.M. (then age 44) a cartoon and asked him why it might be funny. We describe the cartoon in [1], and quote H.M.'s answer in [1a].

[1] *The cartoon:* A distraught woman is saying, "The Pill. The Pill." [like someone dying of thirst in the desert, crying "Water! Water!"] as she crawls out of a messy kitchen containing dirty laundry, unwashed pots and dishes, toys strewn over the floor, and five young children, one crying, one quizzical, and three squabbling with each other.

[1a] H.M. (answering the question, "Why do you think that's funny?"): "Well it's a wonder of the .. uh .. the mother of course going out of the room .. but seeing "The Pill, the Pill" and all the .. like soap suds in a way that there's been raised there ... she can't do anything, however, she has to do everything .. [emphasis in the original] she ... both ways of looking at it ... as you could say .. because the pots and everything. (WM-W: Why.. What's the ... why's she saying "The Pill, The Pill"?) She isn't saying "The Pill, The Pill" it's the little girl that's saying to the boy. (WM-W: Oh, I see, yes that's right ... why's she saying it to the little girl .. little boy?) Well ... to .. point out to the boy that that's what it was that .. the little pill that the mother possibly had dropped in to make the soapsuds and .. and maybe .. she thought maybe well, it was more than one pill that she had put in, and that got .. that's why she'd got so many." (dot strings indicate hesitations of varying lengths; from Marslen-Wilson, 1970).

Close inspection of [1a] indicates that H.M.'s description of [1] was in places incoherent, ungrammatical and difficult-to-understand, e.g., "it's a wonder of the mother". However, Marslen-Wilson's (1970) methods were inadequate for addressing the intact language hypothesis. First, Marslen-Wilson ran no memory-normal controls for comparison with H.M. Second, this "pill cartoon" confounds H.M.'s language production with his memory deficits because oral contraception pills only emerged as a concept after his 1953 lesion. To overcome these problems, the present research incorporated memory-normal controls and tested humor-description abilities for cartoons containing words and concepts familiar to H.M. prior to 1953.

Study 1 tested the Milner et al. (1968) intact language hypothesis: H.M. and six memory-normal controls described

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