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Znanstveni empirično-raziskovalni prispevek

The role of decision speed in the construct of intelligence

*Valentin Bucik**
University of Ljubljana, Department of psychology, Ljubljana, Slovenia

Abstract: A theory of general intelligence in Spearman's sense has been frequently verified via two complementary approaches, the one using psychometric and the other using experimental methodology. The results led to the conclusion that both, psychometric tests and elementary cognitive tasks in different experimental paradigms measure the same things in substantial extent. The rapid, error free information processing, reflecting the efficiency of a nervous system with limited capacity, was supposed to be the essential component of the intellect. This view is sometimes criticised by the authors who claim that high correlations between speed of information processing and psychometric intelligence is simply the consequence of the fact that some intelligence tests themselves are "speeded" and that mental speed is merely a marginal variable in both psychometric tests and elementary cognitive tasks. In our study we tested 88 participants with three psychometric tests, measuring general intelligence in Spearman's sense. Parallel versions of those tests were created by splitting each of them into two equivalent halves by "odd-even" principle. One version was applied under strict time constraints and the other one without time pressure. In addition five speed of information-processing paradigms were applied. The relationship between the mental speed and general intelligence, measured in timed and untimed conditions was examined. Results suggest that the role of speed of information processing is significant in determining general intelligence. Mental speed also seems to be relatively independent with regard to time limitations in intelligence testing. The results are discussed in terms of the neural efficiency presumptions.

Key words: cognitive processing speed, intelligence, testing, time constraint

Vloga hitrosti odločanja pri inteligentnosti

Valentin Bucik
Univerza v Ljubljani, Oddelek za psihologijo, Ljubljana

Povzetek: Teorija splošne inteligentnosti v Spearmanovem smislu je bila velikokrat potrjena s pomočjo dveh ključnih raziskovalnih pristopov v psihologiji, psihometričnega in eksperimentalnega. Na osnovi rezultatov je mogoče zaključiti, da tako psihometrični testi kot preproste kognitivne naloge v eksperimentalnih paradigmah v pomembnem deležu merijo isto komponento. Za hitro in natančno procesiranje informacij v možganih, ki odraža učinkovitost centralnega živčnega sistema z omejeno kapaciteto, se izkaže, da je ena ključnih komponent intelekta. Ta pogled je bil večkrat tarča kritike s strani avtorjev, ki trdijo, da je visoka soodvisnost med hitrostjo procesiranja informacij ter psihometrično inteligentnostjo le posledica dejstva, da je večina testov inteligentnosti sama „limitirana v času reševanja" in da je mentalna hitrost zgolj obstranska spremenljivka tako v psihometričnih testih kot v elementarnih

**Naslov / address: izr. prof. dr. Valentin Bucik, Univerza v Ljubljani, Oddelek za psihologijo, Aškerčeva 2, 1000 Ljubljana, Slovenija, e-mail: tine.bucik@ff.uni-lj.si*

eksperimentalnih kognitivnih nalogah. V študiji smo 88 udeležencev testirali na treh psihometričnih testih splošne inteligentnosti v Spearmanovem smislu. Vzporedne verzije teh testov so bile sestavljene tako, da smo vsak test razpolovili po načelu „par-nepar“. Z eno verzijo so bili udeleženci testirani pod močno časovno omejitvijo, z drugo pa brez časovne omejitve. Poleg tega smo na vseh udeležencih izmerili učinkovitost na petih paradigmah hitrosti procesiranja informacij. Nato smo preverili odnos med mentalno hitrostjo ter inteligentnostjo, merjeno v časovno omejenih in neomejenih okoliščinah. Rezultati kažejo, da je vloga hitrosti procesiranja informacij pri determiniranju rezultata na testu inteligentnosti pomembna. Mentalna hitrost se kaže kot tudi relativno neodvisna glede na časovne omejitve pri testiranju inteligentnosti. Rezultati so interpretirani z vidika predpostavk o učinkovitosti živčnega sistema.

Ključne besede: hitrost mentalnega procesiranja, inteligentnost, testiranje, časovna omejitev

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After about 20 years of research there is an impressive body of evidence suggesting a moderate but significant relationship between psychometric intelligence and speed of execution of elemental cognitive processes, i.e. more intelligent persons display a higher speed of information processing (SIP) in a variety of so-called elementary cognitive tasks (ECTs; see Neubauer, 1993, and Vernon, 1987b, for reviews). The proponents of this "mental speed" approach assume SIP to be the basis of individual differences in general intelligence or *g* (in Spearman's sense, 1927), i.e. mental speed as a latent trait should be located at the apex of the hierarchical system of intellectual abilities (Carroll, 1993a; Gustafsson, 1984, 1988; Jensen, 1991). In this view, mental speed or SIP is viewed as the expression of an inherited feature of the central nervous system, a mechanism with limited capacity (Jensen, 1991; Vernon, 1987a), which should also be responsible for the "positive manifold", i.e. the fact that even batteries of diverse intelligence tests always display positive intercorrelations (Jensen, 1986; Spearman, 1927). This view of the mental speed-IQ relationship was termed the "singularity of mind" view by Ceci (1990a, 1990b), when he proposed his contrasting "specificity of mind" view.

Namely, Ceci states that relationships between microlevel measures of processing efficiency (i.e. ECTs) and macrolevel measures of intelligence are only due to the - acquired and not inherited - sharing of a common knowledge base and gained skills and should be content-specific. On the basis of research evidence resumed/reviewed in Ceci (1990b) he concludes that "it is not unreasonable to suspect that the speed-of-information-processing-IQ correlation is due to individual differences in familiarity with written letters, numbers, and words and correlated differences in identifying them" (Ceci, 1990b, p. 169). Following this view, a verbal ECT should correlate only with verbal intelligence and the same should be true for numerical or visuo-spatial contents.

What does the available research evidence tell us about these two contrasting views? First, several authors have reported empirical evidence in support of the g-hypothesis: Hemmelgarn and Keehle (1984) were the first to report a significant correlation of -.80 between the *g*-loadings of the WISC-subtests and their correlations with the RT slope in the Hick paradigm, i.e. the higher the *g*-loading of a WISC-subtest the higher its (the subtest's) negative correlation with the SIP measure from the Hick paradigm (similar results have been reported by Larson, Merritt and Williams (1988) and by Smith and Stanley (1987)). Additional evidence comes from Vernon (1989) who not only calculated the *g*-loadings of psychometric intelligence tests (IQ*g*) but also from his batteries of ECTs (ECT*g*). The correlations between IQ*g* and ECT*g* ranged from -.26 to -.67 in five different samples. Therefore, all these studies provided evidence in favour of the "singularity of mind view" (contradictory evidence comes from only one study by Ruchalla, Schalt and Vogel (1985)). Indeed, there is large evidence on moderate but significant relationship between psychometric intelligence and the speed of execution of elementary cognitive processes. Therefore some authors assume that SIP is a basis of individual differences in general intelligence or *g* (Beaudacel & Kersting, 2002; Bors, Stokes, Forrin & Hodder, 1999; Bucik & Neubauer, 1996; Deary, 2000; Fink & Neubauer, 2001; Neubauer & Knorr, 1998; Roberts, Pallier & Goff, 1999; Roberts & Stankov, 1999; Shavinina, 2001; Stankov, 2000). Neubauer and Bucik (1996) clearly showed that there is no strong evidence of the "specificity of mind" hypothesis in the relationship between the structure of intelligence and the structure of ECTs in different modalities or contents. Also several studies considering the relationship between the mental speed and the development of cognitive capacities show the important role of fast and effective information processing (Caruso, Witkiewitz, Youngstrom & Glutting, 2001; Demetriou, Christou, Spanoudis & Platsidou, 2002; Fry & Hale, 2000; Weiler, Harris, Marcus, Bellinger, Kosslyn & Waber, 2000). Moreover, the results of some studies (Finkel & Pedersen, 2000; Neubauer, Spinath, Riemann, Borkenau & Angleitner, 2000; Spinath & Borkenau, 2000) explain the strong link between genetic factors and elementary cognitive processes, especially mental speed with intelligence as a covariat.

Nevertheless, serious arguments can still be found in the theoretical discussion about the SIP – intelligence relationship, mainly that the correlation between SIP and IQ measured in the psychometric tests of intelligence is merely a consequence of the fact that intelligence tests themselves are timed and the IQ results therefore reflect not only intelligence, but "reaction speed" as well (Carroll, 1991a; 1991b; Ceci, Nightingale & Baker, 1992; Sternberg, 1994). In addition, some critics claim that there is no evidence to support the causality hypothesis, where speed of processes underlies human intelligence (Sternberg, 1994). Fortunately these arguments can be empirically tested. Namely, there are two aspects of intellectual task performance: speed (time or rate of performance) and level (accuracy of response). A speeded test measures both, while an untimed test is a purer measure of level ability. It is reasonable to expect the correlation of mental speed would be higher with the "speed" than with the “power” tests (Carroll, 1993b). Some proposed theoretical models, tested by the linear structural relation analysis, can show the likeliness of possible causal relations.

Not many studies have been conducted to examine the problem of timed vs. untimed psychometric tests regarding their relationship with mental speed measured by experimental elementary cognitive paradigms (Vernon, 1983; Vernon, 1987a; Vernon, 1987b; Vernon, 1989). The results reflect the approximately equal correlations between mental speed and intelligence regardless time constraints in testing performance. Frearson and Eysenck (1986) reported the correlation of 0,95 between scores on Raven’s Advanced Progressive Matrices, obtained under three different time conditions (20 min., 40 min. and unlimited time to complete the test), which means that the time constraints did not influence the stability of the results at all. They concluded that the correlation between IQ and mental speed is not an artefact but the basic property of effective cognitive functioning, regardless the mode of the testing conditions.

The lack of valid and reliable results of contemporary studies examining the problems of timed and untimed psychological testing urged us to examine this relationship and test the hypothesis that the correlation between SIP and intelligence is artificially high because of the overlap of speed and level variances in psychometric tests. The problem of our study was first to check the convergence of SIP in different elementary cognitive tasks in order to establish the hierarchical structure of elementary cognitive processes, then to examine the degree in which this speed correlates with general intelligence and finally to answer the question whether SIP is related only to specific speed factor in intelligence tests or maybe its role can be comprehended as more general.

Method

Participants

88 psychology students from the University of Ljubljana (74 female, M_{age} = 20,36, *SD* = 1,50) participated in the study.

Instruments and procedures

Three different psychometric measures of general intelligence were used in the study. The first and the third of them were split into two parallel versions in a way that all the odd items were put into one version and all the even items into the other version: In the second test the parallel A and B versions were used.

- *Advanced Progressive Matrices* (Raven, 1999) with 12 items in Set I and 36 items in Set II. APM-T containing 24 even items was administered in a 13 min.

"timerestricted" condition, and APM-U containing 24 odd items was applied in a non-restricted condition.

- *Series Test* (Pogačnik & Bele Potočnik, 1983) is a good figural test of *g* in which a person must find a graphical sign which continues the series of signs. ST-T, version A of ST, with 45 items was administered in a 11 min. "timerestricted" condition, ST-U, version B of ST, with 45 items was administered without time restrictions.
- *The Foreign Words Knowledge Test* (FWKT; Krković & Kolesarić, 1970) is one of the general information tests. The test consists of 100 items; every item represents a foreign word - most often with a Greek or Latin root - and respondent may choose between five alternative domestic words of which only one represents a synonym to the foreign word. Different studies clearly showed relatively high correlations between FWKT and some tests of intelligence, especially those that are good measures of *g* (Krković & Kolesarić, 1970). FW-T containing 50 even items was administered in a 3,5 min. "timerestricted" condition, and FW-U containing 50 odd items was applied in a non-restricted condition.

For these tests the following variable names were used in the data analysis section: APM-T, APM-U, ST-T, ST-U, FW-T and FW-U for timed and untimed testing conditions.

Participants' mental speed abilities were assessed with five speed of information processing paradigms:

- Modified *Hick-Roth-Jensen "Reaction time" paradigm* (Bucik, 1993; Jensen, 1987) is a classical choice-reaction time paradigm, in which the participant is seated in front of a panel with 8 lights with a button beneath each and a so-called "home button". The participant starts the stimulus situation by pressing and holding down the home button with the forefinger of the dominant arm. At this moment a prearranged number of lights switch on. This is followed by an auditory warning signal and a pre-stimulus interval of a random duration between 1 and 2,5 sec. The stimulus is introduced by switching off one of the lights that are switched on. The participant must react as quickly as possible, but accurately, by moving a finger from the home button and pressing the button beneath the light that was switched off. The complexity of the task or the amount of information that needs to be processed (in bits) is determined by the number of lights that are switched on at the beginning of the stimulus situation as is shown in table 1.

  Ten blocks of five presentations of each condition (0, 1, 2 and 3 bits), i.e. 200 situations, were presented to participants. Different components of the reaction time can be calculated, including the time from the stimulus appearance to the lifting of the finger from home button (decision time) and the time from this

Table 1: Stimulus situations in the Hick-Roth-Jensen paradigm (in situations a, b and c there are randomly selected positions of the lights that are switched on as well as the light that is switched off).

	Stimulus conditions	Lights	**bits processed**
a)	1 of 8 lights illuminated (X) and 1 turns off (**X**)	O O **X** O O O O O	**0**
b)	2 of 8 lights illuminated (X) and 1 turns off (**X**)	X **X** O O O O O O	**1**
c)	4 of 8 lights illuminated (X) and 1 turns off (**X**)	O O O X **X** X X O	**2**
d)	8 of 8 lights illuminated (X) and 1 turns off (**X**)	X X X **X** X X X X	**3**

point to the moment of pressing the button beneath the light (movement time). The following variables of SIP were calculated on the basis of *RT* (where *RT* means the decision time, free of the movement time):

- *RTa* - Intercept of the regression line of *RT* on bits of information (in msec.);
- *RTb* - Slope of the regression line of *RT* on bits of information (in msec.);
- M_{RT} - Mean median *RT* of all trial conditions (0, 1, 2, 3 bits) (in msec.);
- SD_{RT} - Average *SD* of *RTs* over trials at each number of bits (in msec.).

- *"Odd-man-out" paradigm* (Frearson & Eysenck, 1986) is performed on the same console as the Hick-Roth-Jensen paradigm, but each time three lights are switch on simultaneously as the stimulus in the way that the distances between the switched-on lights are never equal. The participant must react as quickly as possible, but accurately, by moving the finger from the home button and pressing the button beneath the side light (left or right) that was switched on and is further from the central light (the "odd-man-out" light). Ten blocks of all 24 positions (240 situations) were presented to participants. The following parameters were extracted from the results:

  - *ORT* - mean median *RT* over all 24 displays (in msec.);
  - OSD_{RT} - mean range (maximal *RT* – minimal *RT*) of *RTs* over all 24 displays (in msec.);
  - OR_{RT} - mean *SD* of *RTs* over all 24 displays (in msec).

- *"Inspection time" paradigm* (Nettelbeck & Young, 1989, 1990; Vickers & Smith, 1986) tries to measure the SIP »at the input« i.e. when the participant senses the stimulus. Namely, a figure similar to Greek word PI is presented tachistoscopically on the computer screen for different but very short times (14-114 msec.). One vertical line, left or right is always longer (see Figure 1). In order to avoid after-images the »mask« (a thicker PI with equally long vertical lines) covers the stimulus immediately after the specified duration of

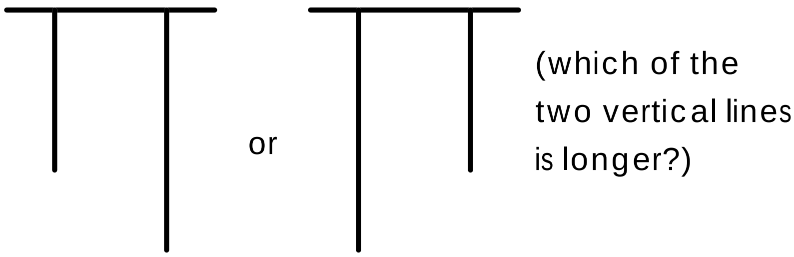

Figure 1: Two different stimuli in the Inspection time task.

stimulus presentation. The participant answers which line is longer by pressing left or right button on the special keyboard. It is not the speed of reaction or answering that counts but the accuracy of responses (the ratio of correct answers in different stimulus presentation times from 14 to 114 msec. It is reasonable to expect that the longer the duration of stimulus, the more accurate the response will be given by the participant.
The following parameters, showing the interpolated times where participant is giving the answer with certain accuracy, were evaluated:

- *IT85* - The interpolated time (in msec.) where participant responded with 85 % accuracy;
- *IT95* - The interpolated time (in msec.) where participant responded with 95 % accuracy;
- *IT975* - The interpolated time (in msec.) where participant responded with 97.5 % accuracy.

- *Lehrl-Fischer "KAI" paradigm* (Kurztest fur Allgemeine Intelligenz; Lehrl & Fischer, 1988) is a short test of speed of processing and the capacity of the Short Term Memory. First, participant must read aloud four sets of 25 not related letters as quickly as possible but without errors. The shortest time of four trials counts. In the next task he/she must recall the strings of unrelated letters and strings of numbers forward and backward. The average of the longest strings of letters and numbers forward and backward gives a capacity of immediate recall. The following variables were calculated from the data:

  - C_k - Speed of processing in bits/sec (100/shortest time of reading aloud);
  - T_R - Immediate recall (average longest string recalled);
  - K_K - The Short Term Memory capacity in bits ($C_k * T_R$).

- *The Lindley-Smith-Thomas "coding" paradigm* (Lindley, Bathurst, Smith & Wilson, 1993; Lindley, Smith & Thomas, 1988) is a SIP task, in which the time necessary for encoding the set of 120 signs (2/3 letters and 1/3 numbers) is measured. The participant is given rows of stimuli to work on (to write down signs in accordance to the stimulus signs, quite similarly to the Coding test in the Wechsler Scales) in three conditions: (a) Copy, or write the items as given (F for F, 8 for 8 ...); (b) Code Forward, or write the next number or letter in the series instead of the printed item (G for F, 9 for 8); and (c) Code Backward, or write the proceeding letter or number in the series instead of the printed item (E for F, 7 for 8). Each situation (copy, code forward and code backward) was performed three times in 60 sec, and the result for each is an average of the latter two whereas the first one is a training trial. Two parameters were evaluated from the data, where the results in the Copy condition were used to balance the performance of the participants for differences in clerical speed and accuracy.

- *CTF* - Coding time for 1 sign coded forward (60 sec/Code Forward)-(60 sec/Copy)
- *CTB* - Coding time for 1 sign coded backward (60 sec/Code Back ward)-(60 sec/Copy)

Results

Table 2 shows the initial results in psychometric measures of intelligence. They all express a substantial loading on the first unrotated factor extracted with the Principal Component analysis. We can call it the *g*-factor. Table 3 shows the initial statistics for the variables calculated in the SIP paradigms. It can be concluded that these are highly reliable measures with sufficient discriminability. Instead of the matrix of correlation between the psychometric measures of intelligence and SIP variables the graphic representation of the relationship is presented. Figure 2 shows the correlation between the SIP measures, explained in the previous section and psychometric meas-

Table 2: The initial statistics of psychometric measures of g (see text for the explanation of variable names).

	AM-T	AM-U	ST-T	ST-U	FW-T	*g* loadings	*M*	*SD*	*Min*	*Max*	Total
APM-T	-					.77	15.55	2.96	7	22	24
APM-U	**.90**	-				.81	18.92	2.98	10	24	24
ST-T	.48	.43	-			.70	33.44	4.08	24	45	45
ST-U	.43	.57	**.74**	-		.73	37.78	3.69	22	44	45
FW-T	.14	.20	.32	.16	-	.54	33.55	6.98	12	47	50
FW-U	.37	.28	.25	.29	**.84**	.62	40.36	4.66	26	49	50

Note:
- Correlations are corrected for restriction of range in intelligence
- Correlations between two versions of the same tests (boldfaced) are boosted by SB formula
- The "*g* loadings" column represents the first unrotated factor, extracted with the PC analysis

Table 3: The initial statistics of SIP measures (see text for the explanation of variable names).

Measure	*M*	*SD*	*Min*	*Max*	**Reliability**
Rta	279.31	36.83	190	406	.81[1]
RTb	46.94	15.49	20	78	.93[1]
MRT	334.03	44.31	243	455	.93[1]
SDRT	78.71	20.99	35	128	.76[1]
ORT	456.73	76.17	268	663	.96[1]
OSDRT	106.12	42.13	34	216	.83[1]
ORRT	283.43	95.61	100	649	.73[1]
IT85	58.35	22.34	27.05	125.79	.86[1]
IT95	83.56	31.83	35.73	159.46	.85[1]
IT975	96.61	37.50	45.43	207.25	.74[1]
C_k	23.86	3.39	16.39	32.26	.94[2]
T_R	6.43	.92	4.85	9.55	.86[2]
K_K	154.23	35.62	81.15	251.61	.92[2]
CTF	.51	.20	.18	1.26	.90[3]
CTB	1.30	.61	.48	3.78	.91[3]

[1] - Split-half (odd-even) - boosted by SB formula
[2] - Parallel versions (A and B) - boosted by SB formula
[3] - *r* between 2. and 3. attempt - boosted by SB formula

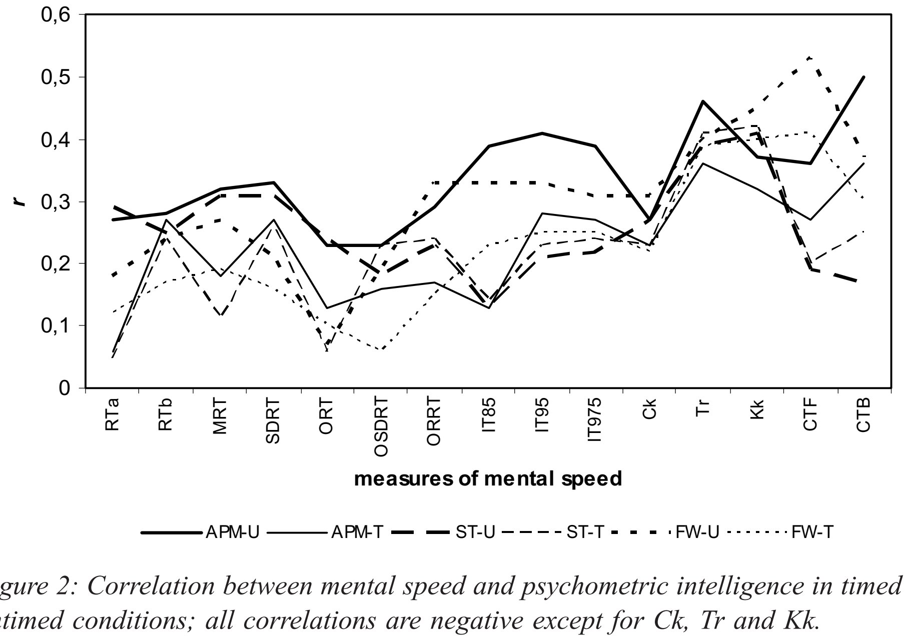

Figure 2: Correlation between mental speed and psychometric intelligence in timed and untimed conditions; all correlations are negative except for Ck, Tr and Kk.

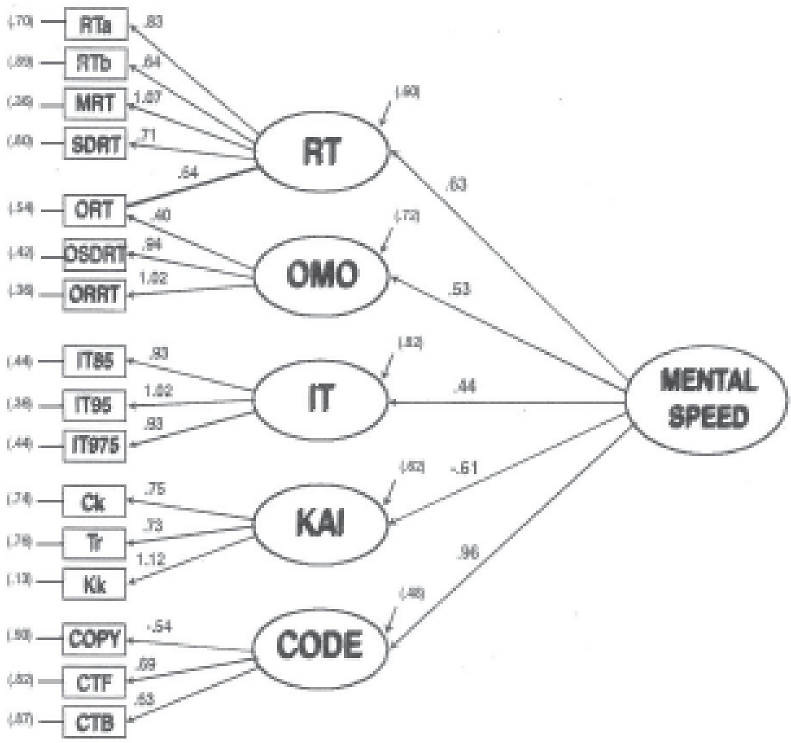

Figure 3: Convergent validation of five SIP paradigms (standardized solution, χ^2 *(df = 98) = 39,67;* χ^2/df *ratio = 0,40; AGFI = 0,93; RMSR = 0,11; NFI = 0,85; numbers in brackets are standard errors of measurement).*

ures of *g*. First, most correlations are in the “right” direction and statistically significant, and second, most of the SIP indicators correlate stronger with the untimed measures than with the timed measures of intelligence.

Then, the convergent validity of the SPI paradigms was established with the linear structural modelling (Du Toit & Du Toit, 2001; Jöreskog & Sörbom, 1993). All indices of fit (including χ^2/df ratio, which needs to be lower than 2, Adjusted Goodness-of-fit index (*AGFI*) and Normed fit index (*NFI*) which need to be as close to 1 as possible, and Root-mean-square-residual (*RMSR*), which needs to be close to zero; Bentler & Bonett, 1980; Bollen, 1989; Brown & Cudeck, 1989; Brown & Cudeck, 1992; Tucker & Lewis, 1973; see Figure 3) clearly show that the model is highly plausible and that different SIP paradigms in fact do measure the same feature, which can be called general (or *g*) mental speed. It is interesting that Coding paradigm seems to give the strongest and most reliable information on mental speed.

In the general model of relationship between the mental speed and the timed

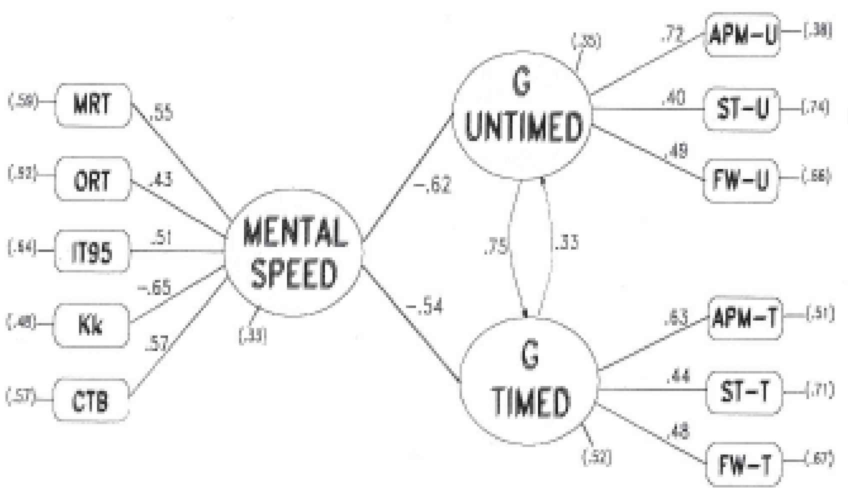

Figure 4: Mental speed and psychometric g under TIMED and UNTIMED conditions (standardized solution, χ^2 (df = 42) = 35,38; χ^2/df ratio = 0,84; AGFI = 0,89; RMSR = 0,13; NFI = 0,63; numbers in brackets are standard errors of measurement; for each paradigm only the variable with the highest loading was used).

and untimed measures of intelligence (Figure 4) it can be seen from the overall goodness-of-fit indices and from the particular standardized coefficients of the relationships that (a) mental speed explains a substantial portion of variance in psychometric intelligence (which is shown as standardized loading coefficients –0,54 and –0,62 in the model presented in Figure 4), (b) it is explaining more information in the relationship with the untimed than in timed measures of intelligence and (c) it is plausible to conclude that the mental speed factor plays an important role in determining the effectiveness of the participants in the psychometric tests of intelligence – it is expressed via confirmation of the causal model stating the influence of mental speed on psychometric intelligence. This is a rather clear evidence of support of the "singularity of mind" view (Ceci, 1990a, 1990b) as well as the hypothesis that the mental speed factor is not marginal in assessing intelligence via psychometric tests.

In order to answer the question of general strength of the relationship between the mental speed as an indicator of the efficiency of the nervous system and intelligence we also calculated the correlation between the composite scores of different SIP paradigms on one and different IQ measures on the other side. The composites were really the mean score of *z*-values of each participant in 15 SIP measures and the mean score of *z*-values of each participant in 6 IQ (half)tests. The correlation ($r_{(z\text{-speed},\ z\text{-IQ})}$) was –0,36 and was statistically significant bellow 1 % risk. We repeated this calculation with the factor scores for each participant on the first unrotated factor, extracted with the Principal components analysis of the 15 SIP measures and 6 (half)measures of intelligence. The correlation ($r_{(FSg\text{-}speed,\ FSg\text{-}IQ)}$) was –0,48 and was also statistically significant ($p < 0{,}01$).

Discussion

The hypothesis of a relationship between mental speed and psychometric intelligence has received strong empirical support in our study: a high speed of information processing in elementary cognitive tasks was associated with high psychometric intelligence. According to the level of convergence it is clear that different elementary cognitive tasks (ECTs) measure the same general latent construct, *g*ECT that could be named general mental speed factor or *g*-speed. High SIP in ECT is related to high intelligence measured by psychometric tests. This is evident also from the composite standardized and factor score correlations. These conclusions are in high accordance with the results of several other studies examining the mental speed-intelligence relationship (Beauducel & Brocke, 1993; Detterman, 1993; Draycott & Kline, 1994; Eysenck, 1987; Hemmelgarn & Kehle, 1984; Hormann & Thomas, 1989; Hunt, 1980; Hussy, 1989; Larson et al., 1988; Lehrl & Fischer, 1988; Levine, Preddy & Thorndike, 1987; Luciano, Wright, Smith, Geffen, Geffen & Martin, 2001; Martin & Zimprich, 2002; Neubauer & Knorr, 1998; Neubauer & Bucik, 1996; Neubauer et al., 2000; Roberts & Stankov, 1999; Salthouse, 2000; Spinath & Borkenau, 2000; Stelmack, Houlihan & McGarry-Roberts, 1993; Vernon, 1987b; Weiler et al., 2000).

It is more interesting and also important that we found higher correlation between SIP and psychometric intelligence, measured in untimed conditions. This fits the data in other available studies (Vernon, 1983; Vernon, 1987a; Vernon, 1987b; Vernon, 1989). It is possible that in a speeded condition when working on a power intelligence test the participant does not pay enough attention to focus on solving the complex and difficult item and that time demands distract him/her. This doesn't happen when working on speeded elementary cognitive tasks that are essentially not difficult. It can be seen in our results that obviously the correlation between the results in SIP paradigms and the results in intelligence tests is not merely a consequence of the fact that in both cases there is a specific speed factor because of the time limit constrains. It seems that mental speed goes well beyond that, perhaps on the field of the role of it in neural efficiency. There are some well known theoretical models, i.e. Eysenck-Furneaux model of comparator, Jensen's model of oscillator, Vernon's "neural efficiency" model, Vicker's model of accumulator or Frank-Lehrl-Fischer model of intelligence (see Vernon, 1987b, for review), which all agree in the claim, first, that human intellect is a neural mechanism with relatively limited capacity, and second, that intelligence is in essence an error free transmission of incoming information through the cortex. The individual differences in transmission are supposed to be caused mainly by the differences in mental speed, error checking and continuance (with mental speed as the only really cognitive variable) and should therefore result in the individual differences in general psychometric intelligence. The models presume that differences in psychometric intelligence and in mental speed depend on genotype and other biological sources, which predispose the structure, activity and capacity of the nervous system. If the neural mechanism with limited capacity has the ability to process information in a complex intelligence test item faster and more accurately, this will result in greater amount of processed information in a certain period of time and greater chance to solve the task before the system will block because of the informational overload resulting in failing to solve the task.

It follows that SIP plays an important and fundamental role in assessing general psychometric intelligence and that it is relatively independent of time limitations. This evidence support the "singularity of mind" view (Ceci, 1990a, 1990b) and is in accordance with the outcomes of other studies (Neubauer & Bucik, 1996). As such it seems to represent a basic efficiency of the central nervous system, which is also reflected in other, more complex cognitive tasks (e.g. psychometric tests of intelligence).

These results are preliminary and are based on relatively small sample and not very carefully chosen psychometric tests for measuring intelligence. The study deserves to be replicated in more controlled conditions regarding time constraints.

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