Pergamon

Archives of Clinical Neuropsychology, Vol. 12, No. 5, pp. 505–512, 1997

0887-6177/97 $17.00 + .00

PII S0887-6177(96)00044-3

Detection of Malingering on the Luria-Nebraska Neuropsychological Battery: An Initial and Cross-validation

R. Kim McKinzey

Center for Psychological Studies, Albany, CA

Marvin H. Podd and Mary Ann Krehbiel

National Naval Medical Center, Bethesda, MD

Abraham J. Mensch

Delaware Youth & Family Center, Wilmington, DE

Candace Conley Trombka

Tulsa, OK

A formula for detecting faked LNNB profiles was validated on 68 experimental malingerers and adequately motivated patients matched on education, age, and severity of profile. The formula was then cross-validated on 51 malingerers and 202 patients. The formula yielded a cross-validated 23% false negative rate and a 9% false positive rate, for an overall hit rate of 88%. If normal and profoundly impaired profiles are eliminated from the cross-validation analysis, the false negative rate is 17% and the false positive rate 7%, for an overall hit rate of 91%. © 1997 National Academy of Neuropsychology. Published by Elsevier Science Ltd

David Faust (Faust, 1996; Faust, Ziskin, & Hiers, 1991) has documented the need for detection of malingering on neuropsychological batteries. Adults (Heaton, Smith, Lehman, & Vogt, 1978), adolescents (Faust, Hart, Guilmette, & Arkes, 1988b), and children (Faust, Hart, & Guilmette, 1988a) are quite capable of faking neuropsychological deficits on the Halstead-Reitan Battery (HRB). The Luria-Nebraska Neuropsychological Battery (LNNB) has like-

The authors thank Douglas E. Harrington, of Coastline Community College, Fountain Valley, CA, for his addition of patient subjects to this study. Many subjects from the Universities of Delaware and Oklahoma State donated their time as part of the Mensch and Conley (respectively) dissertations. We also thank the helpful staff at NNMC.

Address correspondence: R. K. McKinzey, 3045 Telegraph, Oakland, CA 94609. Email: rkm@slip.net

wise been demonstrated to be vulnerable to malingering by adults (Anderson, 1984; Conley, 1985; Mensch, 1983; Mensch & Woods, 1986), who did not need special instructional sets or incentives to provide abnormal profiles.

However, none of these studies provided a formula that could accurately detect malingerers. The LNNB studies were conclusive in demonstrating that, while fakers were not identical to adequately motivated patients, there was considerable overlap. Consequently, the malingerers could not be accurately distinguished from the true patients via decision rules that work well in differentiating normals from people with true neuropsychological deficits. Part of the reason the LNNB studies were unable to provide a decision rule that would identify malingerers was due to their small N (Mensch $N = 32$, Conley $N = 15$, Anderson $N = 29$). The present authors therefore agreed to pool the data and add more subjects for a reanalysis, using the experimental method rather than the "differential prevalence" design decried by Richard Rogers and colleagues (Rogers, Harrel, & Liff, 1993).

METHOD

Subjects

The Malingering group consisted of 85 adults from Delaware (Mensch, 1983) ($n = 30$), Oklahoma State University ($n = 15$), and the National Naval Medical Center (NNMC: $n = 40$). Age range was 18 to 65, ($M = 32.6$, $SD = 12$). Level of education was 12 to 20, ($M = 14.25$, $SD = 2.4$). Critical Level (age $\times$ education) range was 45.8 to 65, ($M = 55$, $SD = 3.7$). All subjects were screened for organicity via careful neuropsychological interviews. In addition, Mensch's group was given the LNNB under standard conditions in a counter-balanced design, and all were able to produce a normal profile.

The true Patient group consisted of 236 people who had been referred for neuropsychological assessment. Thirty-eight Ss were enrolled in a neuropsychological rehabilitation program. They had well-documented head injuries and were given the LNNB as a baseline measure upon their already approved entry into the program. Thus, they had no motivation whatsoever to fake the test. The remaining 198 were culled from the files of a private practice. They also had no discernible motivation (such as pending litigation) to fake the LNNB. Their final diagnoses included: head trauma (8), neoplasm (1), infection (1), CVAs (21), degenerative disease (76), epilepsy (9), hydrocephalus (3), metabolic/toxic (10), congenital (4), psychiatric (40), none (3) and other (22). A deliberate attempt was made to include this broad range of diagnoses in order to make the results generalizable to the caseload of a diverse neuropsychological practice.

The Patient group's years of education ranged from 0 to 20, ($M = 12$, $SD = 3.8$). Their ages ranged from 13 to 91, ($M = 50.2$, $SD = 19.9$). Critical Levels (age $\times$ education) ranged from 48.6 to 83.78, ($M = 61.68$, $SD = 6.9$).

Procedure

All Ss were given the LNNB (Form I). The test was administered according to the instructions given in the manual (Golden, Purisch, & Hammeke, 1985), although the Mensch and Conley Ss were given the LNNB (Form I) according to the instructions given in the previous manual (Golden, Hammeke, & Purisch, 1980).

Mensch's malingering group was given the LNNB in a counter-balanced design under both standard and faking instructions. He and a Master's-level psychologist (both trained in neuropsychological assessment) administered the tests, blind as to instruction group. His

TABLE 1
Item Correlations Done on the Matched Group: Fisher's *R* to *Z*

LNNB Item	Correlation	Count	*p*-Value
item 3	−.620	68	<.0001
item 4	−.516	68	<.0001
item 69	−.494	68	<.0001
item 112	−.444	68	.0001
item 44	−.406	68	.0005
item 66	−.403	68	.0006
item 71	−.403	68	.0006
item 101	−.398	68	.0007
item 67	−.396	68	.0007
item 160	−.386	68	.0010
item 64	−.374	68	.0015
item 261	−.354	68	.0028
item 48	−.326	68	.0065
item 241	.372	68	.0016
item 221	.377	68	.0014
item 187	.382	68	.0012
item 217	.391	68	.0009
item 132	.393	68	.0008
item 192	.396	68	.0007
item 199	.410	68	.0004
item 170	.421	68	.0003
item 174	.451	68	<.0001
item 225	.451	68	<.0001
item 223	.495	68	<.0001
item 239	.516	68	<.0001
item 173	.530	68	<.0001

instructions to the malingering group were given in writing (the exact text is cited in Mensch, 1983).

Conley was blind to instructions when she administered the test to her faking and control groups. The instructions to the Ss were given in writing (the exact text is cited in Conley, 1985).

The instructions given to the NNMC fakers were similar to that given to the Mensch and Conley Ss:

> You will be taking the Luria-Nebraska Neuropsychological Test Battery. It will require approximately two to two-and-one-half hours to complete. The test, which measures disabilities that result from brain injuries, will cover a variety of sensory, motor, and cognitive functions. Pretend you have suffered head injuries in an accident caused by another person or persons. Assume you are involved in litigation to determine how much financial compensation you will obtain from the people responsible for the accident and/or from the insurance companies involved. Imagine that your everyday functioning in and outside of school and/or work has been much worse since your accident, that your potential earning power has been substantially reduced, and that you deserve all the money that the courts will allow you. The results of this test will help determine how large your settlement will be, so fake the most severe disability that you can without making it obvious to the examiner that you are faking.

EXPERIMENT 1

Method

Subjects. Thirty-four Malingerers were matched with 34 Patients on age (within 3 years), education (within 1 year) and level of severity (exact) as measured by the Luria-Nebraska

TABLE 2
Validation of the Formula: Classifications

	Formula Result		
	LNNB Faked: *n* (% of Row)	LNNB Not Faked: *n* (% of Row)	Totals
Malingering Group	30 (88)	4 (12)	34 (100)
Patient Group	0 (0)	34 (100)	34 (100)
			68

Note. Percentages are rounded.

Impairment Index (LNII) (Johnson, Moses, & Bryant, 1984). A Malingering S was selected only if the S's effort was successful in producing an abnormal profile, as defined by any one or more of the five LNNB decision rules (Golden et al., 1985; Johnson et al., 1984; McKinzey, Roecker, Puente, & Rogers, in press) being met.

The Malingering group's age range was 19 to 62 (M = 31.38, SD = 10.5). Their years of education range was 12 to 18 (M = 13.35, SD = 1.7). Their Critical Level range was 50.47 to 64.43 (M = 56, SD = 2.997). Their LNII range was 2 to 5 (M = 2.65, SD = .812).

The Patient group's age range was 20 to 61 (M = 31.8, SD = 10.385). Their years of education range was 12 to 18 (M = 13.44, SD = 1.76). Their Critical Level range was 50.47 to 64.21 (M = 56, SD = 2.964). Their LNII range was 2 to 5 (M = 2.65, SD = .812).

The two groups did not differ significantly from each other on any of the three matched variables (age $t(66) = -.174$, $p = .8625$; education $t(66) = -.207$, $p = .8368$; LNII mean difference = 0).

Procedure. An item analysis was done by calculating the correlation coefficient of each item with group membership (dummy coded as Patient = 1, Malingering = –1). The 34 items (15 with a negative correlation and 19 with a positive correlation) with correlational significance above $p < .01$ (used because of the large number of correlations done) were formulated into either a positive correlation or a negative correlation scale. The two scales were then compared and the scale with the highest mean was used to predict group membership. Items with a lower correlation (and significance) that did not add to the hit rate were eliminated, resulting in 26 items (13 on each scale). Multiplying the item score (weighting) was then applied to the highest correlated items, and retained only if the hit rate was increased.

RESULTS

Table 1 presents the 26 items, the correlations with group membership, and the level of significance. Weighting item 3 (i.e., multiplying the raw item score by 2) decreased the false negative rate by 5% without increasing the false positive rate.

Using the raw scores (0–2) of the items, the formula is: if sum(("item 3" * 2), "item 4," "item 69," "item 112," "item 44," "item 66," "item 71," "item 101," "item 67," "item 160," "item 64," "item 261," "item 48") > sum("item 173," "item 239," "item 223," "item 225," "item 174," "item 170," "item 199," "item 192," "item 132," "item 217," "item 187," "item 221," "item 241"), then "Malingering," otherwise "Patient."

The classifications are presented in Table 2. The overall hit rate is 94%. The empirically derived formula's structure appears to contrast simple tasks (e.g., simple motor and tactile skills, defining simple words, and writing phonemes) with more complex tasks (e.g.,

TABLE 3
Cross-Validation of the Formula: Classifications

	Formula Result		
	LNNB Faked: *n* (% of Row)	LNNB Not Faked: *n* (% of Row)	Totals
Malingering Group	39 (76)	12 (24)	51 (100)
Patient Group	19 (9)	183 (91)	202 (100)
			253

Note. Percentages are rounded.

rearranging words into a sentence, speed of picture arrangement-type tasks, filling in the missing word in a sentence, rapidly reading a complexly constructed paragraph, serial 7s, questions using complex grammatical construction, and list learning performance).

EXPERIMENT 2

Method

Subjects. After the matching procedure, 253 Ss were left for the formula's cross-validation. The Malingering group ($n = 51$) had an age range of 18 to 65 ($M = 33.51$, $SD = 12.9$). Their years of education range was 12 to 20 ($M = 14.86$, $SD = 2.6$). Their Critical Level range was 45.82 to 65 ($M = 54.4$, $SD = 4$). Their LNII range was 1 to 5 ($M = 2.71$, $SD = 1.39$). The Patient group ($n = 202$) had an age range of 13 to 91 ($M = 53.25$, $SD = 19.5$). Their years of education range was 0 to 20 ($M = 11.82$, $SD = 3.99$). Their Critical Level range was 48.6 to 83.78 ($M = 62.639$, $SD = 6.9$). Their LNII range was 1 to 5 ($M = 2.4$, $SD = 1.166$).

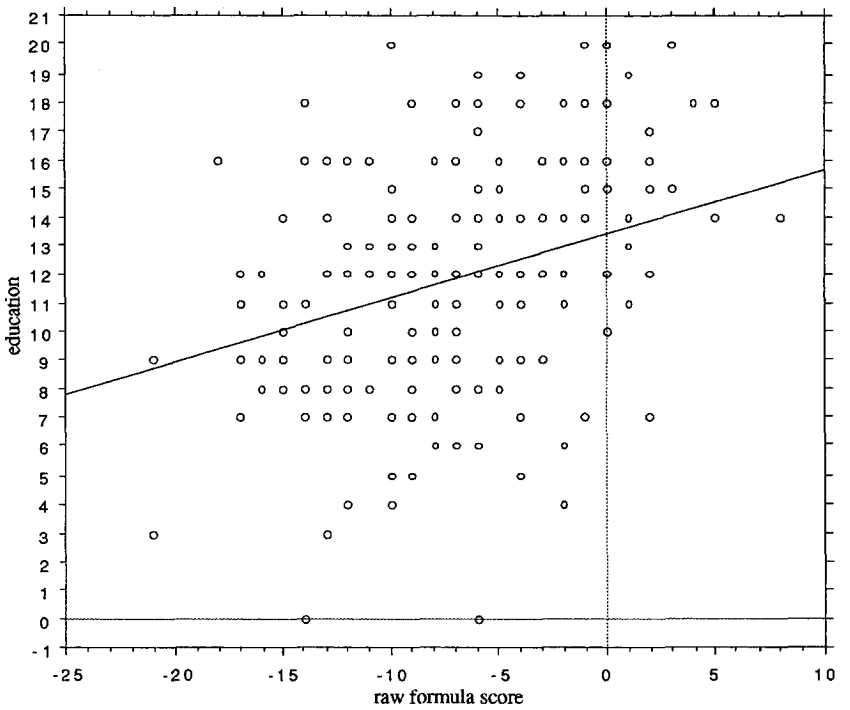
Procedure. The validated formula was applied to the remaining 253 Ss.

Results

The classifications are presented in Table 3. The formula has a cross-validated hit rate of 88%. An inspection of the errors did not reveal any contribution by diagnosis. The false negative errors were not due to education (the correlation of education and formula result in the Malingering group = .153, $p = .2839$). The correlation of age and formula outcome in the Malingering group was significant (.303, $p < .04$), but too low to be of any use in increasing the hit rate.

The false positive errors were not due to age: the correlation of age and formula outcome in the Patient group was not significant (.134, $p > .05$). The correlation of education and formula outcome ($-.236$, $p < .0008$) is highly significant, but is again too low to be helpful in increasing the hit rate. Figure 1 presents the scattergram of the unmatched Patient group, showing the interaction of education and raw formula score: false positives were rare in Patients with less than a high school education.

In contrast, the correlations of LNII with formula outcome in the Malingering group (.119, $p = .4$) and Patient group (.089, $p = .2$) are not significant. However, the formula's accuracy sharply drops on the outside limits of profile severity (i.e., LNII = 1 or LNII = 5). The classifications of group by LNII are presented in Table 4. Eliminating the Ss obtaining either normal (i.e., none of the 5 LNNB decision rules were positive) profiles or profoundly



Note: Raw formula scores greater than 0 are false positives.

FIGURE 1. Scattergram of education and formula result in the unmatched Patient group.

impaired (i.e., those with LNII of 5) profiles reduced the false negative rate to 17% and the false positive rate to 7%, for a hit rate of 91%. The resulting classifications are presented in Table 5.

DISCUSSION

Not surprisingly, high error rates appeared in Ss producing a normal profile and in those with profoundly impaired profiles. Both extremes result in a narrowing of the variance, making discrimination difficult. The validation group deliberately had no normal profiles, since this represents an unsuccessful attempt by 14% (12/85) of the faking Ss. Heaton et al. (1978) also eliminated the 20% of their sample that failed to produce an abnormal HRB protocol when validating their formula. In litigation it is of little concern if the plaintiff fails to demonstrate an abnormal profile, for example, the patient does not succeed at malingering, but rather it is only an issue if the plaintiff succeeds and might be "wrongfully" compensated. Thus, elimination of failed malingerers has no negative impact as they have argued against their own case by achieving a normal profile.

At the other extreme, a patient with a profoundly impaired LNNB profile should have other supporting sources of neurological impairment. A formula result of "Malingering" in an obviously neurologically impaired person with other positive testing (e.g., MRI, CT, EEG, qEEG) would mean little; a "Patient" result with LNII = 5 in a person with no supporting evidence would also mean little. For example, a psychologist interpreting an LNNB profile

TABLE 4
Cross-validation of the Formula: Classifications of Group by LNII

	Malingering Group		
LNII	LNNB Faked: *n* (% of row)	LNNB Not Faked: *n* (% of row)	Totals
One	9 (75)	3 (25)	12 (100)
Two-four	25 (83)	5 (17)	30 (100)
Five	5 (56)	4 (44)	9 (100)
			51
	Patient Group		
LNII	LNNB Faked: *n* (% of Row)	LNNB Not Faked: *n* (% of Row)	Totals
One	9 (18)	41 (82)	50 (100)
Two-four	9 (6)	132 (94)	141 (100)
Five	1 (9)	10 (91)	11 (100)
			202

Note. Percentages are rounded. The LNII is a standardized rating of degree of neuropsychological dysfunction as measured by the averaged elevations over the age × education Critical Level of the C1-C6 and C10-S1 LNNB scales. It was designed to serve the same function as Russell's AIR (Russell, Neuringer, & Goldstein, 1970). The LNII was meant to provide a "graded series of ordinal categories with clinically relevant labels (intact, mild, moderate, marked, or severe impairment)." These severity ratings are intended to "communicate the overall degree of neuropsychological impairment" (Johnson et al., 1984). In this table, intact = 1, mild = 2, moderate = 3, marked = 4, and severe = 5.

with LNII = 5 and a "Patient" formula result from a patient who drove to the appointment, has no supporting imaging, and developed mild complaints after a low-speed car accident would be wise to remember the formula's 44% false negative rate at that severity level (Table 4). Likewise, a psychologist contemplating a "Malingering" formula result in a profile where LNII = 1 should remember the 18% false positive rate at that severity level (Table 4).

The present formula has two advantages: It can be used with protocols that have been given in the past, since no special procedures are needed. In addition, the items are scattered throughout the test, making them more difficult for malingerers to identify and respond to differentially.

TABLE 5
Cross-validation of the Formula: Classifications after Elimination of Normal and Profoundly Impaired Profiles

	Formula Result		
	LNNB Faked: *n* (% of row)	LNNB Not Faked: *n* (% of row)	Totals
Malingering Group	25 (83)	5 (17)	30 (100)
Patient Group	10 (7)	137 (93)	147 (100)
			177

Note. Percentages are rounded, and of the row. Normal profiles are defined by the 5 R Modified Rule: A profile is normal when none of the rules defined in the LNNB manual are met and LNII = 1, with the exception that the 30-Point Clinical Scale Rule is not used with patients over 64 (McKinzey et al., in press).

The results again demonstrate that malingering adults can easily meet one or more decision rules on the LNNB, with the profiles showing a full range of severity. It is the only formula yet derived for identifying malingerers on the LNNB. It is also one of the very few methods of identification of neuropsychological malingerers that has as yet been fully cross-validated. Further research should focus on the false negative rates of populations not included in the cross-validation faking group.

REFERENCES

Anderson, F.N. (1984). *The Luria-Nebraska Neuropsychological Battery: Faking as a response set.* Unpublished doctoral dissertation. University of Nevada, Reno.

Conley, C.G. (1985). *Faking neuropsychological test data: A further examination of the Luria-Nebraska Neuropsychological Battery.* Unpublished doctoral dissertation. Oklahoma State University.

Faust, D. (1996). Neuropsychological (brain damage) assessment. In J. Ziskin (ed.), *Coping with psychiatric and Psychological testimony* (5th ed., Vol. 2, pp. 916–1044). Los Angeles: Law and Psychology Press.

Faust, D., Hart, K.J., & Guilmette, T.J. (1988a). Pediatric malingering: The capacity of children to fake believable deficits on neuropsychological testing. *Journal of Consulting and Clinical Psychology*, **56**, 578-582.

Faust, D., Hart, K.J., Guilmette, T.J., & Arkes, H.R. (1988b). Neuropsychologists' capacity to detect adolescent malingerers. *Professional Psychology: Research & Practice,* **19**, 508–515.

Faust, D., Ziskin, J., & Hiers, J. (1991). *Brain damage claims: Coping with neuropsychological evidence.* Los Angeles: Law and Psychology Press.

Golden, C.J., Hammeke, T.A., & Purisch, A.D. (1980). *The Luria-Nebraska Neuropsychological Battery: Manual.* Los Angeles: Western Psychological Services.

Golden, C. J., Purisch, A.D. & Hammeke, T.A. (1985). Luria-Nebraska Neuropsychological battery: Forms I & II manual. Los Angeles, CA: Western Psychological Services.

Heaton, R.K., Smith, H.H., Lehman, R.A., & Vogt, A.T. (1978). Prospects for faking believable deficits on neuropsychological testing. *Journal of Consulting and Clinical Psychology*, **46**, 892–900.

Johnson, G.L., Moses, J.A., & Bryant, E. (1984). Development of an impairment index for the Luria-Nebraska Neuropsychological Battery. *International Journal of Clinical Neuropsychology*, **6**, 242–247.

McKinzey, R.K., Roecker, C.E., Puente, A.E., & Rogers, E.B. (in press). Performance of normal adults on the Luria-Nebraska Neuropsychological battery, Form I. *Archives of Clinical Neuropsychology.*

Mensch, A.J. (1983). *The ability of non-neurological subjects to simulate brain damage on the Luria-Nebraska Neuropsychological Battery.* Unpublished doctoral dissertation, University of Delaware.

Mensch, A.J., & Woods, D.J. (1986). Patterns of feigning brain damage on the LNNB. *International Journal of Clinical Neuropsychology*, **8**, 59–63.

Rogers, R., Harrell, E.H., & Liff, C.D. (1993). Feigning neuropsychological impairment: A critical review of methodological and clinical considerations. *Clinical Psychology Review*, **13**, 255–274.

Russell, E., Neuringer, C., & Goldstein, G. (1970). *Assessment of brain damage: A neuropsychological approach.* New York: Wiley.