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Choice Reaction Time and Visual Pathway Nerve Conduction Velocity Both Correlate With Intelligence but Appear Not to Correlate With Each Other: Implications for Information Processing

T. EDWARD REED
University of Toronto

ARTHUR R. JENSEN
University of California

Reed and Jensen (1992) studied 147 normal young adults and reported a significant positive correlation between nerve conduction velocity (NCV) in a brain nerve pathway (V:P100) and a measure of nonverbal IQ, in agreement with clinical studies. It was argued that V:P100 is a useful approximation to cortical NCV, should affect the speed of information processing (SIP), and so, should be a factor affecting IQ. In this article the choice and simple reaction times (CRT and SRT) and their differences, in the same subjects, were examined. Individual discriminative (Oddman) RT (ODRT) minus SRT (ODRT − SRT), which is the actual "cognitive time," correlated highest with IQ: $r = -.23$, $p = .005$.

CRT is also a measure of SIP so V:P100 and ODRT − SRT are expected to correlate with each other. In these 147 subjects, however, they cannot be shown to be correlated ($r = .044$, $p = .60$; absolute true value probably $< .20$). This suggests that (1) there are two largely independent neurophysiological processes affecting normal intelligence, and (2) the differences among normal subjects in CRT are not entirely due to differences in mean cortical NCV.

Recent electrophysiological data indicate that normal persons can have different patterns of neural connectivity among cortical regions during a visuomotor task requiring decision. Consequently, the simplest interpretation of the great ODRT − SRT variability observed among our subjects is that it reflects different total lengths of cortical pathway involved in the ODRT task, more intelligent subjects having shorter path lengths on average than less intelligent subjects. This interpretation can also explain the reported lower brain energy requirement of more intelligent persons for doing a specified mental task.

INTRODUCTION

Choice (or discriminative) reaction time (CRT) has been conclusively shown to be negatively correlated with intelligence in many studies over the last several

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Correspondence and requests for reprints should be sent to T.E. Reed, Department of Zoology, University of Toronto, Toronto, Ontario M5S 1A1, Canada.

decades (e.g., see reviews in Jensen, 1982, 1987, 1988; Vernon, 1987). This association is one of the best established correlates of intelligence.

Visual evoked potential (VEP) latencies, detected with scalp electrodes following a visual stimulus, have also been claimed to be negatively correlated with intelligence in many studies over this time period, but some studies did not confirm these claims. Major differences among these studies in subjects (e.g., in ages, sample sizes, normality or not) and techniques (e.g., in placement of electrodes, latencies—short, medium, or long—studied, type of stimulus) probably account for many of the differences among studies in their VEP latency–IQ correlation (reviewed in Callaway, 1975; Reed & Jensen, 1992). When a standard technique is used (reversing checkerboard pattern stimulation, electrodes over the primary visual cortex, studying only a short-latency VEP, i.e., the P100 peak at about 100 ms poststimulus), however, the picture becomes much clearer. Each of three clinical studies of patients with phenylketonuria (which causes severe mental retardation if untreated and may cause mild to minimal mental deficit if treated late or poorly) using this technique showed an increased P100 latency relative to age-matched controls (Creel & Buehler, 1982; Korinthenberg, Ullrich, & Füllenkemper, 1988; Landi et al., 1987).

Our study of 147 normal young adult students (Reed & Jensen, 1992), using these same techniques, extended these findings to the general population: On average, less intelligent subjects had longer P100 latencies, and vice versa ($r = -.212$, $p = .010$, two-tailed; see following paragraph for the higher correlation using nerve conduction velocity). Further support for VEP latency–IQ negative correlations comes from a review of earlier studies that also had visual cortex recording and defined subjects (normal vs. nonnormal, controlled ages), but used flash stimulation and long latencies ($>$ 120 ms). This review again shows that retarded or dull subjects have longer latencies than controls do (Reed & Jensen, 1992). It is now becoming clear that, when standard techniques are used with either short- or long-latency VEPs, lower intelligence is usually associated with longer VEP latencies, and vice versa. A similar evoked potential latency–IQ correlation also appears to hold for unexpected auditory stimuli producing the long-latency P3 (P300) peak (reviewed in Reed & Jensen, 1992), suggesting that latency–IQ correlations occur independently of sensory mode.

The parallelism between the negative CRT–IQ and VEP latency–IQ correlations is expected if both CRT and VEP latency are related to the speed of information processing (SIP) and, in turn, there is a correlation between SIP and IQ. It now seems probable that these relations do exist. The CRT–IQ correlation has long been thought to be mediated through SIP, faster (shorter) reaction times (RTs) indicating faster information processing which, on average, leads to higher intelligence levels, and vice versa (Galton, 1883; Jensen, 1982; Vernon, 1987). Brain nerve conduction velocity (NCV), or more exactly, mean cortical NCV, can be approximated by the NCV of the subcortical visual pathway (retina to thalamus to primary visual cortex) which, in turn, can be estimated from the

P100 latency; this NCV correlates more highly with IQ than P100 does ($r = +.256$, $p = .0017$, two-tailed; correcting for restriction of IQ range—but not for attenuation or test ceiling effect—gives $r = +.37$; Reed & Jensen, 1992). Mean cortical NCV has also been suggested as a factor affecting IQ level because increased values would, on average, increase SIP and consequently IQ, and vice versa (Reed, 1984, 1988a, 1988b; Reed & Jensen, 1992). Because cortical NCV cannot be measured noninvasively but visual pathway NCV (V:P100) can, the relation between CRT and V:P100, each a correlate of intelligence, should therefore be of interest.

In this article we examine this relation in the same 147 subjects described previously for P100 latency and V:P100. Contrary to initial expectation, we do not find a significant correlation between CRT and V:P100. The implication of this may be important for understanding human information processing as it suggests that there may be two largely independent neurophysiological mechanisms affecting intelligence levels in normal persons. We discuss these possibilities in the light of recent brain electrophysiological and neuroanatomical findings.

SUBJECTS AND METHODS

The subjects are the same as those studied and reported by Reed and Jensen (1992). The techniques are also the same as previously reported in detail for VEP and IQ testing (Reed & Jensen, 1991, 1992) and for RTs including choice and discriminative; Jensen & Reed, 1990; Reed & Jensen, 1991. We therefore present this information only briefly here.

Subjects

The subjects were students from three postsecondary educational institutions in the eastern San Francisco Bay region of California; 75 were from a university and 72 were from two community colleges (2 year institutions accepting any high school graduate). All were male, between 18 and 25 years of age, of European ancestry, and in apparent good health. Subjects using corrective glasses wore them during testing. Each gave his informed consent. The subjects were questioned on their handedness and visual acuity and were measured for height, weight, head length (using a cephalometer caliper in the saggital plane with the blunt tips at the glabella and opisthocranion; Olivier, 1969) and oral temperature (during P100 testing).

The university students were given the Raven's Advanced Progressive Matrices intelligence test (Raven, 1983a); the college students were given the Standard Progressive Matrices version (Raven, 1983b). These tests were given without time limit; most students took between 30 and 60 min. For comparability, the Raven scores were converted to equivalent Otis-Lennon IQ scores (general population, $M = 100$, $SD = 16$; Jensen, Saccuzzo, & Larson, 1988).

Methods

Visual Evoked Potential (VEP) Testing. Each subject was tested for P100 VEP latency, following standard clinical procedures (Chiappa, 1990; Lowitzsch, 1989) except that testing was done with both eyes open. The visual stimuli were black and white checkerboard patterns (squares 12.5 mm on a side, subtending a visual angle of 43′ at 1 m) reversing at 2 Hz. Four scalp electrodes were used, including one over the primary visual cortex (O_z), for measuring the P100 peak and its latency (Reed & Jensen, 1992). One hundred to 200 pattern reversals were given in each of two trials. The signal-averaged output was scored for P100 latency using an electronic cursor, including only well-defined peaks. The P100 values analyzed were means of the two trials.

Visual Pathway Nerve Conduction Velocities (NCVs). In order to calculate approximate NCVs for the visual pathway (optic nerve–optic tract–optic radiation) from the P100 latency, the length of this pathway was roughly approximated (see the following) by the subject's head length. This distance varied from 182 to 214 mm ($M = 199.9$, $SE = 0.51$) and was not correlated with IQ score ($r = .12$, $p = .16$). Dividing this distance by the P100 latency gives an approximate corresponding NCV, V:P100. As discussed by Reed and Jensen (1992), latencies between the retina and the primary visual cortex are almost entirely due to nerve conduction time because there are only three synapses in this path, and together they require fewer than 3 ms (of the ca. 100 ms) for signal transmission. It is, therefore, proper to speak of NCV for the visual pathway. The rationale for this estimation of visual pathway NCV is given by Reed and Jensen (1992). Briefly, although not an accurate measure of the true NCVs, these approximate estimates can still be used for *correlation* analysis because, among subjects, the measured head length should be closely proportional to the length of the actual visual pathway and the mean retinal processing time, about 50 ms, so a first approximation can be considered a constant that can be subtracted from the variable of interest (observed VEP latency) without greatly affecting the correlation.

Reaction Times (RTs)

Four RTs were determined in one test session using the Jensen test console (Jensen, 1985). This apparatus consists of a panel of eight button-lights arranged in a semicircle, each 15 cm from a "home" button below them. The subject keeps the home button depressed with the index finger of the preferred hand until one or more of the eight button-lights is lighted and then, as quickly as possible, removes the finger from the home button and presses the indicated button-light. The time from the light onset (stimulus) to removing the finger from the home button is the RT.

After practice sessions, the four RT tests, simple (SRT), choice-1 (CRT1), Oddman (ODRT), choice-2 (CRT2), were given in this sequence. Each RT test consists of 20 (SRT and CRT) or 36 (ODRT) presentations. For each presentation, a warning sound is given and, after an interval of 1 to 4 s, the light(s) come(s) on. For the SRT, the light can come on only in one position. For CRT, the light can come on at any one of the eight positions; it comes on in a different position in each trial. For the ODRT, three lights come on at the same time; the Oddman is more distant from the other two and is the one to be pressed. The next presentation has a different pattern; all possible light patterns, in random sequence, are presented. Presentations and scoring are controlled by a microcomputer. False responses are not scored, but such trials are repeated at the end of the series so that each subject has the same number of error-free responses. For each RT test, the value reported is the median (Jensen, 1985). For each subject, the differences between the ODRT and the mean of CRT1 and CRT2 (ODRT − CMRT), mean CRT and SRT (CMRT − SRT), and ODRT and SRT (ODRT − SRT) are calculated. As reported by Jensen and Reed (1990), this latter RT difference correlated more highly with IQ than did any of the original RTs. Here we examine these three RT differences along with the original RTs.

Statistical Analysis

Distributions of RTs, RT differences, IQ, and visual pathway NCV (V:P100), and their intercorrelations, are calculated. Stepwise regression of IQ on the other variables is performed. The distribution of ODRT − SRT of subjects in the lower IQ tercile (third) is compared with that of the upper IQ tercile. All *p* values reported are two-tailed.

RESULTS

P100 latency was not affected by handedness or the measured physical attributes.

The distributions of the four RTs, plus the mean of the two CRTs, is presented in Table 1. As expected, and as previously reported for somewhat larger samples from this project (Jensen & Reed, 1990; Reed & Jensen, 1991), the means increase from the SRT (267.6 ms) to CRTs (313.3 and 324.7 ms) to ODRT (455.1

TABLE 1
Distributions of Reaction Times (in ms)

	SRT	CRT 1	CRT 2	CMRT	ODRT
M	267.6	313.3	324.7	319.0	455.1
SE	2.3	2.8	3.1	2.8	5.0
SD	27.8	33.9	37.0	33.9	60.4
Minimum	207	240	244	251.0	312
Maximum	355	410	441	410.5	607
Coefficient of variation (%)[a]	10.4	10.8	11.4	10.6	13.3

[a] 100 × *SD*/*M*.

TABLE 2
Distributions of Reaction Time Differences, IQ, and Visual Pathway Nerve Conduction Velocity

	RT Differences (ms)				NCV (m/sec)
	ODRT − CMRT	CMRT − SRT	ODRT − SRT	IQ	V:P100
M	136.1	51.5	187.5	117.9	1.998
SE	3.7	2.0	4.7	0.9	0.007
SD	45.0	24.2	57.2	10.8	0.089
Minimum	15	9.5	25	87	1.75
Maximum	249.5	134.5	324	136	2.22
Coefficient of variation (%)[a]	33.1	47.0	30.5	9.2	4.5

[a] 100 × SD/M.

ms). Table 2 presents the distributions of the three RT differences, IQ, and V:P100. The high mean IQ (117.9) and its restricted range ($SD = 10.8$) of this student sample are as expected. Interindividual variability in RT differences is high, coefficients of variation (100 × SD/M) ranging from 31.5% to 47.0%.

The intercorrelations among IQ, RTs, RT differences, and V:P100 are shown in Table 3. The highest IQ correlation is with V:P100 (+.256, $p = .0017$); the second highest is with the RT difference (ODRT − SRT; −.229, $p = .005$). It is noteworthy here that *none* of the RTs or RT differences has a significant correlation with V:P100. In particular, the correlation between V:P100 and ODRT − SRT is .044 ($p = .60$). The four original RTs correlate among themselves but it is relevant to note here that the lowest of these correlations, +.341, is between the ODRT and SRT and is about half of the other RT correlations.

Stepwise regression of IQ on all the RTs, RT differences, and V:P100, with the probability for entering the regression set at $p = .01$ was performed. In Step 1, V:P100 was entered and in Step 2, ODRT − SRT was entered. The $p = .01$ limit for inclusion was then reached. This regression was significant at the $p = .0001$ level, $F(2, 144) = 10.12$, and the individual probabilities for V:P100 and ODRT − SRT were .0008 and .0025, respectively. The multiple R is .351, R^2 is .123, and the adjusted R^2 is .111. Correcting for the restricted IQ range but not for Raven ceiling effects or for attenuation (Reed & Jensen, 1992) raises R to .485.

Jensen (1987, 1992) has shown that *individual* standard deviations of RTs may correlate with IQ more highly than the RTs themselves. To test the importance of these standard deviations, the above IQ regression was repeated with the four RT standard deviations also included. As before, only V:P100 and ODRT − SRT were entered, in the same order. The remaining variables were nonsignificant at the .02 level. To examine the relations among V:P100, ODRT − SRT, and the remaining RTs and RT differences more closely, Table 4 shows the partial

TABLE 3
Correlations Among IQ, RTs, RT Differences, and V:P100

	Reaction Times					RT Differences			
	SRT	CRT1	CRT2	CMRT	ODRT	ODRT − CMRT	CMRT − SRT	ODRT − SRT	V:P100
IQ	.085	.009	−.090	−.045	−.177*	−.204*	−.161	−.227**	.256***
SRT		.707***	.651***	.709***	.341***	−.076	−.155	−.126	.028
CRT1			.827***	.952***	.617***	.111	.521***	.308***	.143
CRT2				.960***	.672***	.180*	.596***	.393***	.062
CMRT					.675***	.154	.587***	.369***	.105
ODRT						.832***	.555***	.890***	.051
ODRT − CMRT							.303***	.915***	−.007
CMRT − SRT								.661***	.116
ODRT − SRT									.044

*$p < .05$, two-tailed. **$p < .01$, two-tailed. ***$p < .002$, two-tailed.

TABLE 4
Partial Correlations Between IQ and RTs and Differences With V:P100 Only and With V:P100 and ODRT − SRT Partialed Out

	Correlations (*r*) With IQ			
	V:P100 Partialed Out		V:P100 and ODRT − SRT Partialed Out	
	r	*p*	*r*	*p*
SRT	.081	.33	.051	.54
CRT1	−.029	.73	.051	.54
CRT2	−.110	.19	−.014	.86
CMRT	−.075	.37	.018	.83
ODRT	−.198	.017	.051	.54
ODRT − CMRT	−.209	.011	.047	.58
CMRT − SRT	−.198	.017	−.047	.58
ODRT − SRT	−.248	.0025	—	—

correlations with IQ when only V:P100 is partialed out and when both V:P100 and ODRT − SRT are partialed out. The independence of V:P100 and ODRT − SRT is shown after the first partialing (the latter remains significantly correlated). The dependence of the remaining RTs and RT differences after the second partialing is also evident (all *r*s are nonsignificant).

Because the ODRT − SRT difference is the best RT predictor of IQ and has a direct functional interpretation as "cognitive time" (see Discussion), and it also seems largely independent of V:P100, its distribution was studied in more detail. The IQ distribution of the 147 students was divided into approximate terciles (thirds). This arbitrary division is convenient for comparing distribution extremes (first tercile vs. third) while still retaining most of the data. The lower tercile included those subjects with IQs lower than 112 ($n = 46$, $M = 104.9$) whereas the upper tercile included those with IQs higher than 123 ($n = 48$, $M = 129.6$). The distributions of ODRT − SRT for these terciles is shown in Figure 1. Each distribution is unimodal and roughly normal, thus excluding bi- or polymodality. The upper tercile is shifted somewhat to the left of the lower tercile, in agreement with its significantly lower mean (176.0 ± 8.14 (*SE*) vs. 201.1 ± 7.89 ms, $p = .029$). The range of values in each distribution is very wide, from less than 100 ms to 275 or more (for ungrouped values, Tercile 1 has 2 and 5, respectively, at these extremes; Tercile 3 has 3 and 2).

DISCUSSION

The main finding here is that the ODRT minus SRT difference, (ODRT − SRT), which has the highest RT correlation with IQ, and visual pathway NCV, V:P100,

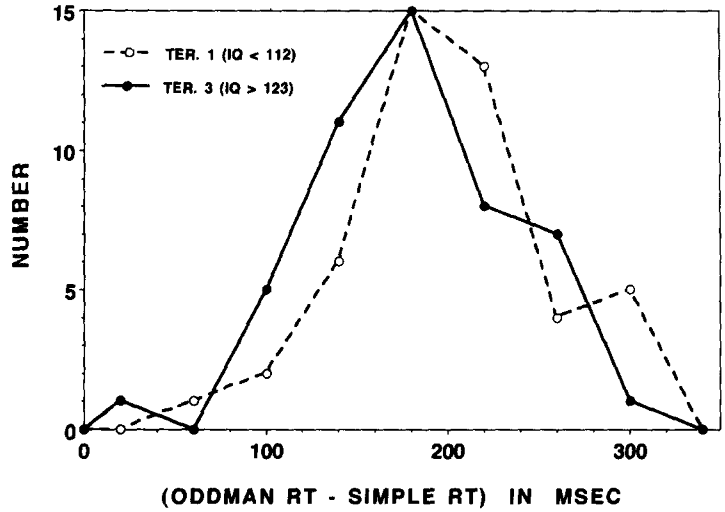

Figure 1. Distribution of (ODRT − SRT) for lower and upper IQ terciles (thirds): Lower IQ tercile, $n = 46$, IQ < 112, mean time = 201.1 ± 7.89 (*SE*) ms; Upper IQ tercile, $n = 48$, IQ > 123, mean time = 176.0 ± 8.14 (*SE*) ms.

which correlates even higher with IQ, cannot be shown to be correlated with each other in this sample of 147 subjects. Consequently, ODRT − SRT and V:P100 together explain more of the variation of IQ than either does alone. The multiple *R* for these two variables—uncorrected for IQ range restriction, attenuation, or test ceiling effects—is .35 whereas the simple *r*s are −.23 and +.26, respectively.

It may be noted here that Vernon and Mori (1992) reported significant correlations between *peripheral* (arm) nerve conduction velocity (PNCV) and intelligence and between PNCV and RT measures; both PNCV and RT contribute significantly to the prediction of IQ in multiple regression. In contrast, Reed and Jensen (1991) failed to find a significant correlation between PNCV (also in the arm) and IQ in a sample of 200 subjects. At present, there is no explanation for his difference in PNCV–IQ correlations. These PNCV correlations, however, are not important to our concern here with *brain* NCV correlations.

Because the failure to demonstrate correlation between ODRT − SRT and V:P100 in this moderate-sized sample is still compatible with a small true correlation, we explored the possible magnitude of such a correlation. First, note hat the relatively low ODRT − SRT to IQ correlation in this study is likely due o lower reliability of the IQ score as a consequence of the less than ideal assessment of intelligence (different Raven's tests for different subjects, conversion of Raven scores to Otis scores, IQ restriction of range, test ceiling effects) and not o the quality of the RT testing (see intercorrelations in Table 3; e.g., $r = +.827$ or CRT1 vs. CRT2). Like RT, the P:100 latency testing also appears to be reliable because the test–retest (several days later) correlation was +.801 (Reed & Jensen, 1992). Then, if the *true* (but unknown) ODRT to V:P100 correlation were −.20 and reliabilities for the ODRT and V:P100 are each .8, as suggested before, the expected correlation should be −.16. Using this value with the z transformation and a sample size of 147 gives a 95% confidence interval for this expected correlation of −.314 to +.002. But our observed ODRT to V:P100 r is +.051 and the ODRT − SRT to V:P100 r is +.044. The simple RT and both CRT correlations with V:P100 also exceed +.002. It therefore appears likely that the absolute values of the true ODRT to V:P100 and ODRT − SRT to V:P100 correlations are less than .20. On the other hand, a value of .10, say, cannot be excluded. Consequently, we can say that ODRT − SRT and V:P100 are largely uncorrelated with each other, the true (absolute value) correlation, with 95% probability, being less than .20. Each variable explains less than about 5% of the variance of the other.

ODRT − SRT is thought to be a good measure of the cognitive time (within the cerebral cortex) required for this discrimination task because the input time (for the visual stimulus to reach the primary visual cortex) of 75 to 100 ms (Reed & Jensen, 1992) and the output time (for the stimulus to go from the motor cortex to the finger tip) of about 20 ms (Reed, 1988b), is subtracted, leaving *only the time within the cortex* required for making the decision (Jensen & Reed, 1990). This cognitive time, like CRT, varies inversely with IQ.

V:P100 is thought to be correlated with the mean *cortical* NCV because most of the P100 latency occurs in the small diameter, slowly conducting nerve fibers of the optic radiation (thalamus to visual cortex) and these fibers are similar in origin, size, and NCV to cortical fibers (Reed & Jensen, 1992). Because, for a specified cortical pathway, cortical NCV, together with the time for synaptic transmission (unknown but probably of the same order of magnitude as conduction time; Reed, 1988b), determines the speed that information (as action potentials) is transmitted, cortical NCV should also help determine the speed of information processing and, consequently, IQ.

In consideration of these arguments, it was surprising that ODRT − SRT and V:P100 could not be shown to be correlated. *This immediately suggests two largely independent processes, one RT-linked and one NCV-linked and, furthermore, that RT differences among subjects are not due solely to subject differences in mean cortical NCV.*

Because the time required for the Oddman decision depends both on the mean cortical NCV and the total cortical distance over which the information for the decision travels, we examine what is known about this distance. This requires knowing which different regions of the cerebral cortex are required for decisions in the Oddman test. The main regions are already quite well known. The visual stimulus must first reach the primary visual cortex (Area 17 of the occipital cortex) and then go to the secondary visual cortices (Areas 18 and 19 of the occipital cortex) for further processing (Kandel & Schwartz, 1985, pp. 378–

382). The left prefrontal (association) cortex is known to be involved in cognitive behavior and motor planning (Kandel & Schwartz, 1985, p. 677). This cortex receives fibers from the secondary visual cortices and the parietal-temporal-occipital association cortex (Goldman-Rakic, 1988; Kandel & Schwartz, 1985, p. 676). Electrophysiological studies, using multiple scalp electrodes in a visuomotor task requiring decisions, clearly show these connections to the left prefrontal cortex (Gevins et al., 1989). Consequently, the information must go to this cortex and, then, in order to produce an output, must also go to the premotor and motor cortices. This motor connection is also known both neuroanatomically (Goldman-Rakic, 1987a, p. 396, 1987b) and electrophysiologically (Gevins et al., 1989).

In addition to the preceding "minimal" cortical pathways for the Oddman information and subsequent decision, there are less direct cortical pathways. Motor control information may also go from the prefrontal cortex to the motor cortex via the thalamus (Goldman-Rakic, 1987b). The detailed studies of Gevins et al. (1989, Figure 2A) also show that, for a visuomotor task requiring an accurate response with the preferred hand (as in the ODRT response), there are a number of additional activated pathways. More importantly, Gevins et al. found that their 7 subjects showed two *different* cortical connectivity patterns when using the preferred hand and two different patterns when using the nonpreferred hand. It seems at least possible, if not probable, that among a larger number of subjects, say 100, additional cortical connectivity patterns would be found.

As it is now known that normal subjects can and do vary in the cortical pathways needed for performing a visuomotor task requiring decisions, it seems likely that some of these paths will be longer than others and therefore, on average, would require a longer cognitive time. The great interindividual variability in cognitive time, approximated by the distribution of ODRT − SRT, and shown by its large coefficient of variation (c.v.) and broad distribution (Figure 1), may be evidence for such differences in cortical path lengths. The c.v. is 30.5% for ODRT − SRT but only 4.5% for V:P100, showing that this great variability in cognitive time is not due to variation in cortical NCV. Subjects having the same mean cortical NCV could still vary greatly in their cognitive times, and consequently, in their ODRTs. This possibility can then provide an explanation for our finding significant correlations of V:P100 and ODRT − SRT with IQ but not with each other: IQ should be higher when the speed of information processing increases and this increase can occur in either or both of two largely independent ways: (1) an increased cortical NCV, or (2) a shorter cortical pathway (and vice versa for lower IQ).

If, as the findings of Gevins et al. (1989) and this study suggest, normal subjects may have varying total lengths of cortical pathway when making correct visuomotor task decisions, an important corollary follows: In more intelligent subjects, the length of this cortical pathway is shorter on average; therefore, fewer neurons need to be activated and less energy is required to make this decision (and vice versa for less intelligent subjects). If this is correct, this neurophysiological scenario could explain the interesting results of Haier et al. (1988) which showed a negative correlation between normal subjects' Raven Scores and cortical metabolism as assessed by positron emission tomography. Haier et al. suggest that more intelligent persons may be more "efficient" in their cognition and so use less energy. Using a shorter cortical pathway to arrive at the correct answer might be the simplest way to be more efficient.

Further studies are required to confirm and extend these findings and interpretations, but it already seems clear that the normal variations in cortical connectivity found by Gevins et al. (1989)—a finding supported by the great interindividual variability in cognitive time shown in this study—offers a new approach to understanding variations in intelligence. The question of how and why such variations in connectivity in normal persons occur may become a major research area in the future.

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