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Imageability effects on sentence judgement by right-brain-damaged adults

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Abstract

Background—For decades researchers assumed visual image generation was the province of the right hemisphere. The lack of corresponding evidence was only recently noted, yet conflicting results still leave open the possibility that the right hemisphere plays a role. This study assessed imagery generation in adult participants with and without right hemisphere damage (RHD). Imagery was operationalised as the activation of representations retrieved from long-term memory similar to those that underlie sensory experience, in the absence of the usual sensory stimulation, and in the presence of communicative stimuli.

Aims—The primary aim of the study was to explore the widely held belief that there is an association between the right hemisphere and imagery generation ability. We also investigated whether visual and visuo-motor imagery generation abilities differ in adults with RHD.

Methods & Procedures—Participants included 34 adults with unilateral RHD due to cerebrovascular accident and 38 adults who served as non-brain-damaged (NBD) controls. To assess the potential effects of RHD on the processing of language stimuli that differ in imageability, participants performed an auditory sentence verification task. Participants listened to high- and low-imageability sentences from Eddy and Glass (1981) and indicated whether each sentence was true or false. The dependent measures for this task were performance accuracy and response times (RT).

Outcomes & Results—In general, accuracy was higher, and response time lower, for low-imagery than for high-imagery items. Although NBD participants' RTs for low-imagery items were significantly faster than those for high-imagery items, this difference disappeared in the group with RHD. We confirmed that this result was not due to a speed-accuracy trade-off or to syntactic differences between stimulus sets. A post hoc analysis also suggested that the group with RHD was selectively impaired in motor, rather than visual, imagery generation.

Conclusions—The disproportionately high RT of participants with RHD in response to low-imagery items suggests that these items had other properties that made their verification difficult for this population. The nature and extent of right hemisphere patients' deficits in processing different types of imagery should be considered. In addition, the capacity of adults with RHD to generate visual and motor imagery should be investigated separately in future studies.

Keywords

Imageability; Right brain damage

The association between the right hemisphere (RH) and imagery in any modality dates back at least to John Hughlings Jackson, who wrote that “the posterior lobe of the right [hemisphere]

... is the chief seat of the revival of images" (Tippett, 1992, p. 415). In 1983, Ehrlichman and Barrett remarked that psychologists had long maintained an implicit association between *visual* imagery and the RH, despite the lack of supporting evidence. Their review of neuropsychological evidence from people who had brain injuries, such as cerebrovascular accidents (CVA), traumatic brain injuries, or commissurotomies, and of EEG and behavioural evidence from non-injured people, failed to convince them that the RH played a special role in visual imagery.

Since that time, Farah has furnished much of the neuropsychological evidence about imagery (for a review, see Farah, 1995). In a 1984 paper Farah analysed 37 case reports of imagery-related deficits in the literature and concluded that only 8 definitively describe deficits in imagery generation, defined as the process that "creates the image in the visual buffer from information stored in long-term visual memory" (p. 247). Among the eight imagery generation deficit cases she reported, she noted that six appeared to have lesions in the posterior left hemisphere (LH) and concluded that imagery generation impairment was associated with damage to that region.

However, as Farah herself admits, this conclusion is limited by the quality and scope of the data contained in the 37 case reports. To provide better evidence Farah, Levine, and Calvanio (1988) investigated a suspected case of imagery generation impairment in a man who had suffered a posterior LH stroke using a task created by Eddy and Glass (1981). In a study on the role of imagery in language comprehension, Eddy and Glass had presented undergraduate students with sentences of two types for verification: 18 "high-imagery" sentences whose verification a previous group of participants had judged to require imagery (e.g., "A grapefruit is larger than an orange") and 18 "low-imagery" sentences whose verification they had judged not to require it (e.g., "There are seven days in a week"; see Appendix for all stimuli). When presented auditorily, sentences of both types had been verified (judged as true or false) with equal accuracy and speed. However, when presented visually, using rapid serial visual presentation (RSVP), high-imagery sentences took 78 milliseconds longer to verify than low-imagery ones, confirming for the authors that visual processes were required to verify the "high-imagery" items. Farah and colleagues' (1988) participant with LHD and suspected image generation deficit responded less accurately than did six adults with RHD to high-vs. low-imagery items in this task.

Tippett (1992) and Sergent (1990) have criticised the validity of using archival reports to localise lesion sites. After reviewing the evidence themselves, Tippet and Sergent conjecture that functions in both hemispheres contribute to some aspect of the imagery generation process. We therefore investigated the long-held clinical impression that RHD disrupts imagery generation. Here, we operationalise "imagery" as a form potentially useful in speech-language therapy: the activation of representations retrieved from long-term memory, similar to those underlying sensory experience, in the absence of the usual sensory stimulation *and in the presence of communicative stimuli*. Unlike in the study by Farah et al. (1988) we compare the performance of a large number of individuals with RHD with that of non-brain-damaged adults (NBD), and we analyse participants' response times. In addition, when analysing our results we classify the high-imagery sentences as "visual-only" or "visuo-motor" and analyse performance on the two separately.¹

¹Farah et al. (1988) similarly divided the high-imagery stimuli into types and analysed their participant's performance on each. However, while they made their divisions according to whether the stimuli concerned colours or the appearances of printed symbols, we made them according to the physical division between the visual and motor systems, which we believe corresponds more closely to representational and processing systems in the brain.

Before our experiment is described here, the “imagery generation” ability impaired in Farah and colleagues’ (1988) participant requires further definition. Basso, Bisiach, and Luzzatti (1980) have suggested that a functional disconnection between visual and verbal “brain centers” (p. 435) underlies some apparent imagery generation deficits. The attempts of Farah and colleagues (1988) to exclude a verbal component in their participant’s deficit—such as asking him to colour everyday objects with appropriately coloured pencils—seem inadequate. Even pictorial representations share features with words that differentiate them from other stimuli. Most obviously, both are symbolic representations, and communicative in function. Yet because the ability to generate imagery specifically *in response to communicative stimuli*, including verbal stimuli, is of great theoretical and potential clinical interest, it is this ability that is examined in our study.

METHOD

Participants

A total of 72 adults participated in this study. Of these, 34 had unilateral RHD due to cerebrovascular accident and 38 were non-brain-damaged (NBD) controls without reported neurological impairment. Biographical and clinical information is found in Table 1. The groups did not differ on demographic variables; however participants with RHD performed significantly more poorly on tests of receptive vocabulary (i.e., Peabody Picture Vocabulary Test), visual perception (i.e., Visual Form Discrimination), and other clinical and neuropsychological measures (see Table 1).

Recruitment sites for participants with RHD included eight rehabilitation centres and acute care hospitals. The following inclusion criteria were met for each participant with RHD: unilateral hemispheric lesion(s) confirmed by clinical CT and/or MRI scan report, a minimum of 4 months post-onset of CVA, and at least 8 years formal education. Participants were excluded if they had medically documented evidence of bilateral lesions, cerebellar or brainstem damage, prior head injuries requiring hospitalisation, premorbid seizures, substance abuse, psychiatric illnesses, or a cognitively deteriorating condition such as Parkinson’s or Alzheimer’s disease.

Individuals in the NBD group were recruited from the laboratory’s research registry, volunteer departments at local hospitals, senior citizen groups, advertisements, referrals from friends and family members of participants, and the university clinical research website. The biographical inclusion criteria were the same as the group with RHD; however, each potential NBD control was interviewed to ensure there was no reported history of neurologic impairment or substance abuse with drugs and/or alcohol. The Mini Mental State Examination (Folstein, Folstein, & McHugh, 1975) was administered as a cognitive screen for the NBD group and a performance of 28 out of 30 was required for inclusion.

Individuals in the RHD and NBD groups were monolingual native speakers of American English with pre-morbid right-handedness and no familial left-handedness via subject report (see Tompkins, Bloise, Timko, & Baumgaertner, 1994, for operationalisations and measures of these variables). Hearing acuity was assessed via a pure-tone air conduction audiologic screening (35dB HL at 500, 1000, and 2000 Hz). Those who did not pass the hearing screening in one ear were asked to repeat 12 words containing primarily fricative consonants. Individuals were excluded if they made more than one repetition error.

Task construction

Experimental stimuli consisted of 18 high- and 17 low-imageability sentences (Eddy & Glass, 1981; see Appendix), each of which was false. A total of 36 filler stimuli were constructed to

be similar in structure to the experimental stimuli; however, all were true. Stimuli were audio recorded by a practised female speaker at a speaking rate that averaged four syllables/second. Recordings were completed in a double-walled, sound-treated booth using an Audio-Technica ATR20 microphone, which was placed approximately 4 inches from the speaker's mouth. Sound Forge v4.5 software was used as stimuli were recorded onto a Dell Optiplex BX260 with a Creative SB Live! Value (WDM) soundcard. Stimuli were transferred to E-Prime software (Schneider, Eschman, & Zuccolotto, 2002). Each trial consisted of the presentation of a trial number, a 500 ms pause, and the spoken stimulus sentence.

The entire task consisted of 71 trials that were pseudorandomly arranged within and across three blocks. Two blocks contained 24 trials and one block contained 23 trials. Four sentence types were included in each block: high-imagery experimental, low-imagery experimental, high-imagery filler, and low-imagery filler. No block contained two consecutive stimulus types or more than three consecutive "yes" or "no" responses, representing true and false respectively. Each block began with two filler trials and ended with one filler trial.

Experimental apparatus and procedures

All stimuli were administered via a Dell Inspiron 5150 notebook computer, through supraural earphones (Beyerdynamic DT150) at a loudness determined by each participant via Quick Mixer v1.7.2. Participants used a two-button manual response box labelled "yes" and "no" to respond to the auditory verification task. Both accuracy and millisecond RTs were generated and stored using E-Prime software.

Testing required three sessions with various tasks interspersed to maximally separate presentations of stimuli. Examiners performed the study in a quiet room at the participants' homes or in the third author's laboratory. Each participant worked with an individual examiner, and each examiner tested people in both the RHD and NBD groups. Prior to the experimental task, participants received extensive orientation, instruction, and practice in using the response box until RTs stabilised. Participants were instructed to use one finger on their right hand to respond, and to return that same finger to a designated location on the response box between trials. The designated location was equidistant from the "yes" and "no" labelled buttons. Participants were instructed to respond as quickly as possible. Participants first practised with five practice trials that were spoken by the examiner to ensure the adequate manipulation of the response box. Then the participant completed 10 practice trials on the computer. Ten practice trials were completed before each block. A standard Windows bell was used as a response deadline on a subset of the filler trials in order to encourage a speedy response.

RESULTS

Alpha level was set at .05 for each of the analyses performed. The data reflect the exclusion of two stimulus items from the high-imagery set (see Appendix) due to at or near chance level performance (.50) by participants in the NBD group.

Primary analysis

Accuracy—Descriptive data on the performances of both groups on high- and low-imagery items are provided in Table 2. Two-way analysis of variance (ANOVA; *Group* – RHD/NBD by *Imagery Type* – High/Low) revealed that the RHD group was less accurate than the NBD group on both high- and low-imagery items, $F(1, 70)=6.40, p=.014, \eta^2=.08$. In addition, both groups were less accurate on high- than on low- imagery items, $F(1, 70)=25.02, p<.001, \eta^2=.26$, and there was no interaction present, $F(1, 70)=1.30, p=.26, ns$.

Response times—Descriptive data on RTs for both RHD and NBD groups on high- and low-imagery items are also provided in Table 2. The findings reflect the exclusion of three participants in the group with RHD and four participants in the NBD group with outlying values for $RT > \pm 3 SD$ of each group mean. Two-way ANOVA (*Group* – RHD/NBD by *Imagery Type* – High/Low) was performed on accurate trials only. The NBD group responded faster than the RHD group, $F(1, 63) = 45.50, p < .001, \eta^2 = .42$. Crucially, a Group by Imagery interaction was also present, $F(1, 63) = 5.42, p = .023, \eta^2 = .02$. Post hoc *t*-tests showed that the NBD group was faster on low-imagery items than on high-imagery items, $t(33) = 2.44, p = .02$, while there was no RT difference between high- and low-imagery items for the RHD group, $t(30) = 1.00, p = .33, ns$.

Post-hoc analysis—Because the Eddy and Glass sentences were not uniform in terms of modality, the first two authors and another rater independently categorised the high-imagery items as “visuo-motor” ($n=7$) or “visual-only” ($n=9$) according to whether they seemed verifiable using motor imagery alone (e.g., a visuo-motor item was “The letter *W* is written with three lines”). Inter-rater reliability was 88% (15/17 items) between the first two raters; the third decided the remaining two items. Descriptive data for high-imagery items categorised as Visuo-motor or Visual-only are provided in Table 3. The accuracy data exclude the same participants that were at or near chance level performance (.50) in the NBD group.

Accuracy—Descriptive data on the performances of both RHD and NBD groups on Visuo-motor or Visual-only items are provided in Table 3. Two-way ANOVA revealed that overall performance was more accurate on Visual-only than Visuo-motor, $F(1, 70) = 5.80, p = .019, \eta^2 = .08$, and the NBD group was more accurate than the RHD group, $F(1, 70) = 6.17, p = .015, \eta^2 = .081$. Lastly, there was a Group (RHD/NBD) by Imagery Type (Visuo-motor/Visual-only) interaction, $F(1, 70) = 5.71, p = .02, \eta^2 = .075$. Post hoc one-way ANOVA showed that the RHD group performed significantly less accurately on Visuo-motor items than Visual-only items, $F(1, 33) = 8.92, p = .005, \eta^2 = .213$. However, no accuracy differences between Visuo-motor and Visual-only stimuli were found for the NBD group, $F(1, 37) = 0.0, p = .989, \eta^2 = 0.0, ns$.

Response times—Descriptive data on the RT performances of both RHD and NBD groups on Visuo-motor or Visual-only items are provided in Table 3. Two-way ANOVA (*Group* – RHD/NBD by *High Imagery Type* – Visuo-motor/Visual-only) for accurate trials showed a significant Group effect with the NBD group performing significantly faster than the RHD group, $F(1, 70) = 19.44, p < .01, \eta^2 = .22$. Additionally, there was a significant Imagery Type effect, with faster performance on Visual-only versus Visuo-motor, $F(1, 70) = 47.59, p < .001, \eta^2 = .41$. There was no interaction present, $F(1, 70) = 1.72, p = .19, \eta^2 = .02, ns$.

DISCUSSION

High- vs low-imagery analysis

Although our sentences were presented auditorily, our results for accuracy and RT for NBD adults did not replicate those found by Eddy and Glass (1981) in the auditory presentation condition. In our experiment NBD adults responded more quickly and accurately to low- than to high-imagery stimuli, while the undergraduate participants of Eddy and Glass (1981) showed no difference between conditions. This discrepancy could be due to the difference in age between our participant populations: the comprehension of high-imagery stimuli may be more affected by ageing than the comprehension of low-imagery ones.² This difference between

²This difference does not hinder our interpretation of the results. A legitimate concern is that brain damage may impact relatively difficult operations more than relatively easy ones, but we found that RHD primarily affected verification speed of the relatively easy type of sentences.

younger and older adults could be accounted for by the higher demands of high-imagery stimuli on working memory and the decline of working memory capacity in ageing (e.g., Baddeley, 1994; Hasher & Zacks, 1988; Salthouse & Babcock, 1991; Salthouse & Mein, 1995). Especially because each of our experimental sentences was false, participants had to perform complex cognitive operations that would have taxed working memory, possibly including alternating attention between multiple representations and generating new ones.

Surprisingly, however, while NBD participants responded more quickly to the low-imagery stimuli, the performance pattern of participants with RHD was like that of the Eddy and Glass undergraduates. That is, there was no RT difference between high- vs low-imagery stimuli for adults with RHD. The result is compatible with Farah's (1984) claim that imagery generation implicates the LH. The claim suggests that imagery generation processes, which are certainly prominent among the processes involved in verifying high-imagery sentences, are among those relatively less impaired in adults with RHD. We assume that participants with RHD, pre-morbidly, would have performed similarly to our age-matched NBD controls. Since working memory capacity for language has been shown to be impaired in people with RHD (Tompkins et al., 1994) we would have expected especially poor performance on high-imagery items by our participants with RHD. Our contrary finding suggests that negative effects of ageing on RT for high-imagery sentences, whether or not they are due to working memory demands, were overshadowed by other effects of RHD.

If imagery generation processes were not impaired in participants with RHD, it is unclear what processes were leading to their poor performance in response to low-imagery stimuli. To investigate this issue we first explored the possibility that syntactic differences between high- and low-imagery items led to our results. Preliminary observations revealed high-imagery sentences to contain a higher number of noun phrases, on average ($M_{\text{high-imagery}}=2.69$; $M_{\text{low-imagery}}=2.41$). High-imagery sentences also contained more words on average ($M=8.44$) than low-imagery sentences ($M=6.24$) as well as more modifiers (high-imagery $M=1.0$; low-imagery $M=0.47$). To determine whether these syntactic parameters affected accuracy and RT, we performed correlations with the dependent variables. Low negative correlations eliminated this possibility, suggesting that syntactic differences between the two types of stimuli did not affect our results.

Another hypothesised characteristic of the low-imagery stimuli that may have led to our results is based on the possibility that to accomplish the verification task, participants must manipulate and hold in working memory both mental representations evoked by the stimuli, and verbal representations retrieved from long-term memory. For low-imagery stimuli this requirement entails a comparison between two verbal representations; but for high-imagery stimuli it entails a comparison between a verbal and an imagistic representation. Previous research has demonstrated that when two tasks hypothetically requiring the same cognitive system are simultaneously performed, performance suffers on each (e.g., Duncans, Martens, & Ward, 1997; Wickens, 1991). Analogously, when two representations that hypothetically reflect the same modality (e.g., language-related or imagistic) are used in a single task, performance on the task may diminish. This effect may be especially great in adults with RHD, whose task performance has been shown to decline when the task involves representations of the same modality that are logically incompatible (e.g. Tompkins, Baumgaertner, Lehman, & Fassbinder, 2000).

Visual-only vs visuo-motor imagery

The crucial result of our post-hoc analysis is that participants with RHD responded with relative inaccuracy to visuo-motor stimuli. We ran correlations for a potential speed-accuracy trade-off in the RHD group. There was a significant negative correlation between visuo-motor item RTs and accuracy ($r=-.401, p<.001$), and a non-significant one between visual-only item RTs

and accuracy ($r=-.28, p=.07$). Because higher accuracy was associated with shorter RTs and lower accuracy was associated with longer RTs in our experiment, these correlations ruled out the potential confound of a speed–accuracy trade-off in the RHD group.

One interpretation of this result is that adults with RHD have a deficit in producing the type of motor imagery that is analogous to the visual imagery we examined. To our knowledge the literature on motor imagery does not link it to RHD. However, because the performance of our participants with RHD was compared with that of NBD adults and not adults with LHD, it is possible that a left hemisphere lesion could affect motor imagery ability in the same way. Parietal lesions of either hemisphere have been reported to impair the content or generation of motor imagery (e.g., Danckert et al., 2002); as many as 20/34 of our RHD participants may have had parietal lesions (although CT/MRI reports do not permit us to specify further).

Caution is warranted in the interpretation of these results, however, due both to their post-hoc nature and to the small number of items included in this analysis. Additionally, while visuo-motor items could possibly be verified using visual and/or motor imagery, verifying visual-only items required visual imagery specifically. It may be that the extra demand posed by visuo-motor items to select a pattern in which to respond caused these items to be difficult for participants with RHD.

CONCLUSIONS AND FUTURE DIRECTIONS

Crucially, despite the claims of Eddy and Glass (1981) and Farah et al. (1988), this study demonstrates that even simple language stimuli have properties unrelated to imagery per se that can affect the ability to respond to them appropriately. The impaired performance of participants with RHD in verifying our “low-imagery” sentences suggests that these sentences possess some properties that pose non-obvious difficulties for people with RHD.

Our results highlight the potential pitfalls of interpreting the responses of people with brain damage to language stimuli without reference to less obvious cognitive abilities. Although some researchers have taken it as given that a person with brain damage performing a task engages in most of the same cognitive processes as a non-brain-damaged person, this assumption should be questioned in both research and clinical endeavours.

Future laboratory research should attempt to equate language stimuli for cognitive demands besides imagery generation, in order to examine the ability of individuals with different types of brain damage to use visual and motor imagery. In relation to rehabilitation, this study suggests that while communicative stimuli should be used by clinicians to evoke imagery only with caution, clients with RHD are often capable of generating and referring to visual images. Further research should also address the intriguing issue of whether engaging a client in imaging daily life communicative situations during treatment would assist with generalisation of treatment gains outside the therapy room.

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APPENDIX

High- and low-imagery experimental stimuli from Eddy and Glass (1981)

High imagery	Low imagery
* A star of David has five points.	There are six days in a week.
Tractors have two very large wheels in the front.	Geology is the study of living matter.
The hot water handle on a sink is on the right.	Middle age comes after old age.
The letter W is formed with three lines.	The best student is at the bottom of the class.
The stars on the American flag are blue.	A country has windows.
George Washington had a beard.	There are three human sexes.
A stop sign has seven sides.	Spring is a month.
** The number 8 can be constructed from a single circle.	A novel is shorter than a novelette.
The accelerator on a car is the left pedal.	The introduction follows the story.
A tic-tac-toe game is drawn with five lines.	Salt is used less often than pepper.
A grapefruit is larger than a cantaloupe.	The prince will one day be queen.
The number 9 can be constructed from two circles.	A pound is heavier than a ton.
The dial on a telephone has nine holes.	Most watchdogs are bulldogs.
A row boat comes to a point in the back.	Animals are stuffed by a toxicologist.
The symbol for degrees is an apostrophe.	Geology studies the history of mankind.
The letter A is formed with four lines.	A father buys children.
A right-handed hitter places the right side toward the pitcher.	The US government functions under a three party system.
Yellow is darker than orange.	[Note: no corresponding low-imagery stimulus provided by Eddy and Glass (1981).]

* Excluded from data analysis due to near chance level performance (.58) by NBD group.

** Excluded from data analysis due to essentially chance level performance (.53) by NBD group.

TABLE 1

Demographic and clinical characteristics of two participant groups

Characteristics	RHD (n=34)	NBD (n=38)	t	p
Age (years)			1.72	.09
Mean (SD)	64.74 (11.57)	60.45 (9.61)		
Range	42–85	45–84		
Gender				
Male	17	19		
Female	17	19		
Education (years)			0.77	.45
Mean (SD)	14.42 (2.96)	13.95 (2.27)		
Range	10–22	12–20		
Lesion site (from CT/MRI report)		Not applicable		
Right cortical anterior	2			
Right cortical posterior	1			
Right cortical mixed	3			
Right subcortical	11			
Right cortical + subcortical	7			
Right MCA	9			
Not Available	1			
Lesion type (from CT/MRI report)				
Thromboembolic	18			
Lacunar	3			
Haemorrhagic	13			
Months post-onset				
Mean (SD)	52.91 (50.99)			
Range	4–167			
* PPVT–III ^a			2.11	.04
Mean (SD)	157.38 (11.22)	162.97 (11.24)		
Range	132–173	115–174		
** Behavioural Inattention Test ^b			3.22	<.01
Mean (SD)	136.79 (13.52)	144.03 (2.86)		
Range	85–146	133–146		
** Visual Form Discrimination ^c			3.36	<.01
Mean (SD)	27.97 (3.61)	30.32 (2.22)		
Range	20–32	24–32		
** Judgement of Line Orientation ^d			3.97	<.01
Mean (SD)	22.68 (5.09)	27.05 (4.26)		
Range	9–30	16–33		

RHD = right hemisphere brain damage; NBD=non-brain damaged; PPVT–III=Peabody Picture Vocabulary Test–III.

* RHD significantly poorer than NBD ($p < .05$).

** RHD significantly poorer than NBD ($p < .01$).

^aDunn and Dunn (1997; maximum=175).

^bWilson, Cockburn, and Halligan (1987; maximum=146; neglect cutoff=129).

^cBenton, Sivan, Hamsher, Varney, and Spreen (1994; maximum=32).

^dBenton, Hamsher, Varney, and Spreen (1983; age and gender corrected score; maximum=35).

TABLE 2Descriptive (*M*, *SD*) and statistical data on accuracy and RTs for low- and high-imagery stimuli

	RHD	NBD
* Accuracy		
High Imagery	.79 (.14)	.87 (.13)
Low Imagery	.86 (.13)	.91 (.09)
** RT (ms)		
High Imagery	1245.54 (214.27)	971.92 (257.30)
Low Imagery	1294.58 (250.00)	876.00 (241.27)

RHD=right-hemisphere-damaged. NBD=non-brain-damaged. RT=response time.

* RHD group less accurate than NBD group on High and Low items, $p=.014$, Both groups less accurate on High- than on Low-imagery items, $p<.001$.** NBD group faster than RHD group, $p<.001$, Group $\times$ Imagery interaction, $p=.023$.

TABLE 3

Descriptive (*M*, *SD*) and statistical data on accuracy and RTs for high-imagery stimuli categorised as visuo-motor or visual-only

	RHD (N=34)	NBD (N=38)
* Accuracy		
Visuo-motor (7 items)	.75 (.20)	.88 (.17)
Visual-only (9 items)	.85 (.12)	.88 (.12)
** RT (ms)		
Visuo-motor (7 items)	1374.65 (481.72)	982.39 (362.15)
Visual-only (9 items)	1633.97 (500.56)	1158.88 (403.72)

RHD=right-hemisphere-damaged. NBD=non-brain-damaged. RT=response time.

* RHD group less accurate on Visuo-motor items than Visual-only items, $p=.015$, Group $\times$ Imagery interaction, $p=.02$.

** NBD group significantly faster than the RHD group, $F(1, 70)=19.44$, $p<.0$, faster performance on Visual-only versus Visuo-motor, $p<.001$.