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Assessment of Neglect Dyslexia with Functional Reading Materials

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INTRODUCTION

Spatial neglect is a neurocognitive disorder in which pathologically asymmetric spatial perception, representation, and motor planning causes functional disability.⁵ Individuals with spatial neglect may fail to attend to information or act on objects appearing in the side of space contralateral to their brain lesion. It is often noted in patients with right hemisphere damage (RHD), following parietal, frontal, temporal cortical, or subcortical injury. Spatial neglect also occurs after left brain stroke.⁵⁻¹⁰

The ability to read is a crucial everyday function that is often under-investigated; it is commonly abnormal in stroke survivors with spatial neglect,^{5, 8, 11} who may demonstrate neglect dyslexia.¹⁻³ Specifically, reading errors related to spatial neglect may occur in the contralesional side of the stimulus when patients read single words, phrases, or prose. For example, a word-level reading error that is manifested in the contralesional side of the word such as reading “lend” for “blend” is an example of neglect dyslexia at the single-word level. Various accounts of neglect dyslexia are considered in the definition of the disorder, with viewer-centered, stimulus-centered, or word-centered neglect dyslexia reported.¹² When a reader omits the left side of the word that falls in his or her left body space, this is termed viewer-centered neglect dyslexia. Readers manifest stimulus- (or word-) - centered neglect dyslexia when they consistently omit or make errors in the word’s initial portion (the “left side” of the word) regardless of the word’s presentation with respect to their body space or the page space (i.e. the word can be presented in a mirror image so that it is left-right reversed, in a vertical or an upside-down orientation, and still the first part of the word, which is the left side of the word, is omitted.)¹² Word-level errors present primarily as omissions and substitutions of letters to the left of the midpoint of the word; addition of letters or confabulation can occur, though it is less frequently reported in neglect dyslexia.³

Vallar et al.³ reviewed the neuropsychological literature on this topic and reported findings from numerous studies, with the overwhelming majority of the literature focused on single subjects whose reading ability was tested using words. Of the 59 single cases reviewed by Vallar et al., 37 (79%) were tested at the word level. Of the remaining 22 cases (21%) that were reviewed, for the majority of these reports, materials included nonwords, letters, numbers, and objects. In only three cases reviewed by Vallar, were there reports of materials that included paragraph level text,^{4, 13, 14} and only one case reported on assessing neglect dyslexia using sentences.¹³ Moreover, even though sentences and paragraph-level text were included in these few reports, these studies did not specifically compare individuals' performance on different types of text nor was it suggested that texts longer than words had ecological validity that would be relevant for neglect dyslexia assessment.

In fact, word-level assessment is the primary evaluation in most studies of neglect dyslexia. When considering reading ability at the word level, lexical features of words influence patient performance on oral reading tasks, and patients may exhibit lexical effects similar to those seen in healthy individuals. For example, patients, as well as healthy individuals reportedly perform better on high-frequency words compared to low-frequency words (the frequency effect), real words over non-words (the lexicality effect), concrete words versus abstract words, and regular over irregular words. Single case reports suggest that people with neglect dyslexia may even maintain syllable stress patterns in their word errors, leading the authors to suggest that lexical stress is part of the lexical information that is preserved in neglect dyslexia.¹⁵ Sensitivity to lexical features of stimuli suggests that, in some patients, visual-orthographic processing is relatively intact, and a later stage lexical-semantic deficit contributes to the errors that take the form of paralexias (for example reading the word *dog* for *cat*).¹⁶ Written stimuli can be varied along several dimensions, such as physical features (number, size, spacing of letters) and lexical parameters (lexicality and morphology) and still induce reading errors. Reading performance that is sensitive to changes in physical parameters may reflect a deficit at the early cognitive processing stage where spatial attention plays a significant role while reading performance sensitive to lexical features of the stimulus may indicate deficits in later-stage cognitive processing.¹⁷ Experimental research focused on neglect dyslexia often examines word-level errors in order to identify characteristics of errors and potential sources of errors in the reading stages and systems. This offers theoretical information that perhaps helps researchers better understand the effect of a spatial deficit on reading performance.

Even when experimental studies that focus on reading at the single-word level ask interesting theoretical questions regarding the sources of errors in the reading stages and systems, they may not give the clinician significant guidance for structuring therapy to improve functional reading, since it is not often in the real-world that people read single words in isolation. With the World Health Organization¹⁸ focus on a biopsychosocial model of health and medicine and the push to integrate functional outcomes when considering measurement tools to document diagnosis and therapy gains, the use of single-word stimuli may not necessarily translate to the assessment of neglect dyslexia in the clinical environment. Neglect dyslexia can occur in multiple spatial scales when a reader is confronted with text: omission of the entire left page of an open book, omission of a left text column or the left side of sentences in a newspaper, omission of the left word in a phrase, or omission of the left letters in a word.³ Yet in Vallar's³ review of the literature in the area of neglect dyslexia, the majority of research has focused on single words only. In this study, we asked: What stimuli are most useful for functionally relevant assessment of neglect dyslexia? Specifically, do single words and phrases or real-life contextual materials such as an article and a restaurant menu, best detect neglect dyslexia? We hypothesized that texts with ecological validity such as the article and the menu task may be more complex and varied than single-word stimuli, and therefore readers with a range of degree of spatial

neglect may demonstrate variable performance on these materials compared to performance on reading isolated, single words and phrases. If this is the case, reading materials more similar to those encountered in everyday life would likely better capture functionally relevant neglect dyslexia and yield more valid information for clinicians to use in presenting the likely impact of spatial neglect on reading-related work and personal activities, and for planning treatment targeted to improve spatial neglect and reading.

METHODS

Participants

Sixty-seven patients (21 female, 46 male) who had sustained either an infarction or an intracerebral hemorrhage in the right brain within two months of admission to an inpatient rehabilitation facility participated in this study. Table 1 summarizes their demographic and baseline characteristics. Based on their medical records, the participants had no other major neurological condition, no history of psychiatric hospitalization, and no diagnosis of blindness or glaucoma. Participants who wore glasses were instructed to put on their glasses before reading any of the materials. All individuals voluntarily participated and gave informed consent, approved by the Institutional Review Board of the Kessler Foundation.

Instrumentation

Tests for Spatial Neglect—All participants were administered a set of tests intended to characterize their spatial neglect symptoms and severity. This consisted of the Behavior Inattention Test (BIT)¹⁹ and the Catherine Bergego Scale (CBS)²⁰ via the Kessler Foundation Neglect Assessment Process (KF-NAP).²¹ The conventional BIT that is a part of the KF-NAP consists of six subtests that include line crossing, letter cancellation, star cancellation, shape and figure copying, line bisection, and representation drawing (BIT criterion cut-off score for spatial neglect was <129). There are additional behavioral subtests of the BIT that are not administered as part of the KF-NAP. The CBS via the KF-NAP assesses 10 categories of everyday activities — limb awareness, personal belongings, dressing, grooming, gaze orientation, auditory attention, navigation, collisions, eating, and cleaning the face after a meal. For each category, a score of 0 (no neglect) to 3 (severe neglect) is given, and the total score ranges from 0 to 30.

Tests for Neglect Dyslexia—Participants read aloud 72 single-words, 20 two-word phrases, a 4-column menu (2 columns per page), and a 3-column article. The words and phrases were centered on a 12 inch-diameter HP laptop computer screen using the Microsoft PowerPoint software. The menu and article were administered in paper format. Participants were not limited in response time and response times were all within a few seconds of the presentation of the stimulus.

Words: Two words lists were alternately administered to participants. Words consisted of 4, 6, or 8 letters and 1-4 syllables, and were presented in 44-point font and Ariel style. Word lists did not differ in frequency (word frequency counts were computed and compared and there was no difference between lists, cf. Kucera and Francis)²². Participants were seated at a desk and centered in front of the computer screen without any other objects in view on the desk or the screen. Head position was maintained centrally, and participants were presented with words in the middle of the computer screen with a colored dot (radius = 7.6 mm) presented in between each test word for three seconds. Letters were separated by a space. In order to confirm that participants attended the center of the screen, and reduce visual after-effects from preceding trials, participants viewed and named the color of a dot (green, blue, red, and yellow, pseudo-randomly presented) appearing before they read each word presented on the screen.

Two-word Phrases: Two phrase lists from the Psycholinguistic Assessments of Language Processing in Aphasia (PALPA)²³ were alternately administered to participants. As in the single-word reading task, participants were presented with phrases in the middle of the computer, again with a colored dot foil presented between each test phrase. Texts were presented in 44-point font and Arial style. Words in a given phrase were separated by a space. Participants were required to name the color of each dot and read each phrase presented on the monitor. See photograph of Powerpoint set up for *Words* and *Two-word Phrases* in Appendix A.

Article: The two articles from the Article behavioral subtest of the BIT¹⁹ were alternately administered to participants (this subtest was not administered as part of the KF-NAP). The article was printed on paper and placed on the center of the desk with its midpoint in line with the participant, without any other objects in view. The article contained three columns (column length = 60 mm, width = 80 mm) with 10 - 14 lines in each column and 1 - 6 words in each line. Participants were instructed to read the article. See Figure 1, example of Article.

Menu: The two menus from the behavioral Menu subtest of the BIT were alternately administered to participants (this subtest was not a part of the KF-NAP). The menu contained left and right letter-sized pages, opening like a book. It was printed on paper and placed on the center of the desk with its midpoint in line with the participant, without any other objects in view. On each page, there were 2 columns with 6 food items in each column. Food items contained 1 - 2 words. Participants were instructed to read all of the items on the menu. See Figure 2, example of Menu.

Procedures

There were two examiners present for all four tasks of the reading assessment. Presentation of reading materials was alternated among participants. For example, the first participant read materials in the following order: *words*, *phrases*, *menu*, and *article*, then *phrases*, *menu*, *article*, *words*, etc. All assessments were audio and video recorded. The recordings were used to double-check scoring for all participants that demonstrated reading errors in the on-line scoring. Two clinicians (blinded to the hypotheses and to participants' scores on neglect testing) with master's degrees rescored participants using the recordings. Inter-rater reliability for scoring was accurate 96% of the time. When there was a discrepancy, a third rater rescored the item.

Words and Phrases—Examiner 1 was seated behind the participant and ran the computer program and instructed the participant throughout the testing. Examiner 2 recorded participants' responses on the paper form. Each trial started with one PowerPoint slide with a colored dot, followed with a slide with a word or a phrase, and immediately a blank slide once the participant initiated vocalization of the word or phrase, then a colored dot, followed with a word or phrase, followed immediately by a blank slide. As soon as the participant began production of the color/word/phrase, Examiner 1 immediately clicked the mouse so the participant did not have time to rethink his/her response. Examiner 2 wrote down what the participant said and scored the participant as correct or incorrect on the scoring sheet. The participant was not limited in time allowed for response and all participants responded either immediately after the stimulus appeared or within a few seconds of the appearance of the stimulus.

Article and Menu—The article and the menu were each placed in midline on the desk in front of the participant. Examiner 1 was seated behind the participant and had a copy of the testing material. Examiner 1 scored the material as the participant read aloud. Examiner 2

sat directly across from the participant and ensured that the test material remained in midline for the testing period. The test was administered in standard fashion, and this included untimed administration. The participant was not cued at any time.

Test Scoring—Words and Phrases were scored for percent correct and percent neglect-related error. The Menu and Article behavioral subtests of the BIT were scored based on the instructions of the BIT, which included assigning a rating from 0-9 based on number of word errors or word omissions by the participant. Percent correct score for the article and the menu tasks were also determined in order to compare performance among the four reading tasks.

Statistical Analyses

We fitted a series of mixed-effects logistic regression models to examine accuracy scores for each text type. Mixed-effects logistic regression addresses two issues related to the nature of response accuracy: A) proportion data are bounded by 0 and 1, and B) repeated measures are nested within subjects. The logistic part allows modeling the nonlinear component of the outcome variable, and this approach has been shown to be superior to an ANOVA approach on transformed data (e.g., arcsine-square-root transformation).²⁴⁻²⁵ The mixed-effects part allows accounting for the clustered nature of the data, being responses (Level-1) nested within participants (Level-2); furthermore, it allows us to examine the variability both within and between subjects and to study the effects and interactions within and across participants.^{26, 27} Data were analyzed with R version 2.15.1²⁸ using the glmer function from the lme4 package (version 0.999999-0).

Model building followed a bottom-up approach, starting with level-1 predictors. Once the level-1 model was satisfactory, we examined the predictive power of level-2 variables. Both fixed and random effects were tested during the model building process and retained only if they improved significantly the model fit. Participants were included as random effects in all models. A model comparison approach permitted us to contrast alternative models progressively more complex. This approach has been shown to be preferable to significance test of individual parameters in arriving at correct statistical inferences.^{29, 30} The Likelihood-ratio test (LR test) and the Akaike Information Criterion (AIC) were used to compare the fit of competing models.

During preliminary inspection of the data, it emerged a strong linear correlation emerged between BIT and CBS scores ($r = -.75, p < .001$). Therefore, we decided to combine the two variables into one “index of neglect severity” measure (CBS-BIT) by computing the mean of the CBS standardized z-scores and the additive inverse of the BIT standardized z-scores, that is, $[zCBS + (zBIT \times -1)] / 2$. Thus, the higher value of the index indicated the greater severity of spatial neglect. The use of the CBS-BIT combined measure provided a more global measure of neglect severity, simplified the complexity of the data, and permitted a more parsimonious explanation of the results. Analyses performed using BIT and CBS scores separately produced the same pattern of results obtained using the CBS-BIT combined measure, therefore only the latter will be reported and discussed. For meaningful interpretation of the CBS-BIT scores see Table 2.

RESULTS

Descriptive statistics for accuracy are reported in Table 1. Following the approach described in the Statistical Analyses section, we fitted a series of mixed-effects logistic regressions to examine the effects of within-subjects factors (Phrase, Word, Menu, and Article), between-subjects variables (MMSE, CBS-BIT, Age, Education, and Days post-stroke), and their interactions on performance accuracy. Variables that were not significant were removed

from the analyses, and only the final model is reported (Table 3). MMSE was included as a covariate to control for the general cognitive impairment and, given its relevance, was the only variable that was kept in the models regardless of its statistical significance.

In sum, based on the final model (Table 3), performance accuracy on the reading tasks was significantly worse as a composite index of neglect severity increased, but that performance was also significantly influenced by the type of reading task (functional reading worse than reading isolated words/phrases). The estimated percentage accuracy for the Article task was 52%. Predicted accuracy for Menu, Phrase, and Word were 70%, 93%, and 89% respectively (Figure 3). A pre-planned contrast was run to test the directional hypothesis that, on average, performance on the Menu and Article tasks would be significantly poorer than performance on the Phrase and Word tasks. Table 4 shows that this contrast is highly significant and that our hypothesis has strong support. We also tested the difference among each pair of the four levels of the task type factor. Results (Table 4) indicate that neither the difference between Menu and Article, nor the difference between Word and Phrase were statistically significant.

Neglect severity, as indicated by the CBS-BIT variable, resulted to have an overall highly significant effect on performance accuracy, but, as previously mentioned, did not moderate the effect of task type on the outcome. For example, a point increase in CBS-BIT score, from 0 to 1 (+1.1 SD), produced .35 (65%) estimated drop in accuracy for Article; .38 (54%) decrease in accuracy for Menu; .19 (20%) decrease in accuracy for Phrase; .26 (29%) decrease in accuracy for the Word task (Figure 4).

Hierarchical regression analysis

To further investigate the relationship between neglect severity and task type we conducted a hierarchical regression analysis with CBS-BIT as the dependent variable and the four tasks Article, Menu, Phrase, and Word as predictors. After controlling for general cognitive impairment, we entered variables in a theoretically constrained order: first we entered Article and Menu, which we predicted to be a better indicator of the neglect severity for its close-to-everyday-life face value; then, we entered the more widely used measures Phrase and Word. This way it was possible to identify tasks that are able to make independent and significant contributions to the model. Results of the hierarchical regression analysis (see Stage-1 in Table 5) showed that Menu and Article predicted a large (53%) and significant proportion of the variance of neglect severity above the variance explained by the covariate MMSE. R squared change in step 3, where Phrase and Word were collectively entered into the equation, was not statistically significant.

Because there was a high correlation among the four tasks, a second set of regression analyses was conducted to examine whether the four tasks differed in their predictive power of the CBS-BIT scores (see Stage-2 in Table 5). Here the order of the tasks was reversed: we entered MMSE at step 1, Phrase and Word at step 2, and Article and Menu at step 3. Results indicate that Phrase and Word accounted for 25% of the variance; more interesting, when Article and Menu were entered they accounted for an additional 27% of variance.

DISCUSSION

While much of the research in the area of neglect dyslexia focuses on reading isolated words and phrases in laboratory environments, we wished to learn whether patients with spatial neglect would have poorer performance reading texts and materials that reflect everyday real-world reading. In this study, we compared reading accuracy on laboratory and functional text: Word, Phrase (isolated and computer-presented reading), and Article, and Menu (daily-life simulation tasks) were compared. Reading accuracy on the Article and

Menu was also significantly poorer than performance on Word and Phrase. A possible contribution to the difference in reading performance includes the greater need for focused attention in the Article and Menu tasks compared to the Word and Phrase tasks. Moreover, for the Word and Phrase tasks a dot in the center of the computer screen may have promoted increased focused attention toward the screen for these trials whereas for the Article and Menu tasks there was no cue provided to increase focus on the materials. Certainly the increased information in the Article and Menu tasks could have additionally affected the load required for maintaining attention to the materials.

Our findings provide evidence for a strong relationship between the functional reading tasks, Article and Menu and neglect severity, suggesting that this type of reading may be a more valid indicator of spatial neglect affecting reading, than is laboratory-administered, isolated word/phrase reading. The Word and Phrase reading tasks were presented from a fixed location in the center of the computer screen while the Article and the Menu tasks inherently involved left-to-right scanning. The need to implement scanning to read these longer text materials may have been an additional factor that made these tasks more difficult for people with neglect dyslexia. Therefore, in comparison to single words or two-word phrases, texts with ecological value such as multi-columned menus and articles may present more difficulty to persons with spatial neglect. This is not surprising, as the ecological texts are more spatially distributed in two-dimensional space, and readers may need to recall more material to abstract meaning in what is read (paragraph-level as opposed to word- or phrase-level reading). Therefore, the spatial set up and the possible need to recall more material to abstract meaning are two potential reasons why the Menu and Article tasks were more difficult to read than the Words and Phrases.

We used a composite index of spatial neglect severity, for which no information has yet been obtained on construct validity, nor on correspondence with other assessments of severity in different spatial networks affecting daily life function. In particular, the generic nature of the composite neglect index we used may have obscured significant differences in Where, perceptual-attentional spatial deficits, versus Aiming, motor-exploratory spatial deficits, which may have different relationships to daily life function.³¹ Reading may require both accurate Where, perceptual-attentional, and Aiming, motor-intentional spatial cognitive processing. By using the CBS-BIT combined measure, we expected we could include variance in spatial neglect performance related to both Where perceptual-attentional spatial deficits and Motor-exploratory spatial deficits, to which the CBS and BIT may be differentially sensitive.³¹ However, participants whose scores were in the moderately-impaired range on the composite spatial neglect index demonstrated the most striking differences in performance on functional versus isolated word/phrase reading materials (Figure 4). If the categories of performance on the composite assessment index correspond with other methods of assessing functional deficit, then when these individuals present in clinical settings, they may not be diagnosed with neglect and with neglect dyslexia when words and phrases are used for assessment, but clearly may manifest clear neglect-related reading difficulty when ecological materials such as an article or menu are used for assessment. Since stroke survivors with spatial neglect are likely to demonstrate anosognosia, or unawareness of deficit¹¹ the patient report of reading problems will not be a good indicator to guide clinician assessment and treatment to optimize function. Our data suggests that patients with moderate spatial neglect may not be diagnosed during reading assessment, consistent with prior research indicating underdiagnosis of spatial neglect in rehabilitation environments.³² The relationship of spatial neglect severity on nonverbal tasks with functional reading provides strong evidence that spatial neglect is disabling in everyday reading behavior, which may in turn have substantial negative consequences in patients' leisure activities, social interaction, and overall well-being. Failure to diagnose spatial neglect and its impact on everyday life may result in healthcare disparities and further health

disparities, since neglect dyslexia may adversely affect return to work, medication self-adherence, financial self-management and even other functional tasks such as use of environmental signage while driving.

Limitations

There were several limitations to this study. Firstly materials were placed in different positions in space. The article and the were placed on the desk in front of the participant while the words and phrases were read from a computer screen in the vertical plain. The different positions of the materials may have affected reading performance. Another limitation of this study is the font size of materials. While the Words and Phrases were presented in 44 point font, the Article and Menu were presented in conventional font size for reading these materials, and this font size was smaller compared to the font size of the Words and Phrases tasks. Presumably the larger font size of the words and phrases might have made these materials easier to read. Moreover, the heavier cognitive load of the Article and Menu tasks may have made these more difficult to read, thus negatively affecting reading performance on these tasks.

Conclusion

Future studies focused on assessment of neglect should include reading tasks focused on validated, ecologically-based real life reading materials. Furthermore, since treatment focus is driven by the assessment process, these findings are relevant to intervention practices. Our participants made more errors on functional versus isolated reading tasks, which suggests that treatment approaches for neglect dyslexia may need to assist the client to develop spatially-distributed attention for reading. Future research should investigate whether reading training that orients clients toward global visual-spatial processing (over training local visual-spatial attention³³), or whether training that incorporates challenging and complex materials, results in better reading improvement in clients with right brain stroke and spatial neglect.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.

One of two articles from the Article behavioral subtest of the BIT. Both articles were used in this study (reproduced with permission).

Tea	Roast chicken	Tomato soup	Grapefruit
Hamburger	Lamb chop	Pork chop	Ham & eggs
Salad	Turkey	Shepherd's pie	Fried haddock
Milk	Veal	Jam tart	Cheese
Apple tart	Boiled eggs	Ice cream	Biscuits
Sandwiches	Melon	Coffee	Apple pie

Figure 2.

Version A of the Menu subtest from the BIT. Version B contained columns in reverse order from left to right (i.e. First row: Grapefruit, Tomato soup, Roast chicken, Tea; reproduced with permission).

Figure 3.
Predicted and observed performance accuracy by task type.

Figure 4.
Predicted performance accuracy by task type and neglect severity (CBS-BIT) for average degree of general cognitive impairment (MMSE = 23.7).

TABLE 1

Descriptive statistics (N = 67)

Variable	Mean(SD)	Min	Max
Age in years	66.87(12.97)	28	90
MMSE	23.66(4)	11	30
Education in years	13.93(3.2)	5	21
Days post-stroke	18.66(9.59)	2	48
BIT	77.94(43.95)	8	143
CBS	15.57(8.57)	0	29
CBS-BIT	0(0.94)	-1.6	1.51
Article	0.51(0.38)	0	1
Menu	0.63(0.34)	0	1
Phrase	0.87(0.25)	0.1	1
Word	0.82(0.28)	0.04	1

Note. MMSE = Mini Mental Status Examination; BIT = Behavior Inattention Test; CBS = Catherine Bergego Scale; CBS-BIT = mean of CBS standardized z-scores and additive inverse of BIT standardized z-scores; Phrase, Word, Menu, and Article = see text for description.

TABLE 2

Correspondence between CBS-BIT scores and estimated BIT and CBS scores (95% CI in square brackets). Estimated scores were obtained regressing BIT and CBS on the combined CBS-BIT variable

Variable	MIN	-1 SD	Mean	+1 SD	MAX
CBS-BIT	-1.6	-0.94	0	0.94	1.51
BIT	[140.4, 155.3]	[113.7, 124.4]	[74.2, 81.71]	[31.51, 42.21]	[4.78, 19.12]
CBS	[0.47, 3.39]	[6.51, 8.6]	[14.83, 16.3]	[22.54, 24.62]	[27.04, 29.84]

Note. BIT = Behavior Inattention Test; CBS = Catherine Bergego Scale; CBS-BIT = mean of CBS standardized z-scores and additive inverse of BIT standardized zscores. For both the regression of BIT on CBS-BIT and CBS on CBS-BIT: $N = 67$, $R^2 = .87$, $F(1,65) = 449.5$, $p < .001$.

TABLE 3

Summary of generalized mixed-effects final model for performance Accuracy

Fixed effects	Estimate	Std. Error	<i>z</i>	<i>p</i>
Intercept	0.12	0.31	0.388	0.698
MMSE	0.06	0.046	1.266	0.206
Menu	0.751	0.443	1.696	0.09
Phrase	2.609	0.536	4.869	<.001
Word	2.08	0.496	4.196	<.001
CBS-BIT	-1.614	0.252	-6.408	<.001
Random effects	Variance	Std. Dev.		
Intercept	0	0		

Note. MMSE = Mini Mental Status Examination (grand mean centered); CBS-BIT = mean of CBS standardized z-scores and additive inverse of BIT standardized zscores. Phrase, Word, and Menu = see text for description. Participants included as random effects.

TABLE 4

Post-hoc analyses for performance accuracy

	Estimate	Std. Error	<i>z</i>	<i>p</i>
Contrast				
Phr.Word – Art.Menu ≤ 0	3.939	0.74	5.322	< 0.001
Comparison ^a				
Menu – Article = 0	0.751	0.443	1.69	0.324
Phrase – Article = 0	2.609	0.536	4.869	< 0.001
Word – Article = 0	2.08	0.496	4.196	< 0.001
Phrase – Menu = 0	1.858	0.519	3.58	0.002
Word – Menu = 0	1.33	0.481	2.77	0.029
Word – Phrase = 0	−0.528	0.539	−0.98	0.76

^aNote. Tukey-HSD tests.

TABLE 5

Summary of hierarchical multiple regression analysis predicting neglect severity (CBS-BIT) scores

STAGE-1						
Variable	Step 1		Step 2		Step 3	
	Coef.(SE)	Beta	Coef.(SE)	Beta	Coef.(SE)	Beta
Intercept	0(.11)		1.29(.15)		1.29(.26)	
MMSE	-.09(.03)	-.4**	-.02(.02)	-.09	-.02(.02)	-.09
Menu			-1.48(.35)	-.54***	-1.54(.4)	-.56***
Article			-.69(.31)	-.28*	-.73(.32)	-.3*
Phrase					-.3(.6)	-.08
Word					.4(.63)	.12
R^2 (R^2 change)	.157(.157)		.683(.526)		.685(.002)	
F for R^2 change	12.07 ($p < .001$)		52.2 ($p < .001$)		0.19 ($p = .83$)	

STAGE-2						
Variable	Step 1		Step 2		Step 3	
	Coef.(SE)	Beta	Coef.(SE)	Beta	Coef.(SE)	Beta
Intercept	0(.11)		1.32(.35)		1.29(.26)	
MMSE	-.09(.03)	-.4**	-.05(.02)	-.21*	-.02(.02)	-.09
Menu					-1.54(.4)	-.56***
Article					-.73(.32)	-.3*
Phrase			.61(.78)	.16	-.3(.6)	-.08
Word			-2.26(.7)	-.67**	.4(.63)	.12
R^2 (R^2 change)	.157(.157)		.411(.254)		.684(.274)	
F for R^2 change	12.07 ($p < .001$)		13.61($p < .001$)		26.44($p < .001$)	

Note. MMSE = Mini Mental Status Examination (grand mean centered). Phrase, Word, Menu, and Article = see text for description.

*
p < .05

**
p < .01

p < .001.