

## Normative Data for Equivalent, Parallel Forms of the Judgment of Line Orientation Test\*

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### ABSTRACT

The Judgment of Line Orientation Test (JLO; Benton, Hamsher, Varney, & Spreen, 1983) permits assessment of visuospatial processing without making demands on motor skills. However, its administration can be time-intensive and frustrating for patients, particularly when used in a geriatric population. We present a single set of normative data to be used for both the odd-item and even-item forms derived from Form V of the JLO based on responses from a healthy geriatric sample. Mean scores and distributions of odd-item and even-item forms were nearly identical, and both forms showed significant correlations with the Developmental Test of Visual-Motor Integration. Cross-validation using the odd form of the JLO on an independent sample from a different geographic location suggested good generalizability of the normative data. We conclude that these JLO short-form normative data may be used in clinical screening situations or when serial assessments are needed.

Most measures of visuospatial processing require some degree of motor dexterity in order to complete the task. As a result, visuospatial processing and motor speed and coordination are often confounded. However, the Judgment of Line Orientation Test (JLO; Benton, Hamsher, Varney, & Spreen, 1983) has no motor requirements, and it emphasizes accurate visual perception of subtle differences in line slope. Patients are asked to identify the angular positions of 30 pairs of target lines positioned above a reference figure containing 11 lines arranged in a semicircle and numbered from 1 to 11. The JLO consists of two forms, H and V, that present the same items but in a different order. Both forms retain a gradation of item difficulty level, with the easiest items being presented at the begin-

ning and harder items presented toward the end. Validity studies of the JLO demonstrate that the test discriminates patients with right-hemisphere damage from those with left-hemisphere lesions, and that the test is most sensitive to lesions of the posterior right cerebral hemisphere (Benton, Hamsher, Varney, & Spreen, 1983; Benton, Sivan, Hamsher, Varney, & Spreen, 1994).

Despite its validity, the JLO can be time-consuming to administer and frustrating for patients, particularly among geriatric or severely impaired individuals. In response to this problem, we examined the comparability of odd- and even-item forms of the JLO in a large mixed clinical sample (Woodard et al., 1996). We concluded that the two JLO short forms have adequate internal consistency, validity, and utility

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for serial assessment in research studies. However, this conclusion was based on a comparison of performance on the 15 odd and 15 even items from individuals who completed the entire 30-item test. Therefore, we cautioned that more detailed clinical use of the two JLO short forms would require further analysis of interform equivalence and collection of normative data.

The purpose of this study was to generate normative data for the JLO odd- and even-item short forms in a sample of healthy, community-dwelling geriatric participants. We also attempted to apply these normative data to a new sample in an effort to cross-validate our results.

## METHODS

### Participants

Participants in the derivation sample were 82 healthy, nondepressed, community-dwelling, geriatric individuals who were recruited as part of a separate research study in Western New York State. The mean age of the derivation sample was 65.8 years ( $SD = 6.7$ ; range = 55–84), the mean educational level was 14.0 years ( $SD = 2.3$ ; range = 9–20), the mean Mini-Mental State Examination (Folstein, Folstein, & McHugh, 1975) score was 27.5 ( $SD = 2.0$ , range = 21–30), and the mean IQ level based on demographic estimates (Barona, Reynolds, & Chastain, 1984) was 110.3 ( $SD = 6.6$ ; range = 86–121). The sample was predominately female (78%), Caucasian (97.6%), and right-handed (93.9%).

The cross-validation sample consisted of 49 healthy, nondepressed, community-dwelling geriatric participants who were recruited as part of a separate research study. The mean age of the cross-validation sample was 67.0 years ( $SD = 6.9$ ; range = 55–79), and all participants had completed at least 11 years of education. The cross-validation sample was again predominately Caucasian (98%), but it was more balanced with respect to gender (53.1% females). No information regarding number of years of education or handedness was available for the cross-validation sample.

### Procedure

The two JLO short forms were constructed using an odd-item/even-item split for Form V as described in our previous study (Woodard et al., 1996). Thus, the 15 odd-numbered items comprised Form O, and the 15 even-numbered items

made up Form E. For each participant in the derivation sample, Form O and Form E were administered in a counterbalanced fashion by a licensed psychologist or by a trained psychometrician in accordance with standardized instructions (Benton et al., 1983, 1994). The delay period between short-form administrations was approximately 45 min, during which a short battery of neuropsychological measures was administered. Participants in the cross-validation sample received only Form O as part of a more extensive neuropsychological battery. This short form was again administered in accordance with standardized instructions by a trained psychometrist.

## RESULTS

In the derivation group, we found no significant effect of administration order (Form E:  $t(80) = .26$ ,  $p = .80$ ; Form O:  $t(80) = -.51$ ,  $p = .61$ ). The two forms correlated significantly with each other ( $r = .55$ ,  $p < .001$ ). This correlation coefficient is somewhat lower than the interform correlation of .76 observed in our previous study (Woodard et al., 1996). However, the scores in our previous study ranged from 0–15, whereas scores ranged from 5–15 for the even form and 6–15 for the odd form in the present study. Thus, the interform correlation in this study is likely to be affected by restriction of range. Indeed, when a correction for restriction of range (Guilford & Fruchter, 1973) was applied using the odd form as the predictor and the even form as the criterion, the interform correlation rose to .71.

When comparing each individual's performance on the two JLO short forms, 77% of the derivation sample had scores on one form that were within 2 points of their score on the other form. In addition, 92% of the derivation sample had JLO short-form scores that were within 4 points of one another. Table 1 presents the frequency distribution and cumulative percentages for the two JLO short forms in the derivation sample and for the odd-item JLO short form in the cross-validation sample. The table indicates that scores below 8 were quite rare in either sample and for either form. Thus, an individual obtaining a score of 7 or less could easily be

classified as having an abnormal score. Roughly two thirds of the derivation sample obtained scores of 11 or greater on each form, and this pattern was also present in the cross-validation sample for the odd-item form. The cumulative percentages associated with each score were remarkably uniform across forms overall, suggesting that the two forms yield very consistent data. Further, at least for the odd-item form, the pattern of scores seems to replicate across samples.

Potential differences in the distribution of scores within the derivation group between Form O and Form E were examined using the Wilcoxon Signed Ranks Test, which considers information regarding both the sign and magnitude of the difference between obtained scores on each form. This analysis revealed no significant difference between the distributions of each form ( $z = -.68, p = .50$ ). These analyses suggested that the means and distributions of the two forms were virtually identical. We then pooled scores from the first short-form administration (Form O  $n = 40$ , Form E  $n = 42$ ) for the derivation sample.

The mean odd-item JLO score for the cross-validation sample was 11.98 ( $SD = 2.3$ ). The pooled JLO scores for the derivation (Form O and Form E) and cross-validation (Form O score) groups were not significantly different ( $t(129) = -1.25, p = .21$ ). A two-sample Kolmogorov-Smirnov test was used to compare the distribution of scores between the derivation and cross-validation sample (across groups). This analysis again revealed no significant differences in distribution shape between the two samples ( $z = .60, p = .87$ ). Both group scores showed significant correlations with the Developmental Test of Visual Motor Integration (VMI; Beery & Buktenica, 1989), and these correlations were not significantly different across forms using Fisher's  $r$  to  $z$  transformation.

Given that the cross-validation and derivation groups did not show systematic differences in mean score, validity coefficients, or distribution shape, we combined the pooled short-form scores from the derivation group with the Form O score from the cross-validation sample ( $N = 49$ ) to produce a final set of normative data against which scores from either Form O or

Table 1. Frequency Distribution of Scores for Short Forms O and E Derived from JLO Form V.

Score	Derivation sample				Cross-validation sample	
	Odd-Item Form		Even-Item Form		Odd-Item Form	
	Frequency	Cum. %	Frequency	Cum. %	Frequency	Cum. %
0	0	0	0	0	0	0
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	1	1.2	0	0
6	1	1.2	0	1.2	0	0
7	5	7.3	2	3.7	3	6.1
8	4	12.2	2	6.1	0	6.1
9	8	22.0	8	15.9	4	14.3
10	11	35.4	13	31.7	7	28.6
11	5	41.5	17	52.4	4	36.7
12	13	57.3	13	68.3	10	57.1
13	12	72.0	10	80.5	7	71.4
14	15	90.2	8	90.2	5	81.6
15	8	100	8	100	9	100

Note. JLO = Judgment of Line Orientation; Cum. % = Cumulative percentage.

Table 2. Descriptive Statistics for JLO Short Forms.

	<i>M</i>	<i>SD</i>	Correlation with				
			VMI	Age	Educ	MMSE	Premorbid IQ
Derivation sample							
Form O	11.6	2.4	.46*	-.13	.11	.10	.21
Form E	11.5	2.1	.46*	-.16	.10	.15	.20
Pooled samples	11.7	2.4	.47*	-.09	.07	.11	.12
Cross-validation sample							
Form O	11.98	2.3	—	-.15	—	—	—

*Note.* JLO = Judgment of Line Orientation; MMSE = Mini-Mental State Examination; VMI = Developmental Test of Visual-Motor Integration. Pooled samples consists of the score of the first short form administration (either Form O or Form E) in the derivation sample and Form O score in the cross-validation sample (Total  $N=131$ ) without adding the one point sex correction for females.

\*  $p < .001$ .

Form E could be compared. Table 2 presents the means, standard deviations, and validity coefficients (correlations with the VMI, age, MMSE, estimated premorbid IQ, and education) for the two short forms in the derivation sample, for Form O in the cross-validation sample, and for the final pooled data.

The final normative sample contained 41 males and 90 females. There was a significant difference between males and females on JLO-short-form score (male  $M = 12.5$ ,  $SD = 2.1$ ; female  $M = 11.3$ ,  $SD = 2.4$ ;  $t(129) = 2.74$ ,  $p < .008$ ). However, JLO short-form score was unrelated to age, education, estimated premorbid full

Table 3. Normative Table for JLO Short Forms O and E Derived from JLO Form V.

Score	Frequency	Cum. %	Interpretation
0	0	0	Severe Deficit
1	0	0	Severe Deficit
2	0	0	Severe Deficit
3	0	0	Severe Deficit
4	0	0	Severe Deficit
5	0	0	Severe Deficit
6	1	1	Moderate Deficit
7	2	2	Moderate Deficit
8	7	8	Mild Deficit
9	6	12	Mild Deficit
10	9	19	Borderline
11	20	34	Normal
12	19	49	Normal
13	25	68	Normal
14	16	80	Normal
15+	26	100	Normal

*Note.* Frequencies are based on the pooled data for the first administration of Form O or Form E in the derivation sample and Form O in the cross-validation sample (Total  $N = 131$ , 41 males, 90 females, overall  $M = 12.3$ , overall  $SD = 2.3$ , range 6-16). One point should be added to scores of female participants before looking up the score on this table, producing a maximum possible score of 16. JLO = Judgment of Line Orientation; Cum. % = Cumulative percentage range.

scale IQ, or MMSE. Because of this gender disparity, systematic addition of a one point correction to the scores of female participants removed group differences (male  $M = 12.5$ ,  $SD = 2.1$ ; female  $M = 12.3$ ,  $SD = 2.4$ ;  $t(129) = .430$ ,  $p < .67$ ). Table 3 presents the final normative data to be used with either Form O or Form E. The frequency of individuals obtaining each score in the derivation sample, the percentile ranges encompassed by each score, and a corresponding clinical interpretation are indicated in the table.

## DISCUSSION

The results of this study suggest that Form O and Form E demonstrate similar mean scores, and the distribution of scores is also quite similar across both forms. Given the high degree of comparability between Form O and Form E, the two forms may be considered to be equivalent in difficulty, making them extremely useful for serial examinations. Although the standard 30-item JLO has two forms, H and V, they are not parallel forms in the strictest sense because they contain the same items presented in a different order. Further, for Form O, we found evidence that the mean score and overall distribution of scores were highly similar across two different samples from disparate geographical locations. The normative data presented in Table 3 may be used to determine the relative standing of an individual's score with respect to these normative samples.

As we noted in our earlier report (Woodard et al., 1996), simply administering either the odd- or even-JLO items and doubling the score to use previously published normative data is a dubious practice that can produce erroneous results. The current study provides adequate normative data for the JLO short form using an independent sample. It is important to emphasize, however, that these normative data are based on an odd/even item split for Form V. Whether or to what extent these normative data would extend to an odd/even item split for Form H is unknown. We strongly recommend that these normative data be utilized *only* with Form V. We also recommend cross-validation of the even-

item form in a new population, although the similarity between forms was so great, the results are not likely to be substantially different. Finally, clinical validation of the performance of the two short forms in terms of their ability to differentiate individuals with focal right and left parietal damage is currently underway.

This study promotes the use of brief assessment techniques and alternate forms with geriatric patients. Brief but accurate assessment procedures are strongly needed in this population in order to minimize fatigue, to facilitate cooperation during the neuropsychological evaluation, and to deliver services in a cost-effective fashion. Other research from our group has demonstrated the cost-effectiveness and validity of similar brief approaches in the domain of memory (Benedict, Schretlen, Groninger, & Brandt, 1998; Benedict, Schretlen, Groninger, Dobraski, & Shpritz, 1996). Whether or not alternate forms reduce practice effects with tests in domains other than memory, including spatial perception, is a question that is also under investigation in our laboratories.

In conclusion, the results of this study are consistent with our previous work in suggesting that the two shortened versions of the JLO can be used as parallel short forms. We recommend using the norms derived in this study, rather than simply administering every other item, doubling the score, and applying the standard JLO normative data. This procedure requires no additional materials and merely uses the standard forms and administration procedure, followed by application of our normative data reported herein. The availability of normative data for the two parallel short forms of the JLO will be helpful for clinical screening or in situations that require serial examinations.

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