Aging, Neuropsychology, and Cognition, 12:89–98

ISSN: 1382-5585/05
DOI: 10.1080/13825580590925143

Psychology Press
Taylor & Francis Group

Reliability and Validity of the Divided Attention Questionnaire

TIMOTHY A. SALTHOUSE AND KAREN L. SIEDLECKI
Department of Psychology, University of Virginia, Charlottesville, VA 22904-4400, USA

ABSTRACT

This study investigated the relations of the Divided Attention Questionnaire (DAQ) developed by Tun and Wingfield (1995) to age, and to measures of divided attention performance. With increased age activities assumed to require divided attention were rated as more difficult, were perceived as becoming more difficult over time, and were performed less frequently. However, no significant relations were found between DAQ ratings and performance on divided attention tasks administered in the laboratory. This suggests that the DAQ may not be a valid measure of divided attention ability as that construct is measured with laboratory tasks. Possible explanations for the lack of relations between the DAQ ratings and measures of divided attention performance are discussed.

Over the past 25 years a number of questionnaires have been developed to assess self perceptions of one's cognitive functioning (e.g., Cognitive Failures Questionnaire - Broadbent, Cooper, Fitzgerald, & Parkes, 1982; Memory Functioning Questionnaire – Gilewski, Zelinski, & Schaie, 1990; Memory Self-Efficacy Questionnaire – Berry, West, & Dennehy, 1989; Metamemory in Adulthood – Dixon, Hultsch, & Hertzog, 1989). A questionnaire designed to assess perceptions of divided attention abilities (the Divided Attention Questionnaire, DAQ) was developed by Tun and Wingfield (1995), who administered it to 83 adults between 18 and 27 and to 245 adults between 60 and 91 years of age. They found that compared to young adults, older adults rated activities hypothesized to involve divided attention as higher in difficulty, having changed in the direction of becoming harder over time, and performed less often. Although these results are informative about age differences in perceptions of

Address correspondence to: Timothy A. Salthouse, Department of Psychology, University of Virginia; Charlottesville, VA 22904-4400. USA. E-mail: salthouse@virginia.edu
Accepted for publication: 27 November 2003

divided attention ability, because they did not include adults between 27 and 60 years of age they were unable to examine the complete relation of age to the DAQ, nor did they provide any evidence of the validity of the DAQ.

There were two goals of the current report. The first was to examine the relations of the DAQ to age in a sample of 394 adults who varied continuously in age between 18 and 91. The second goal was to investigate the relations of the DAQ to measures of divided attention performance because in addition to completing the DAQ, all of the participants performed three pairs of cognitive tasks alone and simultaneously. Research with other questionnaires assessing self perceptions has revealed relatively weak relations between those perceptions and objective measures of performance in the relevant domain (e.g., Hertzog & Hultsch, 2000, suggested that correlations between self reports and memory performance were in the range of .2 to .3 in normal adults), but it is not known whether a similar discrepancy would exist in the domain of divided attention abilities.

METHOD

Participants

The DAQ was administered to two samples of participants from two separate studies. The first sample consisted of 150 participants between the ages of 20 and 91 (Salthouse & Miles, 2002), and the second sample consisted of 261 participants between the ages of 18 and 84 (Salthouse et al., 2003). For the purposes of this paper the two samples were combined to create a single data set. Of the 411 total participants, 394 of them completed the questionnaire and performed three pairs of tasks separately and in combination, and characteristics of this sample by decade are summarized in Table 1.

A subset of 29 adults between 55 and 79 years of age returned to participate in another study after an interval of between 2 weeks and 6 months

TABLE 1. Means (and SDs) for characteristics of the sample

Age *M (SD)*	N	*% F*	YrsEduc *M (SD)*	Health *M (SD)*	Vocab *M (SD)*	DigSym *M (SD)*
22.2 (2.7)	57	56.0	14.3 (2.4)	1.9 (0.8)	45.3 (13.0)	89.8 (17.4)
33.4 (2.4)	51	73.0	16.7 (3.5)	2.0 (0.8)	48.8 (13.0)	88.4 (17.8)
45.0 (2.9)	92	73.0	16.0 (2.2)	1.9 (0.8)	53.1 (8.9)	82.3 (15.4)
53.9 (3.0)	80	67.0	16.2 (2.4)	1.9 (0.9)	54.4 (9.2)	75.9 (16.2)
64.3 (3.1)	58	59.0	16.9 (2.9)	2.1 (0.8)	53.7 (9.3)	67.3 (14.2)
74.0 (3.0)	45	58.0	15.6 (2.2)	2.4 (0.9)	49.8 (10.0)	60.5 (12.6)
83.5 (3.3)	11	45.0	15.8 (3.0)	2.2 (0.6)	50.7 (6.4)	54.0 (15.2)

Note: Yrs Educ refers to years of formal education completed, health was a self rating on a scale ranging from 1 for "excellent" to 5 for "poor," and Vocab and DigSym were raw scores from the Vocabulary and Digit Symbol Substitution Tests from the WAIS III (Wechsler, 1997).

and completed the questionnaire again. The correlation between the scores across the two occasions in this group was used to assess retest reliability.

Tasks and Materials

The DAQ consists of the 15 items listed in Table 2. For each item the participant made three ratings with respect to difficulty, perceived change, and frequency. Difficulty was rated on a five-point scale ranging from 1 for very easy, to 3 for medium, to 5 for very hard. Change was rated on a three-point scale ranging from 1 for easier, to 2 for no change, to 3 for harder. Finally, frequency was rated on a three-point scale ranging from 1 for 0 per week, 2 for 1–6 times per week, and 3 for greater than 6 times per week.

The tasks used to assess divided attention have been described in detail in other articles (i.e., Salthouse, Atkinson, & Berish, 2003; Salthouse & Miles, 2002), and will only be briefly summarized here. In Study 1 (Salthouse & Miles, 2002) the same secondary task was performed with three different primary tasks, and in Study 2 (Salthouse et al., 2003) three different combinations of primary and secondary tasks were performed. The participants in Study 1 used a track ball to try to keep a cursor superimposed on a randomly moving target while simultaneously remembering lists of paired associates, answering questions about a sequence of verbal directions, or reporting the best continuation of a sequence of numbers. One of the task combinations in Study 2 involved the same tracking and paired associates tasks as in Study 1, a second involved using a steering wheel to keep a "vehicle" in the middle of a curved road while repeating digits that occurred two back in a continuous sequence, and the third consisted of counting backwards by 3's while connecting randomly positioned letters in an alphabetical sequence as rapidly as possible. It should be noted that the divided attention tasks in the two studies were originally designed to address a number of methodological issues concerned with adult age differences in divided attention (see Salthouse & Miles, 2002), and were not specifically selected to investigate the validity of the DAQ.

Each task was performed alone both before and after it was performed concurrently with the other task. The following method was used to compute divided attention costs in each combination of tasks. First the error or time scores in each task were expressed in units of standard deviation of single task performance. Next the single task score was subtracted from the dual task score, and finally the two differences were averaged to create a measure of overall divided attention performance across the two tasks. Note that higher values of this average score indicate a greater cost of divided attention because they indicate that performance was poorer when the two tasks were performed simultaneously. See Salthouse and Miles (2002) and Salthouse et al. (2003) for more details about the procedure and its rationale.

All participants were also administered the Vocabulary and Digit Symbol Substitution subtests from the WAIS III (Wechsler, 1997). The

TABLE 2. Means, Standard Deviations, and Age Correlations for Individual DAQ Items

	Difficulty		Change		Frequency	
Item	Mean *(SD)*	Age *r*	Mean *(SD)*	Age *r*	Mean *(SD)*	Age *r*
1. Driving while talking with someone	1.9 (1.0)	.19*	2.0 (0.6)	.33*	2.5 (0.6)	–.24*
2. Driving while reading road signs to exit from a highway	2.4 (1.1)	.17*	2.1 (0.6)	.39*	2.4 (0.6)	–.10*
3. Driving while listening to music on the radio	1.2 (0.6)	.05	2.0 (0.4)	.11*	2.8 (0.5)	–.13*
4. Driving while planning a schedule or a shopping list	2.7 (1.3)	.04	2.1 (0.5)	.24*	2.1 (0.7)	.02
5. Watching TV while reading a book or newspaper	3.1 (1.4)	–.02	2.1 (0.5)	.13*	2.1 (0.8)	.13*
6. Talking with someone while a television show is on in the room	2.8 (1.4)	.18*	2.1 (0.5)	.14*	2.2 (0.7)	–.21*
7. Talking while playing cards	2.2 (1.2)	.23*	2.0 (0.4)	.08	1.7 (0.7)	–.16*
8. Talking to someone in the midst of a crowd of people talking	2.7 (1.3)	.20*	2.2 (0.6)	.16*	2.2 (0.5)	–.16*
9. Talking to someone while preparing a meal or doing chores	2.0 (1.1)	.12*	2.0 (0.5)	.22*	2.4 (0.6)	–.14*
10. Walking while having a conversation with someone	1.4 (0.7)	.12*	2.0 (0.3)	.12*	2.5 (0.6)	–.20*
11. Talking on the phone while checking a calendar or appointment book	2.0 (1.0)	–.05	2.0 (0.4)	.21*	2.4 (0.6)	.08
12. Talking on the phone while someone in the room is talking to you	3.7 (1.2)	.15*	2.3 (0.5)	.12*	2.1 (0.5)	–.09
13. Listening to someone talk while planning your reply	2.6 (1.2)	.09	2.1 (0.5)	.23*	2.3 (0.6)	–.17*
14. Trying to remember a person's name while you are being introduced	3.7 (1.2)	.17*	2.3 (0.6)	.23*	2.2 (0.5)	–.04
15. Doing household chores while thinking about other things	1.5 (0.8)	.09	2.0 (0.4)	.21*	2.6 (0.5)	–.12

Vocabulary subtest requires the participant to provide definitions of words, and the Digit Symbol Substitution subtest requires the participant to write appropriate symbols below digits as quickly as possible according to a code table. As is typically found in studies of aging and cognition, increased age

was associated with a monotonic decrease in the Digit Symbol score but with an increase followed by a leveling off in the Vocabulary score.

RESULTS

For each DAQ item the average ratings, and correlations of the ratings with age, are presented in Table 2. In our sample, items with the lowest difficulty ratings were driving while listening to the radio, walking and talking, and doing household chores while thinking of something else. Items rated most difficult were talking on the phone and to someone in the room, and remembering names when introduced to someone new. The participants in the Tun and Wingfield (1995) sample had a similar rank-ordering of these activities.

Estimates of reliability, and correlations of each type of rating with other variables, are presented in Table 3. In many respects the pattern of correlations is similar to that reported by Tun and Wingfield (1995). For example, the internal consistency and the test–retest estimates of reliability were similar, as were many of the correlations with other variables. The primary discrepancy involved the ratings of perceived change, as several of the correlations involving this variable were larger in the Tun and Wingfield (1995) sample than in the current sample.

TABLE 3. Correlations of Average Ratings

	Difficulty		Change		Frequency	
Variable	T&W	Current	T&W	Current	T&W	Current
Coefficient Alpha	.88	.87	.89	.81	.70	.79
Retest Reliability	.63	.87	.44	.73	.52	.58
Change	.45*	.34*	–	–	–	–
Frequency	–.34*	–.31*	–.22*	.01	–	–
Age	.25*	.19*	.65*	.37*	–.25*	–.21*
Sex	.17	–.02	.00	.07	.08	.07
Education	.05	–.04	.28*	.08	.00	.06
Health	–	.11	–	.10	–	–.11
Vocabulary	.14	–.02	.42*	.14	–.04	.12
Study 1						
Tracking & Paired Associates		.05		.08		–.10
Tracking & Directions		.08		.08		–.14
Tracking & Series Completion		.03		.07		–.06
Study 2						
Paired Associates & Tracking		.06		.13		–.10
NBack 2 & Driving		.03		.06		–.04
Connect & Count		.21*		.12		–.20*

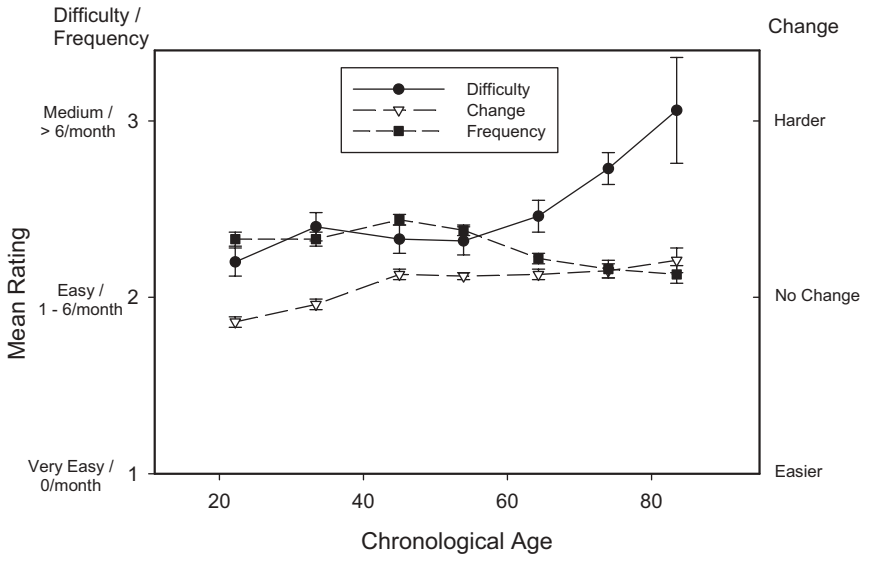
Note: T&W refers to results reported by Tun and Wingfield (1995).
*p<.05.

Tun and Wingfield (1995) hypothesized the existence of three factors with each type of rating, which they labeled routine, monitoring, and speech. The items with primary loadings on the hypothesized factors were numbers 9, 10, and 15 for routine, numbers 1, 2, 3, 4, and 13 for monitoring, and numbers 5, 6, 7, 8, 11, 12, and 14 for speech. An exploratory factor analysis was conducted in an attempt to replicate the pattern reported by Tun and Wingfield (1995). However, the results indicated that the first factor had an eigenvalue of 4.75 and was associated with 31.7% of variance, whereas all other factors had eigenvalues less than 0.7 and were associated with less than 5% of variance. When three factors were specified in a confirmatory factor analysis the fit was significantly better than that in a model with only one factor (i.e., $\Delta\chi^2 = 65.6$, $\Delta df = 3$, $p < .01$), but the correlations among the three factors were all quite high (i.e., .77, .77, and .85), suggesting that if three factors exist they are not very distinct. These results thus provide only weak support for the hypothesis that the items within each type of rating can be grouped into three factors. All subsequent analyses were therefore based on the average for each type of rating.

The confirmatory factor analysis with three correlated factors, based on the ratings of difficulty, frequency, and change, was repeated in a multiple group analysis to determine whether the factor structure was invariant across adults between 18 and 49 ($N = 200$) and between 50 and 94 ($N = 194$) years of age. The only coefficients that differed significantly ($p < .01$) across the two groups were the regression coefficients for two items referring to change. The loadings of the change ratings on the change factor were significantly larger for the young group than for the older group for the questions referring to driving while reading road signs (#2) and walking while having a conversation with someone (#10). Because these differences were relatively small, and were the only ones that were significant out of the 48 regression coefficients and covariances that were examined, the measurement structure of the DAQ can be inferred to be quite similar in at least these two age groups.

The possibility of non-linear age relations was investigated by successively entering age-squared and age-cubed terms after the age term in hierarchical regression analyses on the average difficulty, change, and frequency ratings. All of age-squared terms were significant, but none of the age-cubed terms were significantly different from zero. The proportions of variance associated with the linear and quadratic age relations were, respectively, .037 and .021 for difficulty, .140 and .025 for change, and .045 and .025 for frequency. In order to illustrate these trends the mean ratings are portrayed in Figure 1 as a function of decade. It can be seen that the age differences were fairly small in absolute terms, but that increased age was associated with ratings that the activities were more difficult, performed less frequently, and perceived to have become harder. The most pronounced non-linear trend was a greater age-related increase in the difficulty ratings after about age 60.

FIGURE 1. Mean ratings (and standard errors) for the three dimensions of the DAQ as a function of age. Note that the axis for the change ratings is on the right, and the axes for the difficulty and frequency ratings are on the left.



As noted earlier, all of the participants performed three pairs of tasks alone and in combination, and thus it was possible to examine correlations between the DAQ ratings and the divided attention cost measures. These correlations are presented in Table 3 where it can be seen that only two of the 18 correlations were significantly different from zero. Both significant correlations involved the Connect and Count task, and indicated that the divided attention costs were greater when activities mentioned in the DAQ were rated as more difficult, and when they were rated as performed less frequently.

Although the very low correlations in Table 3 raise doubts about the validity of the DAQ as a measure of divided attention ability, single variables are not optimal for investigating validity because they are neither exhaustive nor exclusive in their representation of the intended construct. A preferable procedure is to rely on multiple variables as indicators of the relevant construct, and then examine relations of various predictors with a latent construct that represents the variance the indicator variables have in common. Because this procedure yields a more comprehensive and reliable assessment of the construct, it should provide a stronger test of any relations that might exist between the DAQ dimensions and the measures of divided attention ability.

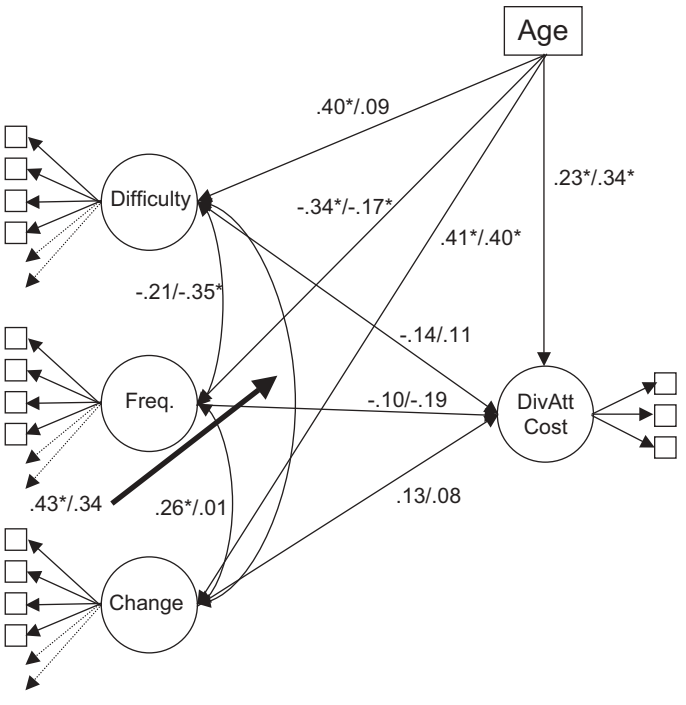
Different combinations of tasks were performed by the participants in Studies 1 and 2, and thus separate structural equation analyses were conducted on the data from the two studies but each analysis contained latent constructs

representing divided attention performance across three combinations of tasks. An age-squared term was included in the initial models, but it did not improve the fit and thus non-linear age terms were not included in the reported models.

The analyses of data from both studies revealed that the divided attention cost variables had significant loadings on the latent construct, with the loadings ranging from .36 to .81. This pattern provides evidence for the convergent validity of the divided attention constructs. Standardized coefficients for the complete structural model, including those for paths that were not statistically significant, are portrayed in Figure 2. The first number in each pair is the coefficient from Study 1, and the second is the coefficient from Study 2. The models had relatively good fits in both sets of data as the χ^2/df, CFI and RMSEA fit statistics, were, respectively, 2114/1118, .95, and .08 for Study 1, and 2334/1118, .96, and .07, for Study 2.

There were some differences in the relations among variables in the two data sets. For example, the ratings of age to the DAQ ratings, and the

FIGURE 2. Structural model illustrating relations between the three types of ratings of the DAQ (on the left) and a latent construct representing divided attention ability. The first number in each pair is the standardized coefficient for the analysis of Study 1 data, and the second number is the standardized coefficient for the analysis of Study 2 data.



relation between the frequency and change ratings, were smaller in Study 2 than in Study 1. However, the results in the two data sets were similar in two important respects. First, in both studies increased age was associated with significantly larger divided attention costs. And second, in neither study was there a significant relation between any of the DAQ ratings and the latent construct representing divided attention ability.

DISCUSSION

The current data and analyses confirm the findings of Tun and Wingfield (1995) that the DAQ is reliable, and that with increased age activities that appear to involve divided attention are rated as more difficult, perceived to have changed in the direction of becoming harder, and performed less frequently. Because the current sample consisted of adults with a continuous range of age, it was also possible to determine that the relations between age and the DAQ dimensions were not simply linear, but also had a quadratic trend.

The major new finding in the current study was the general absence of relations between the DAQ ratings and measures of divided attention performance. Moreover, this pattern was not only apparent in the relations with the individual measures of divided attention, but also in analyses involving latent constructs representing divided attention ability. To the extent that the DAQ is considered a measure of divided attention ability, these results suggest that it may have little or no validity.

However, it is instructive to consider possible reasons for the lack of relations between the DAQ ratings and the divided attention measures. One possibility is that the questionnaire refers to familiar everyday activities, and performance in the somewhat contrived divided attention tasks performed in the laboratory may not be valid reflections of the type of divided attention that occurs in more natural activities. According to this interpretation, then, the problem may not be that the DAQ lacks validity, but rather it is the laboratory tasks of divided attention that have low levels of external validity.

A second possibility is that the self perceptions assessed in the DAQ may not be accurate reflections of actual divided attention ability. In other words, the DAQ may be valid with respect to one's perceptions about his or her divided attention abilities, but these perceptions may have little or no relation to actual divided attention ability. As mentioned earlier, a similar weak linkage between one's perceived ability and his or her actual level of ability has been reported in other cognitive domains (e.g., see review in Hertzog & Hultsch, 2000). A consensus has not yet been reached regarding the reasons for this discrepancy between perceived and actual ability, but it should be recognized that self perceptions could be more important in determining many of the choices in one's life, independent of the individual's objectively determined level of performance.

Regardless which of these, or other, interpretations ultimately proves most plausible, the results of the current study are informative in indicating that self ratings of difficulty, change, and frequency of activities that appear to involve divided attention can be assessed reliably and are related to age in adulthood, but do not necessarily reflect the ability to divide one's attention among different combinations of laboratory tasks.

REFERENCES

Berry, J.M., West, R.L., & Dennehy, D.M. (1989). Reliability and validity of the Memory Self-Efficacy Questionnaire. *Developmental Psychology*, *5*, 701–713.

Broadbent, D.E., Cooper, P.F., Fitzgerald, P., & Parkes, K.R. (1982). The Cognitive Failures Questionnaire (CFQ) and its correlates. *British Journal of Clinical Psychology*, *21*, 1–16.

Dixon, R.A., Hultsch, D.F., & Hertzog, C. (1989). The Metamemory in Adulthood (MIA) Questionnaire. *Psychopharmacology Bulletin*, *24*, 671–688.

Gilewski, M.J., Zelinski, E.M., & Schaie, K.W. (1990). The Memory Functioning Questionnaire for assessment of memory complaints in adulthood and old age. *Psychology and Aging*, *5*, 482–490,

Hertzog, C. & Hultsch, D.F. (2000). Metacognition in adulthood and old age. In F.I. M., Craik & T. A. Salthouse (Eds.), *The handbook of aging and cognition* (2nd ed.,) (pp. 417–466). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Salthouse, T.A., Atkinson, T.M., & Berish, D.E. (2003). Executive functioning as a potential mediator of age-related cognitive decline in normal adults. *Journal of Experimental Psychology: General*, *132*, 566–594.

Salthouse, T.A., & Miles, J.D. (2002). Aging and time-sharing aspects of executive control. *Memory & Cognition*, *30*, 572–582.

Tun, P.A., & Wingfield, A. (1995). Does dividing attention become harder with age? Findings from the Divided Attention Questionnaire. *Aging and Cognition*, *2*, 39–66.

Wechsler, D. (1997). *Wechsler Adult Intelligence Scale – Third Edition (WAIS III)*. San Antonio, TX: The Psychological Corporation.