Relation of Successive Percentiles of Reaction Time Distributions to Cognitive Variables and Adult Age

TIMOTHY A. SALTHOUSE
Georgia Institute of Technology

The reaction time distributions for each individual in a moderately large sample of adults were analyzed in terms of percentiles, and then each reaction time percentile was correlated with a number of cognitive variables and with age. A very similar pattern was evident across five sets of reaction time tasks. This consisted of the correlations with the cognitive variables remaining stable, but those with adult age decreasing, from the fastest to the slowest responses emitted by the individual. Contrary to recent reports (Kranzler, 1992; Larson & Alderton, 1990), these results suggest that all portions of the reaction time distribution contain qualitatively similar individual difference information.

It is plausible to speculate that there is relatively little inter-individual variation among the fastest reaction times (RTs) produced by individuals, but much greater variation among their slowest RTs. If this is true it could occur for at least two reasons. First, because RTs cannot be negative they have a lower limit of zero, and thus there is a measurement floor but no measurement ceiling. This implies that the range of scores will necessarily be compressed with fast RTs as they approach zero, whereas there is no natural limit on slow RTs. As a consequence of this asymmetry, inter-individual variability may be less for fast RTs because of the restriction on the lower end of the measurement scale.

A second, and theoretically more interesting, reason for less inter-individual variation among the fastest RTs is that the RT distribution might be composed of a mixture of fast, partially automatic, responses, and slower, consciously controlled, responses. If this is the case, and if there are fewer individual differences in automatic processes than in conscious controlled processes, then smaller inter-individual variation would be expected among people's fastest responses than among their slowest responses. In fact, Spieler, Balota, and

Direct all correspondence to: Timothy A. Salthouse, School of Psychology, Georgia Institute of Technology, Atlanta, GA 30332-0170

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Faust (1996) proposed that many RT distributions may be composed of a mixture of a Gaussian distribution and an exponential distribution, and that the exponential distribution is primarily responsible for the slowest RTs. As might be expected, these researchers found adult age differences in a parameter reflecting the slowest percentiles of the RT distribution. However, age differences were also evident in parameters reflecting other percentiles of the RT distribution, and thus the process responsible for the exponential distribution was apparently not the only factor in their study contributing to age-related individual differences in overall RT.

Either because of less restriction of range, or because of greater similarity of the controlled processing involved in slow RT responses and in many cognitive tasks, the relations between RT and other cognitive variables might be expected to increase from an individual's fastest to his or her slowest responses. Some empirical support for this expectation is available in a study by Larson and Alderton (1990). These researchers were interested in investigating what they termed the "worst performance rule" which is that "The worst RT trials reveal more about intelligence than do other portions of the RT distribution (p. 310)." Indeed, they found that the correlations with a Gf/Gc composite of intelligence and with a measure of working memory were greater at slow RTs than at fast RTs. Kranzler (1992) has also reported that correlations between RT and a measure of intellectual g increased from the individual's fastest to his or her slowest reaction times.

However, earlier analyses of two RT tasks did not exhibit this pattern (Salthouse, 1993a). In those analyses the correlations with adult age and with several cognitive variables remained stable from the 10^{th} through the 90^{th} percentiles of the RT distribution. For example, the proportion of variance associated with a composite cognitive measure was very similar for the 90^{th} (i.e., $R^2 = .245$), 50^{th} (i.e., $R^2 = .244$) and 10^{th} (i.e., $R^2 = .232$) percentile RTs. Furthermore, when the fastest RTs were statistically controlled there were little or no significant age-related effects on either the 50^{th} percentile or the 90^{th} percentile RTs. In contrast to the findings by Kranzler (1992) and Larson and Alderton (1990), therefore, the Salthouse (1993a) results suggest that nearly all of the relations between RT and cognitive variables (and between RT and age) were evident in the individual's fastest responses.

The purpose of the current report is to describe analyses designed to attempt to replicate and extend the results of Salthouse (1993a). The primary data are from a sample of 383 adults between 18 and 88 years of age in two recent studies who performed several RT tasks as well as a battery of cognitive tests. The two RT tasks performed by all participants were the same digit digit and digit symbol reaction time tasks examined in the Salthouse (1993a) study. However, because it is possible that the patterns vary across types of RT tasks, data from a subset of 186 of the adults who also performed additional RT tasks were analyzed in the same manner. The cognitive tests included assessments of vocabulary, perceptual speed, matrix reasoning (with a task similar to the Raven's Progressive Matrices), episodic memory (with a multiple trial free recall task), and spatial visualization (with a cube assembly task).

METHOD

Participants

The primary data were derived from all individuals with complete data on the relevant variables from two recent studies (Salthouse, Fristoe, McGuthry, & Hambrick, in press;

Salthouse, McGuthry, & Hambrick, 1997). Data were available from a total of 383 participants (mean age = 47 years, 61.9% females) in the complete sample, with between 61 and 78 adults in each decade from the 20s through the 60s, and another 38 individuals between 70 and 88 years of age. The average years of education completed was 15.1 (SD = 2.5), and self-rated health averaged 2.1 (SD = 0.9) on a 5-point scale where 1 = excellent and 5 = poor. Correlations with age were .03 for both education and self-reported health, and -.07 with gender (coded 0 for male and 1 for female).

The subsample who performed the additional RT tasks consisted of 186 adults (mean age = 46 years, 61.3% females) who had complete data in the relevant tasks from the Salthouse, Fristoe, McGuthry, and Hambrick (in press) study. (A number of these individuals had missing data or low levels of performance in the primary task of interest in that study, and thus their data were not included in the other report.) There were 70 adults between 18 and 39 years of age, 73 between 40 and 59, and 43 between the ages of 60 and 83. The average years of education in the subsample was 14.9 (SD = 2.4), and self-rated health averaged 2.1 (SD = 0.9) on the 5-point scale. Correlations with age were .06 for education, .03 for self-rated health, and .03 with gender.

Procedure

Primary Reaction Time Tasks. The digit digit and digit symbol reaction time tasks were administered on computers. The stimulus displays in both tasks consisted of a code table at the top of the screen containing nine pairs of items, and a probe pair in the middle of the screen. The pairs of items in the digit symbol task consisted of digits and symbols, and thus the research participant had to refer to the code table to determine whether the items in the digit symbol probe pair were associated with one another. All items in the digit digit task consisted of digits, and thus the research participant merely had to decide whether the probe digits were physically identical. The instructions were that responses (i.e., the "/" key for same, and the "Z" key for different) should be made as rapidly and accurately as possible. The tasks were presented with 18 trials of practice on digit digit, 90 trials on digit digit, 18 trials of practice on digit symbol, two blocks of 90 trials each on digit symbol, followed by a final 90 trials on digit digit.

Cognitive Tasks

The cognitive tasks were administered with paper-and-pencil procedures. The vocabulary test consisted of 10 5-alternative multiple-choice synonym questions and 10 5-alternative multiple-choice antonym questions. A total of 5 min were allowed to complete both sections. Four perceptual speed tests were administered (i.e., pattern comparison, letter comparison, number matching, and pattern matching). Each involved an instruction page with several examples, and two test pages for which participants were allowed 30 sec each.

Items in the pattern comparison test consisted of pairs of patterns composed of three to nine line segments, and items in the letter comparison test consisted of pairs of three to nine letters. Approximately one-half of the pairs in each test page were identical, and one-half differed in the identity of a single element. Participants were instructed to write an "S" between the pairs that were the same, and to write a "D" between the pairs that were different, and to do so as rapidly and accurately as possible.

Items in the number matching and pattern matching tests consisted of a two-digit target number or target pattern on the left, and five alternative numbers or patterns on the right. The task was to circle the alternative on the right that matched the target on the left, and to do so as rapidly and accurately as possible.

The free recall test was based on the Rey Auditory Verbal Learning Test (Schmidt, 1996), and consisted of five study-test trials of a list of 15 words presented in the same order (i.e., drum, curtain, bell, coffee, school, parent, moon, garden, hat, farmer, nose, turkey, color, house, river). The words were read by the examiner at a rate of about one word every 2 sec, and 45 sec were allowed for written recall after each list. Each recall attempt was written on a separate page in a booklet.

The matrix reasoning test resembles the Raven's Progressive Matrices Test, and was initially developed as a computer-administered test (i.e., Salthouse, 1993b). Each item in the test contained a 3x3 matrix of geometric patterns with the lower right cell blank. Immediately below the matrix was a set of eight alternatives representing possible completions of the matrix. The task for the participant was to mark the best completion of the matrix from the set of alternatives. The test began with two practice problems with the answers provided, and then participants were allowed 10 min to complete as many of the problems as possible.

The cube assembly test was based on a test originally described by Shepard and Feng (1972). Items in the test consisted of displays of six connected squares which were to be assembled to form a cube. One of the squares was shaded to represent the base of the cube, and two of the squares contained arrows. The task for the participant was to decide whether the arrows would point at one another when the cube was assembled, and to indicate the decision by marking "Y" for yes, or "N" for no. Two illustrated practice problems preceded the test of 24 items, for which participants were allowed 10 min.

Additional Reaction Time Tasks

The additional reaction time tasks performed by 186 of the participants consisted of three pairs of tasks with the members of the pair having identical stimuli but different decision rules. Stimuli in each task consisted of either one or two digits presented in the middle of the computer display. The decision rules for the tasks were to press the key corresponding to the digit appearing on either the right (right task) or left (left task) of the display, press the "/" key if the digit was more than 5 and the "Z" key if it was less than 5 (more/less task) or press the "X" key if the digit was odd and the "." key if the digit was even (odd/even task), and press the digit corresponding to either the sum of (addition task) or the difference between (subtraction task) the two digits. The same digits were never repeated on successive trials, the digit 5 never appeared in the more/less and odd/even tasks, and all answers in the addition and subtraction tasks were between 1 and 9.

The three pairs of tasks were administered within a series of nine blocks of trials after the presentation of written instructions. The first two blocks within the series each consisted of 10 trials of practice with one of the two tasks. The next practice block consisted of 20 trials in another condition that is not relevant for the current purposes. If there were no questions following the practice trials, the sequence of experimental trials began. This consisted of 50 trials with one task (e.g., respond to the right digit), 50 trials with the other task (e.g., respond to the left digit), two blocks each of 100 trials in the other experimental

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The three pairs of tasks were administered within a series of nine blocks of trials after the presentation of written instructions. The first two blocks within the series each consisted of 10 trials of practice with one of the two tasks. The next practice block consisted of 20 trials in another condition that is not relevant for the current purposes. If there were no questions following the practice trials, the sequence of experimental trials began. This consisted of 50 trials with one task (e.g., respond to the right digit), 50 trials with the other task (e.g., respond to the left digit), two blocks each of 100 trials in the other experimental condition not relevant in the current context, 50 trials with the second task (e.g., respond to the left digit), and 50 trials with the first task (e.g., respond to the right digit). The right and left tasks were administered in the first series, the more/less and odd/even tasks in the second series, and the addition and subtraction tasks in the final series. In each series of tasks the participants were instructed to respond as rapidly and accurately as possible.

RESULTS

Digit Digit and Digit Symbol Tasks

Average accuracy in the digit digit and digit symbol RT tasks was 97.5% and 97.0%, respectively. Accuracy was significantly correlated with RT, -.21 for digit digit and -.16 for digit symbol, indicating that people with the highest accuracy also had the fastest RTs. However, because the average level of accuracy was very high it was ignored in subsequent analyses.

The two experimental blocks of 90 trials each within a given task were combined, and then the percentiles determined for each individual's distribution of 180 trials. Figure 1 portrays the mean RTs at each percentile as a function of age decade. Notice that there were steady increases in RTs from the fastest to the slowest percentiles, but that a similar pattern was evident for all age groups. The nearly parallel functions suggests that the absolute differences between age groups remained fairly constant from the individual's fastest RTs to his or her slowest RTs.

As is typically the case, inter-individual variability of the RTs increased with increases in the means. Table 1 contains the standard deviations and the ratios of standard deviations to means as a function of RT percentile. Notice that although the ratios increased only slightly from the 10^{th} through the 50^{th} percentiles, the increase was more substantial for later percentiles, and this was especially true for the digit digit task.

The correlations between age and RTs at successive percentiles in the two tasks are illustrated in Figure 2. It can be seen that the correlations decrease from the fastest to the

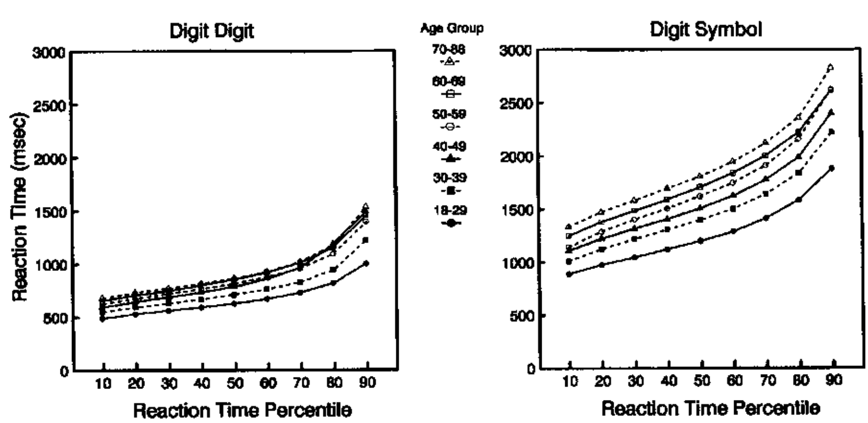

Figure 1. RT as a function of successive percentiles and age group

Table 1. Ratios of Standard Deviations to Means as a Function of RT Percentile

(N = 383)

	Digit Digit		Digit Symbol	
	SD	*SD/Mean*	*SD*	*SD/Mean*
RT Percentile				
10th	107	.18	269	.24
20th	122	.19	298	.24
30th	139	.20	329	.25
40th	161	.22	361	.25
50th	194	.25	392	.26
60th	250	.30	433	.27
70th	323	.35	498	.28
80th	597	.56	599	.30
90th	718	.53	843	.35

(N = 186)

	Right/Left		More/Odd		Add/Subtract	
	SD	*SD/Mean*	*SD*	*SD/Mean*	*SD*	*SD/Mean*
RT Percentile						
10th	169	.19	106	.19	173	.17
20th	168	.18	107	.18	198	.18
30th	172	.17	110	.17	227	.20
40th	188	.18	121	.18	261	.21
50th	205	.19	138	.19	305	.23
60th	227	.20	175	.22	344	.25
70th	258	.21	258	.29	412	.27
80th	311	.23	408	.38	512	.30
90th	493	.32	792	.54	719	.35

slowest percentiles, indicating that the age relations are actually somewhat weaker for an individual's slowest RTs. This decrease may seem surprising because Figure 1 indicates that absolute magnitudes of the age differences were at least as large in the slow percentiles as in the fast percentiles. However, Table 1 reveals that overall variability increased from the fastest to the slowest RTs, particularly for the digit digit task, and thus the decrease in the proportion of variance associated with age (or the square root of that proportion when referring to correlations) probably reflects nearly constant absolute differences representing smaller proportions of an increasing amount of total variance.

As a means of testing for independent influences at different RT percentiles, hierarchical regression analyses were carried out to control the 10th percentile RT when examining relations of age on the 50th percentile RTs, and to control the 50th percentile RT when examining relations of age on the 90th percentile RTs. The results of these analyses are summarized in the top portion of Table 2, where it can be seen that the only significant effects related to age were in the opposite direction of the zero-order effects. For example, increased age was associated with slower responses for the 10th percentile RTs, but after controlling the 50th percentile RTs, increased age was associated with faster responses for the 90th percentile RTs. This apparent reversal is likely attributable to an over-correction

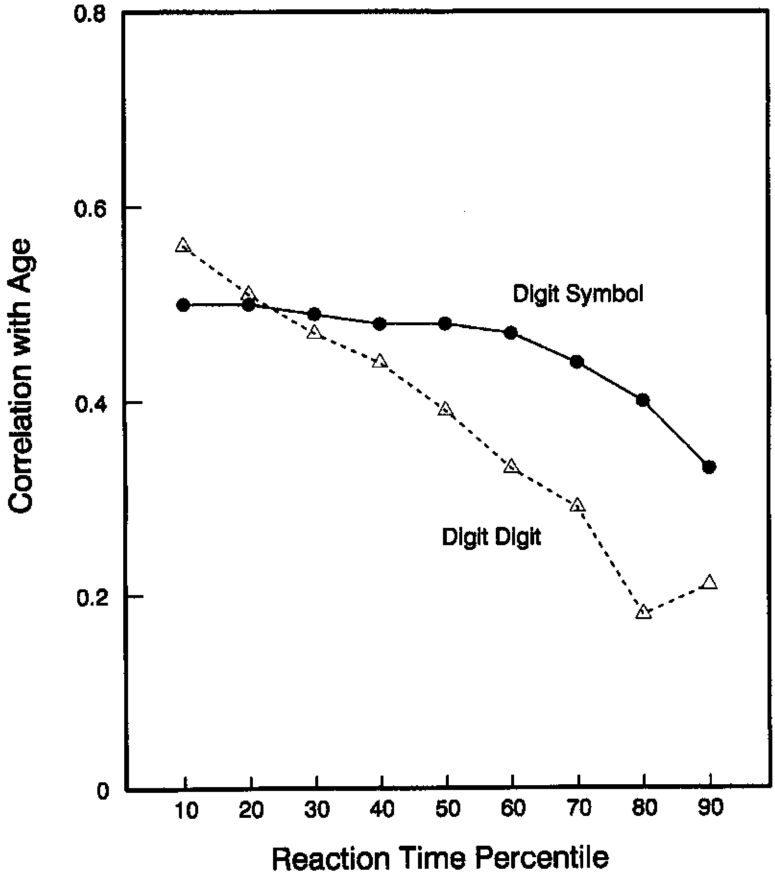

Figure 2. Correlations of age wit successive percentiles of the RT distribution for the digit digit and digit symbol tasks

of the age-related influences on the higher percentile RTs because it is apparent in Figure 2 that the age correlations decreased from the 50^{th} to the 90^{th} percentiles, and thus control of the stronger relation resulted in a change in the direction of the weaker relation.

Correlations were also computed across the two RT measures at each percentile. If relations to other variables are stronger at higher percentiles of an individual's RT distribution then the same pattern should also be evident in the relations among similar variables. However, as can be seen in Table 3, the correlations between the digit digit and digit symbol RTs after partialling age were highest in the middle percentiles. (The pattern in these and subsequent analyses was very similar with the raw correlations, albeit with generally larger values, but the age-partialled values are reported to minimize the influence of potentially spurious relations.)

Before analyzing relations of the RT percentiles to the cognitive variables composite measures were formed by averaging z-scores for the antonym and synonym vocabulary

Table 2. Standardized Regression Parameters from Hierarchical Regression Analysis on Different RT Percentiles

(N = 383)

	Digit Digit RT			*Digit Symbol RT*		
	10th	*50th*	*90th*	*10th*	*50th*	*90th*
Predictor						
Age	.56*			.50*		
10^{th}		.88*			.85*	
Age		-.09*			.05	
50^{th}			.81*			.94*
Age			-.11*			-.11*

(N = 186)

	Right/Left RT			*More/Odd RT*			*Add/Subtract RT*		
	10th	*50th*	*90th*	*10th*	*50th*	*90th*	*10th*	*50th*	*90th*
Age	.53*			.53*			.42*		
10^{th}		.69*			.64*			.95*	
Age		.20*			.14			-.12*	
50^{th}			.91*			.83*			.96*
Age			-.11			-.18*			-.17*

Table 3. Correlations After Partialling Age Between RTs from Different Tasks at the Same Percentiles

	(N = 383)	*(N = 186)*		
	Digit Digit Digit Symbol	*Right/Left More/Odd*	*Right/Left Add/Subtract*	*More/Odd Add/Subtract*
RT Percentile				
10^{th}	.59	.33	.58	.28
20^{th}	.65	.41	.63	.39
30^{th}	.68	.49	.71	.46
40^{th}	.71	.52	.71	.52
50^{th}	.70	.57	.69	.54
60^{th}	.66	.56	.68	.54
70^{th}	.63	.51	.68	.55
80^{th}	.47	.46	.67	.50
90^{th}	.55	.40	.63	.54

measures, and by averaging z-scores for the pattern comparison, letter comparison, pattern matching, and number matching measures. The age-partialled correlations with these and the other cognitive variables at each RT percentile are portrayed in Figure 3. Inspection of the figure reveals that there is no evidence of a systematic increase in the magnitude of the correlations when moving from the fastest RTs to the slowest RTs.

The final set of analyses conducted on the digit digit and digit symbol data examined the RT—cognitive correlations at different RT percentiles after control of the RTs from earlier percentiles. The purpose of these analyses was to determine whether the relations between an individual's slowest RTs and different cognitive variables were independent of

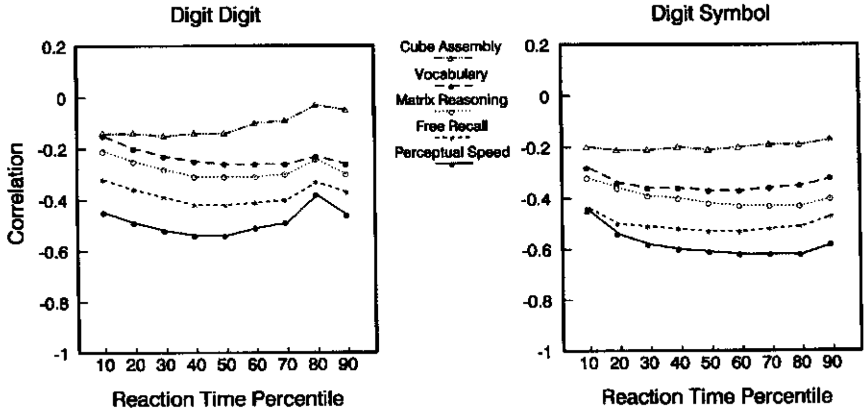

Figure 3. Correlations after partialling age between successive percentiles of the RT distribution and various cognitive measures

Table 4. Standardized Regression Parameters from Hierarchical Regression Analyses on Cognitive Variables

	Cognitive Variables				
	Vocab	*CubeAssm*	*Recall*	*MatReas*	*PSpd*
RT Percentile					
		Digit Digit RT (N = 383)			
10^{th}	.07	-.24*	-.46*	-.40*	-.62*
50^{th} after 10^{th}	-.46*	-.05	-.40*	-.30*	-.37*
90^{th} after 50^{th}	-.24*	.15	-.07	-.07	-.02
		Digit Symbol RT (N = 383)			
10^{th}	-.06	-.28*	-.54*	-.47*	-.60*
50^{th} after 10^{th}	-.40*	-.15	-.57*	-.56*	-.81*
90^{th} after 50^{th}	-.20	.10	.00	-.03	-.06
		Right/Left RT (N = 186)			
10^{th}	.03	-.18	-.50*	-.45*	-.60*
50^{th} after 10^{th}	-.25	-.26	-.52*	-.59*	-.84*
90^{th} after 50^{th}	-.29	-.04	-.05	-.13	-.11
		More/Odd RT (N = 186)			
10^{th}	.21*	-.24*	-.32*	-.32*	-.45*
50^{th} after 10^{th}	-.28*	-.18	-.70*	-.52*	-.76*
90^{th} after 50^{th}	-.37*	.04	-.15	-.11	-.02
		Add/Subtract RT (N = 186)			
10^{th}	-.16	-.20*	-.59*	-.51*	-.74*
50^{th} after 10^{th}	-.52*	-.23	-.37*	-.30*	-.25
90^{th} after 50^{th}	-.81*	-.09	-.14	.07	.20

Notes: Vocab = Vocabulary, CubeAssm = Cube Assembly, Recall = Free Recall, MatReas = Matrix Reasoning, and Pspd = Perceptual Speed.
*p<.01

his or her fastest RTs. Results of regression analyses predicting the cognitive variables from the 10th percentile RT, from the 50th percentile RT after partialling the 10th percentile RT, and from the 90th percentile RT after partialling the 50th percentile RT, are summarized in the top portion of Table 4. (Note that these regression analyses were based on the original data, and not on the age-partialled data as was the case for the correlations reported in Figure 3.) It can be seen that most of the relations were still significantly different from zero for the 50th percentile RT after controlling the 10th percentile RT, but they were not significant for the 90th percentile RT after controlling the 50th percentile RT. This asymmetry is likely attributable to the U-shaped pattern of correlations in Figure 3 in which the strongest relations were evident on the middle percentile RTs. That is, controlling a variable (10th percentile RT) with a weak relation does not account for all of the variance in a variable with a strong relation (50th percentile RT), but controlling a variable with a strong relation (50th percentile RT) does account for most of the variance in a variable with a weak relation (90th percentile RT).

The relations with the composite vocabulary measure are an exception to the pattern just described because there was no relation between vocabulary and the 10th percentile RTs, but a moderate negative relation emerged with the 50th percentile RT after control of the 10th percentile RT. This pattern seems to imply that the residual variance in the middle

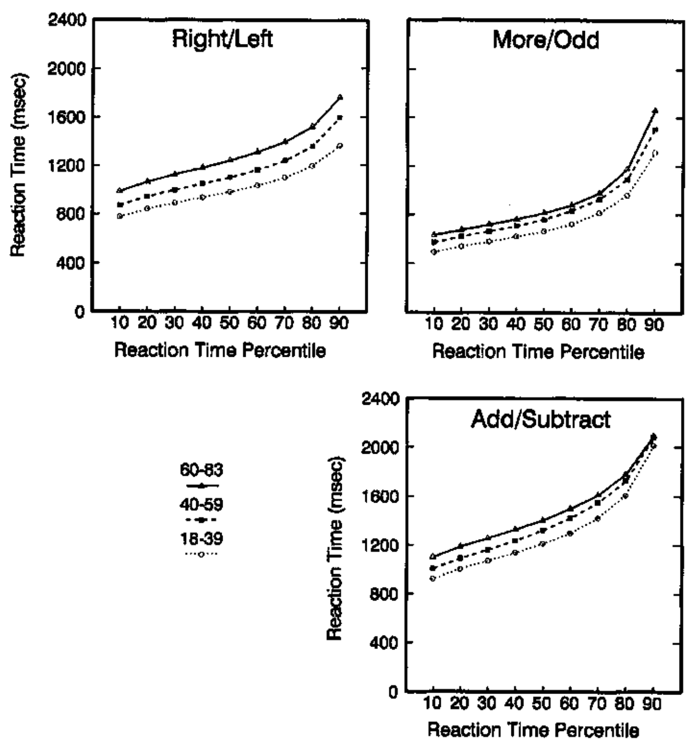

Figure 4. RT as a function of successive percentiles and age group in the three RT tasks performed by a subsample of participants

percentile RTs that was not shared with the faster RTs was negatively related to level of vocabulary, but it is not clear what that residual variance represents, nor why there was little overall relation between RT and vocabulary at any of the percentiles.

Additional RT Tasks

Each of the six RT tasks was administered in two blocks of 50 trials each. However, because the tasks were presented in pairs, and because the median RTs in the two members of each pair were highly correlated (i.e., .80 to .92), the trials within the pairs were combined to form three RT distributions of 200 trials each. As with the digit digit and digit symbol RT tasks, the correlations between RT and accuracy were small (i.e., -.22 to .14) and the average levels of accuracy were high (i.e., 93.6% to 97.2%), and thus accuracy was ignored in subsequent analyses.

Mean RTs at each percentile as a function of age group for the right/left, more/odd, and add/subtract RT tasks are portrayed in Figure 4. Like the digit digit and digit symbol tasks, the functions were nearly parallel across age groups.

The standard deviations and ratios of standard deviations to means across successive RT percentiles are presented in the bottom of Table 1. As was the case with the digit digit

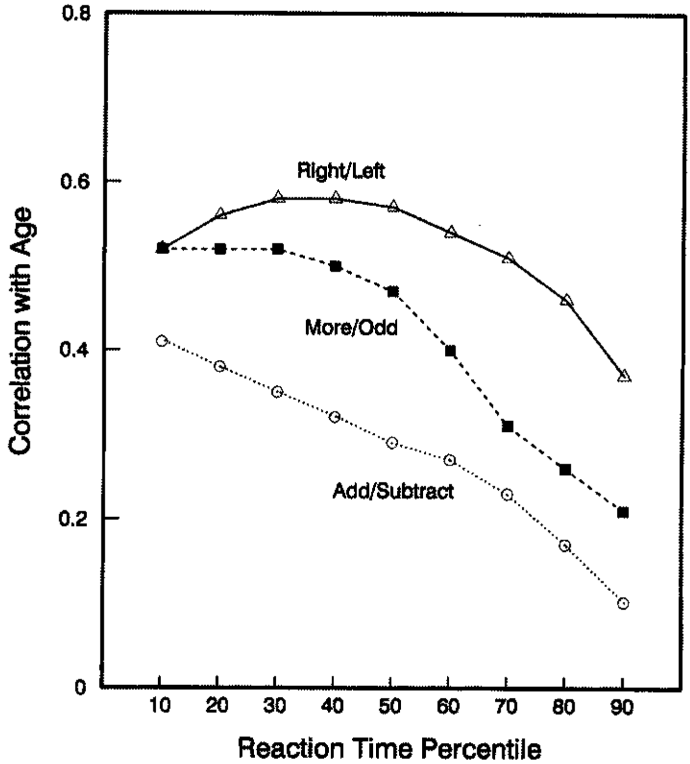

Figure 5. Correlations of age with successive percentiles of the RT distribution for the right/left, more/odd, and add/subtract tasks

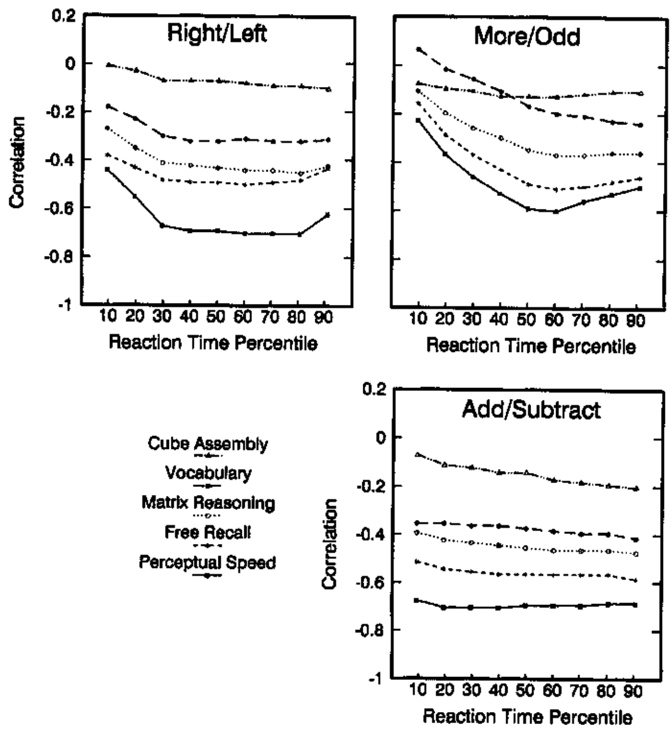

Figure 6. Correlations after partialling age between successive percentiles of the RT distribution and various cognitive measures for the three RT tasks performed by a subsample of participants

and digit symbol tasks, the variability increased only slightly to about the 50th percentile RT, with more substantial increases from the 50th to the 90th percentile RT.

Figure 5 contains correlations between age and successive RT percentiles for the three sets of tasks. The decrease in the correlations from the fastest to the slowest RT percentiles is similar to that in Figure 2. Once again, the increase in variability (cf. Table 1) combined with the nearly constant absolute age differences (cf. Figure 4) is probably responsible for this decrease.

The pattern of results with respect to independent age-related influences, summarized in Table 2, was also similar to that with the digit digit and digit symbol tasks. The increase followed by a decrease in the magnitude of the correlations between RTs at the same percentile from different tasks, summarized in Table 3, also paralleled findings from the previous tasks.

The age-partialled correlations between successive RT percentiles and the cognitive variables are illustrated in Figure 6. Once again the overall pattern closely resembles that from the digit digit and digit symbol tasks as the correlations are nearly constant from the fastest to the slowest percentile RTs. In the more/odd tasks most of the correlations become more negative when moving from the 10th to the 50th percentiles, but from that point on they remained fairly stable.

Finally, the results of the hierarchical regression analyses controlling RTs from earlier percentiles are summarized in Table 4. As in the digit digit and digit symbol tasks, there were some significant relations involving the 50^{th} percentile RTs after control of the 10^{th} percentile RTs, but generally not with the 90^{th} percentile RTs after control of the 50^{th} percentile RTs. Once again, the relations with vocabulary were an exception to this pattern.

Discussion

Contrary to two recent studies, but consistent with an earlier report by Salthouse (1993a), there were no stronger relations to cognitive variables or to age with the slowest RTs produced by individuals than with the fastest RTs or with RTs in the middle of the distribution. Because a generally similar pattern was evident in five different sets of RT tasks, the results can be considered fairly robust.

There are several methodological differences between this study and the earlier reports by Kranzler (1992) and Larson and Alderton (1990) which found support for the "worst performance rule" in which the RT-cognitive correlations were greatest for the slowest RTs. For example, both of the earlier studies used samples of young adults whereas the current sample consisted of adults from a wide age range. The reaction time tasks in the earlier studies may also have been somewhat simpler than those used in this study because the median RTs in those studies were quite a bit faster than the median RTs in the tasks of the current study, despite a greater number of trials in each task in the current study (i.e., 180 to 200 vs. 32 to 82 in the earlier studies). And finally, research participants received 18 or 20 trials of practice before the experimental trials in each of the tasks of the current study, whereas there was no mention of any practice trials in the Larson and Alderton (1990) study. Kranzler (1992) stated that participants in his study "were given as many practice trials as they desired before beginning testing (p. 257)," but neither the average number nor range of practice trials was reported. Unfortunately, it isn't clear which, if any, of these methodological differences might be responsible for the inconsistent pattern of results across studies.

Perhaps the most important implication of the current results is that all regions of the RT distribution appear to carry similar types of information with respect to individual differences in cognition. If RT distributions are really a consequence of the influence of different processes, then the lack of differential relations across successive percentiles suggests either that the same mixture of two processes contributes to each percentile, or that the different processes have nearly equivalent relations to cognitive variables. In either case, the current data raise questions about the usefulness of multi-process models of RT distributions in individual differences research because they suggest that the different regions of the RT distribution may be functionally equivalent with respect to the relations they have with other variables.

The relations between the cognitive variables and the fastest RTs were smaller than those for slower RTs for some tasks, but there was little difference between the 50^{th} percentile (median) and 90^{th} percentile RTs. This pattern suggests that results based on analyses of measures of central tendency (e.g., mean or median) are not misleading in individual difference research because there was no evidence of independent effects involving the slowest RTs after control of the median RTs. In other words, a single measure representing the middle of the RT distribution will probably be sufficient for most individual difference comparisons because it seems to capture the bulk of the systematic variance in reaction time that is associated with other variables.

The absolute magnitude of the age differences was slightly larger among the slowest responses produced by the individuals, but these responses were actually associated with smaller proportions of age-related variance than faster responses. This apparent paradox likely occurs because the total variance increases more from the fastest to the slowest RT percentiles than do the age-related differences, and thus when the overall variance is increasing a nearly constant absolute difference corresponds to a smaller proportion of the total variance.

To summarize, the results of these analyses are clearly inconsistent with Larson and Alderton's (1990) "worst performance rule." Not only were the relations to other cognitive variables nearly the same for the slowest (or worst) RTs produced by the individual as for faster RTs, but the relations with age were actually weaker for the slowest RTs than for faster RTs. Although task or procedural variations may be responsible for some of the inconsistency in results, it is important to note that similar patterns were apparent in each of the five sets of tasks in the current project.

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