Available online at www.sciencedirect.com
SCIENCE DIRECT®
Brain and Cognition 57 (2005) 165–167
Brain and Cognition
www.elsevier.com/locate/b&c

Probability matching in the right hemisphere

Michael B. Miller[a,*], Monica Valsangkar-Smyth[b]

[a] *Department of Psychology, University of California, Santa Barbara, CA 93106-9660, United States*
[b] *Dartmouth College, United States*

Accepted 12 August 2004
Available online 11 November 2004

Abstract

Previously it has been shown that the left hemisphere, but not the right, of split-brain patients tends to match the frequency of previous occurrences in probability-guessing paradigms (Wolford, Miller, & Gazzaniga, 2000). This phenomenon has been attributed to an "interpreter," a mechanism for making interpretations and forming hypotheses, thought to reside exclusively in the left hemisphere. In this study with a split-brain patient, we had him guess one of two types of faces, stimuli known to be preferentially processed in the right hemisphere of this patient. Unlike previous studies using other kinds of stimuli, the right hemisphere matched the frequency of the previous occurrences of a face-type, but the left hemisphere did not.

1. Introduction

Humans have a special capacity or need to interpret the world around them, and the claim from studies of split-brain patients (patients who have had their corpus callosum severed, disconnecting the two hemispheres, because of intractable epilepsy) is that this "interpreter" is specialized to the left hemisphere (Gazzaniga, 2000). Gazzaniga and colleagues have demonstrated the existence of such an interpreter in several experiments in which the left hemisphere felt the need to explain responses made outside of its control (e.g., by the left hand under control of the right hemisphere). Previously, we developed a new technique to examine this need by the left hemisphere to explain or "to look for patterns" using a simple probability-matching paradigm that was used extensively more than 50 years ago (Wolford, Miller, & Gazzaniga, 2000). The paradigm involves having the participant guess which of two events will happen on the next trial. Typically, humans "frequency match," that is, they tend to guess the alternatives in the proportion at which they have been presented in the past. So if the two alternatives are 'top' and 'bottom' and top occurs on 70% of the trials, participants will tend to guess 'top' about 70% of the time. Frequency matching is curious because the optimal strategy is not to frequency match, but to maximize, that is, to always guess the most frequent alternative. Species other than humans consistently maximize. We found that the left hemisphere of split-brain patients frequency matches, but that the right hemisphere does not (Wolford et al., 2000).

Recently, we found that the tendency in humans to use this non-optimal strategy of frequency matching can be manipulated in a variety of ways. For example, subjects will resort to maximizing in paradigms in which the subjects are simultaneously engaged in a working memory task, or if the benefits and costs for incorrect choices are enough to induce them to adopt a maximizing strategy, or if the subjects believe the sequence appears to be more random because we included many more alternations then would happen in a truly random sequence (Wolford, Newman, Miller, & Wig, in press).

In this study, we examine whether there are circumstances in which the right hemisphere can be induced

* Corresponding author.
E-mail address: miller@psych.ucsb.edu (M.B. Miller).

0278-2626/$ - see front matter © 2004 Published by Elsevier Inc.
doi:10.1016/j.bandc.2004.08.038

to frequency match. Corballis (2003) has proposed the existence of a "right hemisphere interpreter" using paradigms involving a modal boundary completion and illusory line motion. In several respects the right hemisphere is superior to the left, particularly for tasks relying on visuospatial processing (Gazzaniga, 2000). This superiority in low-level processing may lead to higher-order "interpretive" processes occurring primarily in the right hemisphere. A modal completion relies on visual grouping to resolve the spatial ambiguity since there are no subjective contours, and Corballis found that the right hemisphere was superior to the left in doing this. In the current study, we used a variant of the typical probability-matching paradigm to test whether the right hemisphere would frequency match if the stimulus were preferentially processed in the right hemisphere. Therefore, we replaced the normal stimuli in this paradigm with faces, which we knew from previous studies is preferentially processed in the right hemisphere of this patient (Miller, Kingstone, & Gazzaniga, 2002).

2. Methods

JW is a split-brain patient whose corpus callosum has been severed due to intractable epilepsy, and whose case history has been reported extensively (Gazzaniga, 2000). JW participated in two sessions. Each session consisted of 4 blocks of 100 trials each. The stimuli consisted of 400 unfamiliar male faces. Thirty percent of the male faces had facial hair. The faces were created using a standard face-profiling program. All stimuli were presented and all responses were collected on a computer. Each trial began with a row of three arrows (>>>) pointing right or left. The arrows signified which visual field to make a prediction in. If the arrows pointed to the right, he was told that either a face with facial hair or a face without facial hair would appear on the right side of the screen. He was instructed to guess whether the face would have facial hair by pressing the appropriate key on the right side of the keyboard with his right hand. Hundred milliseconds after his guess, a face was presented 4° to the right of fixation for 100 ms. A face with no facial hair was presented with probability .7 and a face with facial hair with probability .3. If the arrows were pointing to the left, then the patient was instructed to respond to the left side of the keyboard with the left hand and the subsequent stimuli were presented to the left visual field. The sequence in the left visual field was independent of the sequence in the right visual field. All of the sequences were generated randomly using a random number generator. JW was told to always maintain fixation on the center arrows. Feedback on the proportion of correct guesses was provided at the end of each block of trials.

3. Results and discussion

When JW made guesses about face stimuli presented to the right hemisphere, he chose a face with no facial hair on 71% of the trials (68% in session 1 and 74% in session 2) that matched the probability that faces with no facial hair occurred (70%). When he made guesses about face stimuli presented to the left hemisphere, he consistently chose a face with facial hair more than he chose a face without facial hair (No-facial-hair guesses: 21% in session 1 and 44% in session 2). When we used each block as a case, the difference between the responses of the two hemispheres was significant ($t(7) = 5.77$; $p < .001$) (see Fig. 1).

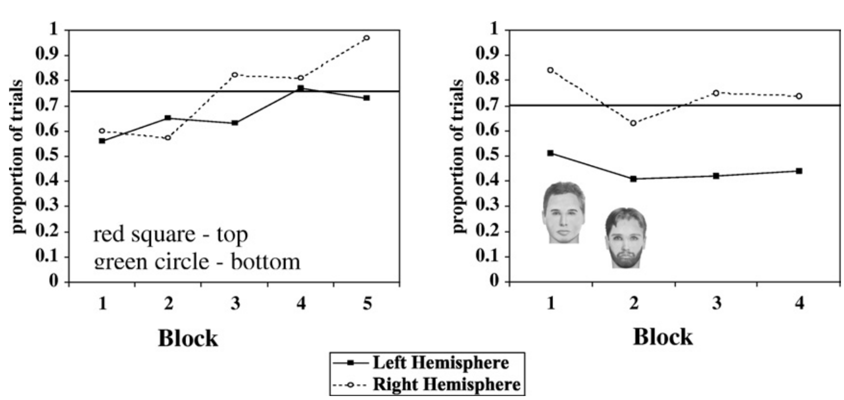

Fig. 1. The left hemisphere but not the right of a split-brain patient "frequency matches" in a probability-matching paradigm in which the choices are "red square at top" or "green circle at bottom" (chart on left based on data from Wolford et al., 2000) whereas the right hemisphere but not the left frequency matches in a probability-matching paradigm in which the choices are "face with facial hair" or "face with no facial hair" (chart on right, data from session 1). The ordinate indicates the proportion of trials that the most frequent stimulus was chosen by JW. The horizontal line for each chart indicates frequency matching or the proportion of trials that the most frequent stimulus occurred (set at .75 for the study on the left and .70 for the present study on the right).

It is not clear why the left hemisphere consistently chose the least frequent stimuli on several blocks (on the other blocks JW chose the most frequent stimuli 50% of the time), but subsequent testing revealed that JW's left hemisphere had no trouble distinguishing between the two types of faces using the same timing parameters. Frequency matching, though, requires not only the ability to distinguish stimuli but also a willingness to keep track of a sequence of events. It may be the case that the left hemisphere did not try very hard knowing that face recognition is the responsibility of the right hemisphere. In testing sessions using non-facial paradigms subsequent to the original Wolford et al. (2000) study, we observed similar minimizing responses (consistently choosing the least frequent stimuli or simply alternating between stimuli) by the right hemisphere while the left hemisphere continued to frequency match. It may be the case after repeated sessions in this paradigm that one hemisphere of patient JW simply defers to the other hemisphere depending on the nature of the task.

In the original Wolford et al. (2000) study, we attributed frequency matching in the left hemisphere to a left hemisphere "interpreter." In verbal queries of the patient, JW often mentioned that he thought there was a complicated pattern to the sequence of events. This response by JW would be consistent with the notion that an "interpreter" is continuously forming hypotheses about the world, and that it is driven to find patterns of causation and regularity. But is the interpreter an exclusive function of the left hemisphere? As mentioned earlier, Corballis (2003) has proposed the existence of a "right hemisphere interpreter," one that is dedicated to constructing a veridical, visual representation of the world. The findings reported in the present study would suggest that the right hemisphere interpreter suggested by Corballis (2003) extends beyond superiority in visual intelligence, and that it would include instances of causal reasoning about the sequence of events. Interestingly, JW's left hemisphere expressed that he was simply guessing in his predictions about the faces. Unfortunately, we can not verbally query the right hemisphere as we can the left hemisphere, so further testing will need to be conducted to determine whether frequency matching for faces presented to the right hemisphere is necessarily a search for patterns.

References

Corballis, P. M. (2003). Visuospatial processing and the right-hemisphere interpreter. *Brain and Cognition, 53*, 171–176.

Gazzaniga, M. S. (2000). Cerebral specialization and interhemispheric communication: Does the corpus callosum enable the human condition?. *Brain, 7*, 1293–1326.

Miller, M. B., Kingstone, A., & Gazzaniga, M. S. (2002). Hemispheric encoding asymmetries are more apparent than real. *Journal of Cognitive Neuroscience, 14*, 702–708.

Wolford, G. L., Miller, M. B., & Gazzaniga, M. (2000). The left hemisphere's role in hypothesis formation. *Journal of Neuroscience, 20*, 1–4.

Wolford, G. L., Newman, S. E., Miller, M. B., & Wig, G. S., (in press). Searching for patterns in random sequences. *Canadian Journal of Experimental Psychology*.