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Five Validation Experiments of the Test of Memory Malingering (TOMM)

Laura M. Rees
Q E II Health Sciences Centre

Tom N. Tombaugh
Carleton University

David A. Gansler and Nancy P. Moczynski
Tufts University School of Medicine

The Test of Memory Malingering (TOMM; T. N. Tombaugh, 1996) is a newly developed visual recognition test that uses pictures of common objects as stimuli. Prior normative research with community-dwelling adults and neurologically impaired patients has shown that the TOMM possesses a high degree of specificity and is not affected by demographic variables such as age and education. The current series of 5 integrated experiments was designed to provide important validation data. Converging evidence from all studies showed that scores on the TOMM are able to detect when an individual is not putting forth maximum effort. Overall, the TOMM's high levels of sensitivity and specificity suggest that it has high promise as a clinical test for detecting malingering of memory impairments.

Recent interest in the detection of malingering, the intentional faking or exaggeration of symptoms for personal gain, has generated a consistent body of evidence showing that recognition procedures are particularly sensitive in detecting someone feigning memory impairment during neuropsychological assessment. Much of this evidence stems from a procedure commonly referred to as symptom validity testing (SVT). This is a two-item, forced-choice recognition paradigm originally used for the detection of sensory impairments (Brady & Lind, 1961; Grosz & Zimmerman, 1965) and later modified to determine malingering of cognitive deficits (Pankratz, 1979; Pankratz, Fausti, & Peed, 1975). More recently, SVT has further been developed by Hiscock and Hiscock (1989) and Binder and Willis (1991). The most popular variation of this procedure contains a series of trials where a five-digit number is presented on each trial and is followed by a delay interval and a two-choice test trial containing the original number and a novel five-digit number. Although this procedure has demonstrated clinical utility, it is not without difficulties, including the lack of a standardized cutoff score other than chance, a high number of false negatives when chance performance is used as a cutoff score, and questionable face validity (Guilmette, Hart, & Giuliano, 1993; Lezak, 1995; Prigatano & Amin, 1993).

An alternative recognition paradigm for detecting malingering is suggested by cognitive research showing that individuals have a remarkably high capacity for storing and retrieving visual information. Picture recognition has been shown to be particularly robust among geriatric and amnesic patients (Freed, Corkin, Growdon, & Nissen, 1989; Hart & O'Shanick, 1993; Huppert & Piercy, 1978; Kopelman, 1985; Shepard, 1967; Standing, Conezio, & Haber, 1970). Recently, neuropsychological tests of recognition memory have been used in the detection of malingering. For example, Millis and colleagues (Millis, 1992, 1994; Millis & Putnam, 1994) have had some success using the Recognition Memory Test (Warrington, 1984) to detect malingering. Working within this framework, Tombaugh (1996) developed the Test of Memory Malingering (TOMM).[1] On each of the two learning trials, pictures of 50 common objects are individually administered followed by a test series of 50 two-choice recognition panels. On the retention trial, only the 50 two-choice recognition panels are administered. Normative data from 475 community-dwelling adults and 161 neurologically impaired patients show that the TOMM is relatively insensitive to age, education, and genuine memory impairment. Moreover, results from a single experiment showed that the TOMM readily distinguished between university students who were instructed to deliberately fake memory impairments and those who were instructed to "try their best."

The five experiments contained in the present article extend

Laura M. Rees, Department of Psychology, Rehabilitation Centre, Q E II Health Sciences Centre, Halifax, Nova Scotia, Canada; Tom N. Tombaugh, Department of Psychology, Carleton University, Ottawa, Ontario, Canada; David A. Gansler and Nancy P. Moczynski, Department of Psychology, Tufts University School of Medicine.

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Correspondence concerning this article should be addressed to Tom N. Tombaugh, Department of Psychology, Carleton University, B550 Loeb Building, 1125 Colonel By Drive, Ottawa, Ontario, Canada K1S 5B6.

[1] To obtain copies of the TOMM, contact Multi-Health Systems, 908 Niagara Falls Boulevard, North Tonawanda, New York 14120-2060 (1-800-456-3003 or 1-800-268-6011).

this previous research and provide converging lines of evidence that the TOMM is a clinically useful measure in the detection of malingering. We administered the TOMM to individuals instructed to simulate cognitive impairment resulting from a head injury, as well as to litigating people who were at high risk for malingering. Simulation studies approximated, to the greatest degree of practicality, a clinical situation. In order to increase the generalizability of the results, different types of participants were used, including university students, community-dwelling adults, and neurologically impaired individuals. Finally, accuracy scores from the paper-and-pencil version were augmented with latency data obtained with a computerized version of the TOMM.

Experiment 1

The normative article on the TOMM (Tombaugh, 1997) reported that test performance was relatively unaffected by age, education, and various types of cognitive impairment, but it was sensitive to malingering. The sensitivity of the test to detect feigned memory deficits was based on the results of an experiment that used a simulation paradigm with cognitively intact individuals. In an attempt to address some of the criticisms levied against simulation designs (e.g., Franzen, Iverson, & McCracken, 1990; Nies & Sweet, 1994; Rogers, 1988; Schretlen, 1988) and to better approximate the conditions occurring in a clinical setting, the procedure (a) incorporated a differential monetary incentive based on test performance, (b) encouraged individuals to gain knowledge about the type of cognitive impairments they were asked to simulate, and (c) used a brief questionnaire at the end of the experiment to determine whether the simulators actually complied with the instructions.

One possible shortcoming of the experiment was that the participants in this study, unlike many malingerers who had undergone repeated neuropsychological testings, lacked any experience with the TOMM. This naïveté about the TOMM may have restricted their ability to produce a credible simulated performance. That is, in the absence of knowledge about the relative difficulty of the TOMM, individuals who were asked to simulate the effects of a traumatic brain injury (TBI) may have overreacted to the perceived difficulty of the test and unrealistically lowered their performance. In order to evaluate the effects of test sophistication on the ability of the TOMM to discriminate between malingering and nonmalingering participants, the present experiment used a within-subject design in which individuals were administered the TOMM under two instructional sets—to malinger and to "try their best."

Method

Participants. Twenty students from an introductory psychology class were randomly assigned to one of two groups that differed only in the sequence in which individuals were instructed to either malinger or try their best: malingering–best (M-B, $n = 11$; 4 men and 7 women) or best–malingering (B-M, $n = 9$; 2 men and 7 women). Mean age and education of the M-B group were 20.4 years ($SD = 4.4$) and 13.3 years ($SD = 0.6$), respectively. Mean age and education of the B-M group were 24.6 years ($SD = 7.8$) and 14.1 years ($SD = 1.0$), respectively. Each participant received course credit for participation.

Materials. The TOMM consisted of two learning trials and a delayed retention trial. The learning trials consisted of a study and a test phase. The study portion of each learning trial contained 50 line-drawn pictures (targets) each presented for 3 s. During the test phase, each target was paired with a new line drawing (distractor). The position of the target was counterbalanced for top and bottom positions. A delayed retention trial, consisting of only the test phase, was administered 20 min after completion of the two learning trials. The duration of time required to administer the three trials was approximately 15 min. Feedback on the correctness of the response was provided on each trial. During the delay interval, a recognition test using complex geometric designs was administered. In order to obtain an estimate of the perceived difficulty of the TOMM, participants were asked at the beginning of each test phase to estimate how many of the pictures they thought they would be able to recognize (i.e., estimated score).

Procedure. Demographic information (e.g., age and education) and medical history were obtained from all participants. Participants with a medical history suggestive of central nervous system impairment were excluded from data analysis (e.g., those with a prior history of head injury, alcohol abuse, current clinical depression). Participants were randomly assigned to one of the two groups. Group M-B received the malingering procedure first and the try-your-best condition second. Group B-M received the reverse sequence of conditions.

In the malingering condition, participants met with the examiner 1 week before testing. During that time, the nature of the experiment was described, and the following brief scenario was presented (adapted from Tombaugh, 1997, p. 265). Participants were informed that the person who most accurately simulated the cognitive impairments caused by a brain injury would receive a $50 prize. In order to encourage participants to feign memory impairment on the TOMM and to discourage them from displaying overly obvious behavioral signs of malingering such as inattention and lack of cooperation, they were informed that the $50 reward would be based on test scores alone and not on their behavior during the test session. Finally, they were given 1 week to prepare and told that they could use any resource available to them.

Scenario

> In this study you will be asked to complete a set of tasks that are often used to measure a variety of changes that occur in people who have brain damage. As you take each test, we would like you to assume the role of someone who has experienced some brain damage from a car accident.
>
> Pretend that you were involved in a head-on collision. You hit your head against the windshield and were unconscious for 15 minutes. You were hospitalized overnight for observation and then released. Gradually, over the past few months, you have started to feel normal again. However, your lawyer has informed you that you may get a larger settlement from the court if you look like you are still suffering from brain damage. In the real world, the usual purpose of the tests you are about to take is to determine if the accident has produced any impairments in your abilities due to brain damage.
>
> As you portray the above person, try to approach each test as you imagine this person would respond if he or she had been given the same instructions from his or her lawyer or someone else hoping to influence the amount of the settlement. Try to create responses on the tests that will convince the examiner that you are truly brain damaged, keeping in mind that settlement monies depend upon your being diagnosed as cognitively impaired on these tests. Also be aware that having a lawsuit pending often raises the suspicion that people may try to exaggerate their difficulties. That means your impairments resulting from the head injury must be believable. Major exaggerations, such as not being able to do anything, remembering absolutely nothing, or completely failing to respond, are easy to detect.

Participants returned approximately 1 week later (7 to 9 days) to be tested. Before testing, informed consent was obtained. Individuals were asked to reread the scenario and then to demonstrate that they fully understood what was expected by paraphrasing the instructions to the examiner.

The procedure was the same for the try-your-best condition with the exception that participants were asked to perform to the best of their ability. Individuals in this condition did not receive the scenario. At the end of the study, participants were asked whether they had been able to comply with the instructions and the degree to which they had used the 1-week study period to learn more about the effects of head injury.

Results and Discussion

Obtained scores. Mean obtained scores for each condition are shown in Table 1. Inspection of the table shows that regardless of order of administration or trial, scores are markedly higher for the try-your-best condition than for the malingering condition. This observation was confirmed by subsequent analyses of variance (ANOVAs) appropriate to a two-way mixed design with order (B-M vs. M-B) as the between-subjects variable and instruction (malingering vs. best) as the within-subject variable. Only the main effect due to instruction was statistically reliable: Trial 1—order, $F(1, 18) = 0.02$, $p > .05$; instruction, $F(1, 18) = 157.57$, $p < .001$; Instruction × Order, $F(1, 18) = 0.08$, $p > .05$; Trial 2—order, $F(1, 18) = 0.79$, $p > .05$; instruction, $F(1, 18) = 88.40$, $p < .001$; Instruction × Order, $F(1, 18) = 0.79$, $p > .05$; Trial 3—order, $F(1, 18) = 0.05$, $p > .05$; instruction, $F(1, 18) = 86.50$, $p < .001$; Instruction × Order, $F(1, 18) = 0.07$, $p > .05$.

The TOMM uses two criteria for the detection of malingering: (a) a score lower than 45 on either Trial 2 or on the retention trial, and (b) a score lower than chance on any trial. The application of the first criterion correctly identified 95% of individuals instructed to malinger (malingering first = 91% vs. malingering second = 100%) and 100% of those individuals who were instructed to try their best. Although this result is consistent with prior research showing that the TOMM has high sensitivity and specificity (Tombaugh, 1997), it extends these results by showing that prior experience with the TOMM does not affect its ability to detect malingering.

Application of the second criterion identified substantially fewer persons feigning memory impairment. Chance performance on the TOMM is a score of 25. Application of the binomial formula (Siegel, 1956) shows that a score of 19 is significantly below chance performance at the 95% level of confidence (one-tailed test). No participant in the try-your-best condition scored below chance on any trial. On the malingering condition, only 1 individual scored below 25 on Trial 1 (malingering first = score of 8), only 2 participants scored below chance on Trial 2 (malingering first = scores of 24 and 10), and 6 individuals scored below chance on the retention trial (malingering first = scores of 15, 8, and 4; malingering second = scores of 24, 23, and 19). Thus, relying on chance level performance would have misclassified 90% (95% at the 95% level of confidence) of the participants simulating malingering on Trial 2 and 70% (80% at the 95% level of confidence) of them on the retention trial.

Estimated scores. Mean estimated scores on the TOMM are presented in Table 1. When participants were first administered the TOMM, estimated scores were equivalent between the malingering and try-your-best conditions, showing that the TOMM was perceived to be the same difficulty under both conditions. These estimated scores (< 30) are substantially lower than the Trial 1 obtained scores (> 48) for the try-your-best condition. This comparison strongly suggests that the individuals initially perceived the difficulty of the TOMM to be greater than its actual difficulty. On the remaining two trials, the estimated scores increased for the best condition, whereas they remained relatively constant for the malingering condition. ANOVAs using only the estimated scores for the first administration confirmed these observations: Trial 1, $F(1, 18) = 0.30$, $p > .05$; Trial 2, $F(1, 18) = 5.47$, $p < .05$; retention trial, $F(1, 18) = 10.40$, $p < .01$.

Table 1
Means and Standard Deviations of Obtained Scores and Estimated Scores on the Test of Memory Malingering (TOMM) for Malingering-Best (M-B) and Best-Malingering (B-M) Groups in Experiment 1

	Order of administration							
	First				Second			
	Malingering		Best		Malingering		Best	
Measure	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Obtained scores								
Trial 1	30.3	8.6	48.9	1.5	30.4	3.0	49.6	0.5
Trial 2	33.6	10.6	50.0	0.0	30.2	4.8	50.0	0.0
Retention	28.0	13.8	50.0	0.0	26.9	5.0	50.0	0.0
Estimated scores								
Trial 1	26.4	10.3	28.9	8.6	30.0	8.1	46.8	3.0
Trial 2	31.6	10.6	41.3	7.3	31.9	8.6	49.5	0.7
Retention	27.4	12.3	42.0	6.4	29.1	7.8	49.5	0.8

Note. Group M-B received the malingering condition first and the try-your-best condition second. Group B-M received the reverse sequence of conditions.

The finding that estimation scores were equivalent between groups on Trial 1 and substantially lower than the obtained performance for the controls highlights an important factor that underlies the effectiveness of malingering tests. That is, the perceived difficulty of the test should outweigh its actual difficulty. If estimation of performance reflects perception of test difficulty, then both groups perceived the degree of difficulty of the TOMM in a similar manner. After exposure and feedback (Trial 1), controls adjusted their estimated scores upward, reflecting that the TOMM was no longer perceived to be as difficult as perceived initially. Although simulators adjusted their estimate upward on Trial 2, scores were significantly lower than those of the control group. Such findings indicated that simulators artificially kept their scores low, even though exposure to the test revealed that it was not as difficult as initially perceived.

When the TOMM was administered a second time, estimated scores comparable to those during the first administration were observed for the malingering condition, whereas those for the best condition were substantially higher: Trial 1—order, $F(1, 18) = 4.56, p < .05$; instruction, $F(1, 18) = 15.32, p < .001$; Instruction × Order: $F(1, 18) = 13.30, p < .01$; Trial 2—order, $F(1, 18) = 1.97, p > .05$; instruction, $F(1, 18) = 42.43, p < .001$; Instruction × Order, $F(1, 18) = 4.06, p > .05$; retention trial—order, $F(1, 18) = 1.13, p > .05$; instruction, $F(1, 18) = 52.17, p < .001$; Instruction × Order, $F(1, 18) = 3.61, p > .05$. Thus, although experience gained during the first administration obviously increased the estimated scores for participants who were trying their best, it exerted little influence on the estimated scores for individuals instructed to malinger.

Experiment 2

Although it is a common practice in experimental simulation studies to administer only the malingering test being evaluated, this rarely occurs in clinical practice where the malingering test is embedded within a battery of neuropsychological tests. Because the individual has the opportunity to compare the malingering test with other tests measuring the same cognitive ability, the clinical situation presents a distinctively different environment in which to detect malingering than occurred in Experiment 1.

In a clinical setting, the success of a malingering test depends largely on its face validity as a test of cognitive ability. That is, the test must appear to be a legitimate test of neuropsychological functioning, otherwise an individual malingering may suspect the validity of the test. It is possible that when malingering tests are presented in isolation, such as occurred in Experiment 1, their true purpose is less obvious than when they are administered in conjunction with other neuropsychological tests. We evaluated this hypothesis in the present experiment by embedding the TOMM within a series of other tests. Because previous experiments (Tombaugh, 1997) indicated that the TOMM possesses a high degree of face validity as a memory test, we predicted that performance on the TOMM would be similar to that observed in Experiment 1.

Method

Participants. Forty-four students from an introductory psychology class were randomly assigned to one of two groups: malingering group ($n = 25$; 17 men and 8 women) and control group ($n = 19$; 12 men and 7 women). Mean age of the malingering group was 21.5 years ($SD = 2.3$). Mean age of the control group was 21.8 years ($SD = 4.3$). Each participant received course credit for participation.

Materials. In addition to the TOMM, the following tests were used: California Verbal Learning Test (Delis, Kramer, Kaplan, & Ober, 1987); Mental Control, Digit Span, and Visual Reproduction subtests of the Wechsler Memory Scale—Revised (Wechsler, 1987); Trail Making Test A and B (Lezak, 1995); Ruff Figural Fluency Test (Ruff, 1988); Controlled Oral Word Association (FAS & Animals; Lezak, 1995); Information subtest from the Wechsler Adult Intelligence Scale—Revised (Wechsler, 1981); and Finger Tapping Test (Lezak, 1995).

Procedure. Participants were randomly assigned to the malingering group or to the control group. Demographic information and medical history were obtained from all participants. Those participants with a medical history suggestive of central nervous system impairment were excluded. The procedures described in Experiment 1 were administered to both groups, except that the TOMM was embedded in a series of neuropsychological tests rather than being presented alone, and participants in each group were instructed to only malinger or try their best. The TOMM was administered approximately 30 min after the beginning of the session. Testing took approximately 2 hr.

At the end of the experiment, test performance of the individuals malingering was examined to determine which profile most closely corresponded to what is typically seen in a brain injured, cognitively impaired population. That person received the $50 prize. For the control group, a random drawing for $50 was made.

Results and Discussion

Obtained scores. Mean obtained scores are presented in Table 2. Scores for Trial 1, Trial 2, and the retention trial are markedly different for the two groups, with the control group scoring higher than the malingering group. Scores were analyzed by a one-way (group) repeated measures (trials) ANOVA. A significant effect for group and trial was obtained, $F(1, 42) = 68.93, p < .001$; $F(2, 84) = 12.77, p < .001$, respectively. The Group × Trial interaction was not significant, $F(2, 84) = 2.85, p > .05$. One-way ANOVAs revealed that the malingering group scored significantly lower than the control group on each trial of the TOMM: Trial 1, $F(1, 42) = 78.71, p < .001$; Trial 2, $F(1, 42) = 48.41, p < .001$; retention trial, $F(1, 42) = 69.72,$

Table 2
Means and Standard Deviations of Obtained Scores and Estimated Scores on the Test of Memory Malingering (TOMM) for Malingering and Control Groups in Experiment 2

	Malingering group		Control group	
Measure	*M*	*SD*	*M*	*SD*
Obtained scores				
Trial 1	32.6	7.8	48.8	1.7
Trial 2	35.7	8.9	49.9	0.2
Retention	34.3	8.2	50.0	0.0
Estimated scores				
Trial 1	24.9	9.6	33.4	9.1
Trial 2	36.2	9.8	44.0	7.6
Retention	31.0	10.6	44.1	7.6

$p < .001$. Regression analyses performed on Trial 2 scores for all participants and for only those individuals feigning cognitive impairment showed that an insignificant amount of the total variance was accounted for by gender (1% and 3%, respectively) and age (< 1% and < 1%, respectively).

Examining the distribution of scores for each group on each trial revealed that by Trial 2, all individuals in the control group received a score of 49 or 50 correct. In comparison, only 2 malingering persons (8%) received a score of 49 or 50. When the cutoff score of 45 was applied, all control individuals and 21 of the 25 malingering individuals were correctly identified (100% specificity and 84% sensitivity). On the retention trial, specificity remained at 100%, and sensitivity increased to 88%.

The distribution of scores was also analyzed according to chance levels of responding. No participant in the control group received a score below 49 on Trial 2 or on the retention trial. Moreover, only 12% of those malingering received a score of lower than 25 on Trial 2 (scores = 16, 18, and 22). On the retention trial, 12% also scored below 25 (scores = 18, 20, and 23). Thus, using below-chance performance (i.e., score of 25) as the criterion, 88% of those malingering would have been misclassified on Trial 2 and on the retention trial. Application of the more stringent score of 19 (95% level of confidence) would have produced even higher misclassification rates (96% for Trial 2 and 92% for the retention trial).

Analysis of the debriefing interview revealed that the participants did not identify the true intent of the TOMM when it was given in the context of other legitimate neuropsychological tests. That is, the TOMM had good face validity as a test of learning and memory.

Estimated scores. Mean estimated scores are presented in Table 2. Similar estimation scores occurred for both groups on Trial 1. On Trial 2 and on the retention trial, malingering individuals had lower scores compared with the controls. Estimation scores for each trial of the TOMM were analyzed with a repeated measures ANOVA. Results revealed significant effects for group, trial, and Group × Trial: group, $F(1, 42) = 11.40$, $p < .002$; trial, $F(1, 84) = 30.74$, $p < .001$; Group × Trial, $F(1, 84) = 8.15$, $p < .001$. One-way ANOVAs performed on estimation scores for each trial revealed that no significant difference existed between malingering individuals and controls on Trial 1, $F(1, 42) = 1.92$, $p > .05$. However, scores on Trial 2 and on the retention trial revealed that individuals in the malingering condition estimated their performance to be significantly lower than controls: estimate Trial 2, $F(1, 42) = 9.04$, $p < .01$; estimate retention, $F(1, 42) = 20.73$, $p < .001$.

In summary, the results of Experiment 2 show that the TOMM is a useful measure for discriminating between malingering individuals and controls. The results show that (a) the TOMM accurately differentiated malingering individuals from controls with a high degree of sensitivity and specificity, (b) the perceived difficulty of the test outweighed the actual difficulty, indicating that the TOMM is not perceived as an obvious measure of malingering, and (c) the TOMM had high face validity as a measure of memory functioning.

Experiment 3

The ability to successfully feign memory impairment depends on more than merely the motivation to do so. To a large degree, it requires accurate knowledge about the effects of the neurological disorder in question and the ability to translate this information into producing a credible neuropsychological profile. Several researchers have speculated that most simulators lack sufficient knowledge about the type of cognitive impairments associated with the neurological condition they are asked to simulate (Aubrey, Dobbs, & Rule, 1989; Baker, Hanley, Jackson, Kimmance, & Slade, 1993; Brandt, 1988; Goebel, 1983; Grouvier, Prestholdt, & Warner, 1988).

Keeping this in mind, we encouraged participants in both of the preceding experiments to learn about the effects of head injury before participating in the experiments. Although participants were given 1 week to increase their level of knowledge, it is possible, perhaps even likely, that they were not very knowledgeable about the cognitive impairments associated with TBI at the time of the experiment. Thus, their performance on the TOMM may have reflected, at least in part, the lack of an adequate information base. Moreover, even if individuals had learned about the effects of TBI, knowledge gained from secondary sources may not have been sufficient to ensure an adequate presentation of memory deficits compared with knowledge acquired through the actual experience of the trauma.

Thus, in order to ensure that participants were truly knowledgeable about the types of cognitive impairments caused by TBI, we recruited individuals for Experiment 3 who had actually suffered a TBI. Half of the individuals simulated malingering while the remaining half were controls. Scores from the two groups were compared with those from a cognitively intact control group.

Experiment 3 is unique in that we were unable to locate any other published simulation study in which TBI patients were asked to exaggerate (i.e., malinger) their current symptoms or those that they had experienced previously. The composition of the groups increases the clinical relevance of the findings and provides extremely useful data against which the performance of cognitively intact simulators (e.g., Experiments 1 and 2) can be compared.

Method

Participants. TBI participants were recruited through advertisements placed in the local newspapers, university alumni magazine, local head injury associations, a community TV channel, hospitals, and private practice. All volunteers signed an informed consent and a medical release form allowing access to their medical records pertaining to the head injury. The Philadelphia Head Injury Questionnaire (Curry, Ivins, & Gowen, 1991) was used to obtain specific information about participants injuries such as the description of the event, length of coma, various cognitive and/or physical problems following the injury. Other than parking, no financial remuneration was provided.

Participants were divided into two groups: TBI malingering ($n = 8$; 4 men and 4 women) and TBI control ($n = 10$; 6 men and 4 women). For reasons of comparison, 10 cognitively intact individuals (6 men and 4 women) from Experiment 2 were used as a control group (cognitively intact control). Mean age and education for the TBI malingering group were 41.8 years ($SD = 14.2$) and 13.5 years ($SD = 2.5$), respectively. Mean age and education for the TBI control group were 44.4 years ($SD = 14.3$) and 14.0 years ($SD = 2.7$), respectively. The cognitively intact control group was significantly younger than the two TBI groups (23.4 years, $SD = 5.5$). Mean number of years of education was 13.0 ($SD = 0.0$).

Severity of injury was measured by the length of unconsciousness (Lezak, 1995, p. 755; mild = less than 20 min; moderate = greater than 20 min, but less than 6 hr; severe = greater than 6 hr). The TBI control group contained 10 individuals with mild head injuries. The TBI malingering group had 6 individuals with mild injuries and 2 with moderate injuries. No member of either TBI group was involved in litigation or compensation case.

Procedure. The same procedures described previously in Experiment 2 were used for all participants. Testing took approximately 2 to 3 hr to complete.

Results and Discussion

Obtained scores. Mean obtained scores are presented in Table 3. Inspection of the table shows that scores for Trial 1, Trial 2, and the retention trial are markedly higher for the TBI control and cognitively intact control groups than for the TBI malingering group. Subsequent analyses confirmed this observation.

A one-way repeated measures ANOVA revealed a significant effect for group and trial: group, $F(2, 25) = 68.70$, $p < .001$; trial, $F(2, 50) = 7.90$, $p < .01$. The Group × Trial interaction was not significant, $F(4, 50) = 1.22$, $p > .05$. One-way ANOVAs and Tukey's honestly significant difference paired comparisons revealed that on each trial the TBI malingering group scored significantly lower than both the TBI control group and cognitively intact control group, which were not significantly different from each other: Trial 1, $F(2, 25) = 53.20$, $p < .001$; Trial 2, $F(2, 25) = 59.60$, $p < .001$; retention trial, $F(2, 25) = 52.00$, $p < .001$. Regression analyses performed on Trial 2 scores for all participants and for only those individuals feigning cognitive impairment showed that gender (1% and < 1%), education (7.9% and 12%), and age (1% and 7%) accounted for only a small portion of the total variance.

Application of the cutoff score of 45 on Trial 2 yielded 96% specificity and 100% specificity for the TBI control and cognitively intact control groups, and 100% sensitivity for the TBI malingering group. On the retention trial, specificity and sensitivity were each 100% for all groups.

Table 3
Means and Standard Deviations of Obtained Scores and Estimated Scores on the Test of Memory Malingering (TOMM) for TBI Malingerers, TBI Controls, and Cognitively Intact Controls in Experiment 3

	TBI malingering group		TBI control group		Cognitively intact control group	
Measure	*M*	*SD*	*M*	*SD*	*M*	*SD*
Obtained scores						
Trial 1	28.1	7.8	47.5	3.6	49.3	0.8
Trial 2	32.1	7.3	49.6	0.6	50.0	0.0
Retention	31.6	8.0	49.6	0.7	50.0	0.0
Estimated scores						
Trial 1	25.7	14.5	38.5	13.2	35.5	9.8
Trial 2	27.8	14.4	46.0	8.1	42.4	6.6
Retention	32.1	16.0	47.2	5.3	45.8	6.5

Note. TBI = traumatic brain injury.

The distribution of scores for all individuals was analyzed according to chance levels of responding. No participant in the TBI control or cognitively intact control groups scored below chance on any trial of the TOMM. Four TBI participants who simulated cognitive impairment scored below 25 on Trial 1 (scores = 20, 22, 22, and 24). Only 1 person in the TBI malingering group scored below chance on Trial 2 (score = 19), and 3 scored below chance on the retention trial (scores = 21, 24, and 25). Thus, as in the two previous experiments, relying on chance-level performance results in a high misclassification rate. As shown, using chance level as the cutoff score misclassified 50% of all the individuals simulating malingering on Trial 1, 94% on Trial 2, and 62% on the retention trial. The more stringent score of 19 would have misclassified 100% on Trial 1, 94% on Trial 2, and 100% on the retention trial.

Estimated scores. Mean estimated scores are presented in Table 3. As with the results of the first two experiments, estimated scores are equivalent between the groups initially and are substantially lower than obtained scores, indicating that the perceived difficulty of the test outweighed the actual difficulty. On the remaining two trials, estimation scores for the two control groups increased while those for TBI malingering group remained constant. Estimation scores for each trial of the TOMM were analyzed with a repeated measures ANOVA. Results revealed a significant group effect, $F(2, 25) = 6.65$, $p < .005$, and trial effect, $F(2, 50) = 12.70$, $p < .001$. In contrast, the Group × Trial interaction was not significant, $F(4, 50) = 1.31$, $p > .05$. One-way ANOVAs performed on scores for the individual trials revealed no significant differences between groups on Trial 1, $F(2, 25) = 2.58$, $p > .05$. On Trial 2, there was a significant group effect, $F(2, 25) = 6.04$, $p < .01$. Tukey's honestly significant difference paired comparisons revealed that both TBI and cognitively intact control groups estimated their performance at similar levels, with estimates significantly higher than those of the TBI malingering group. On the retention trial, individuals in the TBI malingering group scored significantly below participants in the TBI and cognitively intact control groups, $F(2, 25) = 7.79$, $p < .01$.

In summary, results from Experiment 3 show that when individuals with preexisting knowledge of the effects of TBI on cognitive abilities are asked to malinger, they perform substantially lower than TBI controls. This finding is similar to the performance of university students asked to malinger and indicates that first-hand knowledge of TBI did not appear to influence performance on the TOMM.

Experiment 4

The simulation paradigm used in the first three experiments represents one of the two most frequently used research strategies for validating malingering tests. The second research strategy, which has been shown to produce parallel effects to those found in simulation studies, evaluates individuals in situations where the likelihood of malingering is great. A prime example is when the opportunity for financial compensation exists, such as occurs in personal liability suits or disability petitions. The traditional way this second strategy has been implemented is by comparing the performance of people who are litigating with those that have a similar neurological insult but who are not

litigating (e.g., Binder, Villanueva, Howieson, & Moore, 1993; Binder & Willis, 1991; Greiffenstein, Baker, & Gola, 1996; Millis, 1994). In Experiment 4, we used this strategy as another way of providing converging evidence that the TOMM is a clinically useful measure of malingering. The performances of litigating TBI patients, nonlitigating TBI patients, and cognitively intact hospital controls were compared.

Method

Participants. Three groups of individuals composed Experiment 4. The TBI litigating (n = 13; 12 men and 1 woman) and the TBI nonlitigating groups (n = 13; 9 men and 4 women) consisted of TBI patients from either a neurological unit, a neuropsychiatry unit, or an outpatient neuropsychological assessment service. All litigating patients were pursuing either a personal liability suit or a disability petition. Mean age for the TBI litigating group was 39.2 years (SD = 8.0), with a mean education of 11.8 years (SD = 3.1). Mean age for TBI nonlitigating patients was 37.4 years (SD = 13.1); mean education was 13.3 years (SD = 2.1). A third group, hospital controls, consisted of 13 male hospital inpatients who had received a complete neuropsychological evaluation and were judged to be without any significant cognitive impairment. No individual in this group admitted to being involved in any type of compensation hearing or litigation. Mean age was 45.9 years (SD = 15.0), and mean education was 13.5 years (SD = 2.1). The sample was heterogeneous with respect to diagnostic category: presymptomatic Huntington's disease (n = 3), alcohol abuse (n = 3), multiple chemical sensitivity (n = 1), seizure disorder (n = 1), myocardial infarction (n = 1), and unknown etiology (n = 4).

Severity of injury was measured by the length of unconsciousness (Lezak, 1995). The TBI litigating group contained 5 individuals with mild head injuries, 4 with moderate head injuries, and 4 with severe head injuries. The TBI nonlitigating group consisted of 4 individuals with mild head injuries, 2 with moderate head injuries, and 7 with severe head injuries.

Procedure. For all groups, the TOMM was administered in the context of a complete neuropsychological evaluation. Because of the diversity of etiologies, a standard neuropsychological battery of tests was not administered. The TOMM was administered approximately 30 min after the beginning of each session. No estimation scores were requested because previous experience had shown that many clinical patients object to this procedure.

Results and Discussion

Mean scores are presented in Table 4. Inspection of the table shows that scores for Trial 1, Trial 2, and the retention trial are markedly higher for the hospital control group and the TBI nonlitigating group compared with the TBI litigating group. Subsequent analyses confirmed this observation.

Table 4
Means and Standard Deviations of Scores on the Test of Memory Malingering (TOMM) for Hospital Controls, Nonlitigating TBI Patients, and Litigating TBI Patients in Experiment 4

	Hospital control group		Nonlitigating TBI group		Litigating TBI group	
Measure	*M*	*SD*	*M*	*SD*	*M*	*SD*
Trial	47.9	2.1	45.3	5.0	26.6	10.5
Trial 2	50.0	0.0	49.5	1.0	32.9	12.5
Retention trial	50.0	0.0	50.0	0.0	35.4	10.3

Note. TBI = traumatic brain injury.

A repeated measures ANOVA revealed significant group and trial effects: group, $F(2, 36) = 29.50$, $p < .001$; trial, $F(2, 72) = 21.30$, $p < .001$. The Group × Trial interaction was also significant, $F(4, 72) = 12.60$, $p < .04$. One-way ANOVAs and Tukey's honestly significant difference paired comparisons revealed that the TBI litigating group scored significantly lower than the TBI nonlitigating and hospital control groups on each trial: Trial 1, $F(2, 36) = 37.90$, $p < .001$; Trial 2, $F(2, 36) = 23.50$, $p < .001$; retention trial, $F(2, 36) = 23.10$, $p < .001$.

Examining the distribution of scores for each group on each trial revealed that on Trial 2 no participant in the hospital control group obtained a score of less than 50, and no participant in the TBI nonlitigating group scored less than 47. In contrast, 11 of the TBI litigating individuals scored below 47, with 10 of these having scores below 45. Thus, using the cutoff score of 45 suggests that only 23% of the TBI litigating group put forth their best effort in comparison to 100% of the TBI nonlitigating and hospital control groups. Similar effects were found on the retention trial.

The distribution of scores for all participants was analyzed according to chance levels of responding. No person in the hospital control or nonlitigating groups scored below chance on any trial of the TOMM. For the litigating group, on Trial 1, 7 individuals scored below 25 (4 scored below 19). On Trial 2, 3 people scored below chance (2 scored below 19), and on the retention trial, 2 individuals scored below chance (none scored below 19). Thus, as in the previous experiments, using below-chance scores produced substantially different profiles than observed with an empirically determined criterion.

In summary, findings from Experiment 4 further substantiate previous research results that the TOMM is sensitive to detecting when individuals do not put forth maximum effort. Thus, comparable findings regarding performance on the TOMM occur when using either simulation paradigms or when comparing litigating and nonlitigating individuals in a clinical setting.

Experiment 5

The use of response latencies to detect malingering has been suggested by several researchers. For example, Brandt (1988) speculated that malingering people will take longer to process information, resulting in increased response latencies for incorrect responses. Rose, Hall, and Szalda-Petree (1995) reported that response latencies measured by a computerized version of the Portland Digit Recognition Test (PDRT) increased the detection of malingering compared with classification rates using number of correct responses. Following this lead, a computerized version of the TOMM (TOMM–C) was used in Experiment 5 to further explore the possibility that latency data may be useful in detecting malingering with the TOMM. Additionally, data are presented, comparing performance on the paper-and-pencil version to that obtained on the TOMM–C.

Method

Participants. Forty participants were randomly assigned to one of two groups: computer malingering (c-malingering, n = 20; 9 men and

11 women) and computer control (c-control, n = 20; 10 men and 10 women). Mean age of the c-malingering group was 30.6 years (SD = 8.4), with 13.2 years of education (SD = 1.6). Mean age of the c-control group was 25.7 years (SD = 7.6), with 13.1 years of education (SD = 1.5). Fourteen participants were students from an introductory psychology class who received course credit for participation. The remaining 26 people were volunteers from the community who received no financial remuneration.

Materials and procedure. Administration of the stimulus material on the TOMM–C used the same format as on the paper-and-pencil version with one exception. The pictures were presented on the left and right side of the screen rather than at the top and bottom of the page. The TOMM–C was programmed for a PC Windows environment with millisecond timing. Individuals selected either the left or right picture by pressing either the left or right "Ctrl" key. Following each response, the words *correct* or *incorrect* were presented below the selected picture. The procedure was identical to that described in Experiment 1, except performance estimates were not requested, and each condition was administered only once to each group.

Results and Discussion

Mean number of correct responses for each group is shown in Table 5. Statistical analyses showed the performance of the control group to be higher than that of the malingering group on each trial: Trial 1, $F(1, 38) = 293.40$, $p < .001$; Trial 2, $F(1, 38) = 265.90$, $p < .001$; Trial 3, $F(1, 38) = 119.60$, $p < .001$. Regression analyses performed on Trial 2 scores for all participants and for only those individuals feigning cognitive impairment showed that gender (1% and 6%), education (< 1% and 2%), and age (6% and 2%) accounted for only a small portion of the total variance. Using the suggested cutoff score of 45, 100% sensitivity and 100% specificity were achieved. Thus, overall, the results from Experiment 5 are comparable with those occurring in the first two experiments.

Table 5 also contains results from a previous experiment that tested university students with an identical procedure with the paper-and-pencil version (Tombaugh, 1997; Experiment 4). Visual inspection of these data showed that TOMM–C produced results virtually identical to those obtained with the paper-and-pencil version. An ANOVA appropriate to a 2 (computer vs. paper-and-pencil) × 2 (malingering vs. control) factorial design verified these observations: Trial 1—administration type, $F(1, 76) = .01$, $p > .05$; instruction, $F(1, 76) = 234.21$, $p < .001$; Administration × Instruction, $F(1, 76) = 0.65$, $p > .05$; Trial 2—administration type, $F(1, 76) = 0.00$, $p > .05$; instruction, $F(1, 76) = 430.63$, $p < .001$; Administration × Instruction, $F(1, 76) = 0.06$, $p > .05$; retention trial—administration type, $F(1, 76) = 2.64$, $p > .05$; instruction, $F(1, 76) = 34.28$, $p < .001$; Administration × Instruction, $F(1, 76)$ 2.16, $p > .05$.

Table 5
Means and Standard Deviations on the Computerized Test of Memory Malingering for Malingering and Control Groups in Experiment 5 and on a Previously Published Experiment (Tombaugh, 1997)

	Experiments			
	Experiment 5		Tombaugh (1997)	
Measure	*M*	*SD*	*M*	*SD*
Controls				
Trial 1	47.4	2.4	47.8	2.5
Trial 2	49.7	0.5	49.9	0.8
Retention	49.9	0.2	49.7	1.1
Malingering				
Trial 1	26.5	4.9	27.2	6.8
Trial 2	28.3	5.8	27.9	7.3
Retention	30.5	7.9	26.5	7.4

Table 6
Means and Standard Deviations of Response Latencies (in Seconds) for Correct and Incorrect Responses on the Computerized Test of Memory Malingering (TOMM) for Malingering and Control Groups in Experiment 5

		Malingering group		Control group			
Trial	*n*	*M*	*SD*	*M*	*SD*	*t*	*df*
Correct responses							
Trial 1	20/20	3.12	0.84	1.78	0.83	−2.02*	38
Trial 2	20/20	2.51	0.77	1.02	0.19	−5.04*	38
Retention trial	20/20	2.40	0.76	0.94	0.87	−8.04*	38
Incorrect responses							
Trial 1	20/17	3.23	0.78	3.35	2.29	0.20	35
Trial 2	20/6	2.84	0.90	0.98	0.50	−6.41*	24
Retention trial	20/1	2.80	1.08				

Note. The two numbers given for n refer to the number of individuals included in the analyses for the control and malingering groups, respectively. No latency data are included for controls making incorrect responses on the retention trial because only 1 person was included in this condition.
* $p < .001$.

The mean response latency scores for the correct and incorrect responses on the TOMM–C are presented in Table 6. Response times (RTs) for correct responses progressively decreased over all three trials for both groups and were significantly shorter on each trial for the control group. A different profile emerged for incorrect responses. Whereas RTs tended to decrease over trials, response latencies were only significantly different on Trial 2. No data are reported for controls on the retention trial because only a single incorrect response occurred for 1 person.

The longer response latencies for participants instructed to malinger may simply reflect their belief that brain-damaged individuals take longer to respond. Within this context, Rose et al. (1995) reported that brain-damaged individuals had even longer RTs on the computerized PDRT than analog malingerers. This indicates the need for further normative research prior to using latencies scores on the TOMM–C for detection of malingering in a clinical situation.

An alternative, information-processing hypothesis for the increased latencies is that they reflect, at least in part, increased processing time for the malingering participants. That is, individuals instructed to try their best merely select the stimuli they feel are correct and respond faster with practice. Participants asked to malinger, on the other hand, not only must process the choice stimuli to determine which are correct but they also must decide whether to respond truthfully or to falsify their answers. This increased processing time is reflected in longer RTs. The

failure to observe any differences for incorrect responses in Trial 1 is due to the increased response latencies for the controls. Presumably, this reflects their lack of experience with the task and their need to spend more time processing stimuli where the correct choices are not readily apparent.

General Discussion

The results from the five experiments provide compelling convergent evidence that the TOMM readily differentiated between malingering and nonmalingering individuals. High levels of sensitivity and specificity were obtained with different types of participants (university students, patients with TBI, and hospital outpatients), different types of experimental designs (simulation and compensation seeking), and different procedures for presenting the stimulus material (paper-and-pencil and computer). The ability of the TOMM to discriminate between malingering and nonmalingering individuals occurred when the comparison was between different groups of individuals and when each participant served as his or her own control. Moreover, similar levels of sensitivity and specificity were reported when the TOMM was presented alone and when it was embedded in a battery of neuropsychological tests. Finally, speed of responding, as well as accuracy of responding, was useful in differentiating between malingering and nonmalingering individuals.

Correct identification of individuals instructed to malinger was highly dependent on the type of decision rule used. Historically, forced-choice procedures have used below-chance performance as the criterion used to identify malingering (Binder, 1990; Binder & Pankratz, 1987; Hiscock & Hiscock, 1989; Pankratz, 1983). This criterion is based on the assumption that less-than-chance accuracy occurs because the person was able to correctly identify the correct stimulus but chose not to select it on the test trial. Application of this criterion in the present series of experiments identified relatively few participants who feigned cognitive impairment. This unacceptably low level of sensitivity is consistent with previous research, showing that individuals suspected of malingering or asked to simulate the performance of brain-injured patients perform at above-chance-level of accuracy (Beetar & Williams, 1995; Binder & Willis, 1991; Guilmette et al., 1993; Martin, Gouvier, Todd, Bolter, & Niccolls, 1992; Prigatano & Amin, 1993; Slick, Hopp, Strauss, Hunter, & Pinch, 1994).

In contrast to the above, use of an empirically based criterion score yielded high levels of sensitivity. This finding illustrates the necessity of validating a malingering test with an appropriate clinical reference group. In the present case, the cutting score of 45 (90% correct) on either Trial 2 or on the retention trial was derived primarily from a group of 45 TBI patients, only 1 of whom had a score less than 45 on Trial 2 or on the retention trial (Tombaugh, 1997). These results, coupled with those in the present experiments, suggest that when the TOMM is used clinically any score lower than 45 on Trial 2 or on the retention trial should raise concern that the individual is not putting forth maximum effort. Of course, as with any test, this score is viewed as a guideline with the likelihood of malingering increasing as the score deviates further from the normative baseline.

The ability of the TOMM to differentiate between malingering and nonmalingering individuals is attributable primarily to three factors. First, comparison of the estimated and obtained scores shows that the TOMM appeared to be much more difficult than, in fact, it was. This level of perceived difficulty is important because previous research has shown that individuals feigning memory impairments will be more readily detected when they believe that a test is difficult (Bickart, Meyer, & Connell, 1991; Slick et al., 1994). The results from the four experiments that used simulation designs showed that participants who malingered did not differ significantly from their respective control groups on estimated performance on Trial 1. If estimation of performance reflects perception of test difficulty, this equivalency shows that all groups perceived the difficulty of the test in a similar manner. Judging from the highly accurate scores on Trial 1 by individuals who were instructed to try their best, the initially perceived difficulty was substantially higher than the actual difficulty. After exposure and feedback on Trial 1, controls adjusted their estimate scores upward, reflecting that the test was no longer perceived to be as difficult as initially perceived. Although individuals in the malingering group tended to adjust their estimates upward on Trial 2, their estimates were substantially lower than those of the controls. Such findings suggest that individuals who malingered artificially suppressed their estimations and then used these estimates to calibrate their actual performance. This is particularly evident in the retest scores in Experiment 1. Individuals in the M-B group, who were instructed to perform to the best of their ability after having been instructed to malinger, increased their estimated scores for each trial, with the greatest increase occurring on Trial 1 (see Table 1). In contrast, when individuals in the B-M group were retested, they did not alter their estimation score on Trial 1 from the initial score, but they substantially decreased their estimation scores on Trial 2 and on the retention trial. These scores, as well as their accuracy scores, are remarkably consistent with those obtained by individuals in the M-B group. This indicates that regardless of the order of administration, people instructed to malinger attempted to match their actual performance with their estimated performance.

Second, the effectiveness of the TOMM is attributed to its lack of sensitivity to cognitive deficits associated with TBI. This is clearly illustrated in Experiments 3 and 4 where highly accurate performance was obtained by TBI controls and nonlitigating TBI patients, respectively. The performance of the two groups was comparable to that observed with cognitively intact individuals tested in the other experiments. These results are consistent with previously reported data showing the TOMM to be insensitive to the effects of age, education, and different types of neurological impairment including TBI (Tombaugh, 1997). One possible shortcoming of the present series of experiments is the failure to include a psychiatric control group to evaluate the possible effects of psychiatric symptomatology, such as depression, on the TOMM. Such a determination is desirable to avoid misclassifying nonmalingering individuals who simply have an adverse affective response to trauma. This is a particularly important issue because depression is one of the common sequalae to TBI, and other authors (Binder & Willis, 1991) have reported that scores on some measures of malingering are slightly lower for depressed patients. However, evidence from several different sources indicates that scores on the TOMM are

not sensitive to the effects of depression. The original normative sample (Tombaugh, 1997), on which the criterion score of 45 was based, contained several patients who had been diagnosed as depressed. In addition, representative response-relevant psychiatric symptoms presumably were represented in the TBI controls in Experiments 3 and 4. Finally, preliminary results from ongoing research (Boulay, Rees, & Tombaugh, 1997) showed that TOMM scores from 11 depressed patients from an affective disorders clinic were not significantly different from age-matched controls.

Third, responses from debriefing questions asked at the end of the experiments showed that the TOMM has high face validity as a memory test. That is, it was perceived to be a legitimate measure of cognitive ability. No participant identified it as a malingering test or stated that it was easy to fake.

In conclusion, data from five separate experiments provide substantial evidence that the TOMM is a valid and clinically useful measure of malingering or memory impairment.

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