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Is Subnormal Cognitive Performance in Schizophrenia Due to Lack of Effort or to Cognitive Impairment?

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Abstract

Background: Several studies have reported globally impaired cognitive performance in schizophrenia. However, Gorissen et al. (2005) suggested that test performance may be distorted due to insufficient effort among many patients with schizophrenia. Here, we report on a replication study.
Objective: Two issues are addressed: a) What is the estimated prevalence of insufficient effort in schizophrenia? b) When only patients passing the effort tests are studied, what kind of impairment is found?
Methods: We tested n=70 inpatients diagnosed with schizophrenia according to DSM-IV-TR, 45 of them residents in a long-term care unit. Each patient volunteering for the study was asked to perform with the best of his/hers abilities. A comprehensive battery of psychological tests including the Word Memory Test (Green 2003) was administered. Suboptimal effort was defined as poor performance in the WMT.
Results: 26% of the patients failed the WMT effort measures. Insufficient effort was neither correlated with years of education, treatment with 1st or 2d generation antipsychotics, age at examination, age at illness onset, duration of illness, number of hospitalizations, nor severity of psychopathology (PANSS scores). Effort explained the largest share of variance in cognitive performance (partial η^2=0.41). Patients with sufficient effort showed deficits in psychomotor speed and executive functioning remained.
Conclusions: Cognition may not be globally impaired in schizophrenia, rather, performance below normal in most of the tests may be due to insufficient engagement. Since the patients studied here had no secondary motivation to perform below their true abilities, lack of effort may be considered as an original symptom of schizophrenia (German J Psychiatry 2014; 17(1): 1-9).

Keywords: effort; schizophrenia; cognition; WMT; PANSS

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Introduction

Pervasive cognitive impairment has been described as a core feature of schizophrenia. Individuals with schizophrenia perform poorly on measures of higher mental processes such as attention, memory, executive functioning and motor skills. Although less obvious than psychotic symptoms, cognitive impairment has considerable impact on coping with everyday life and reduces the prospects of occupational and social reintegration. According to a review by Heinrichs and Zakzanis (1998), involving 204 studies of cognitive performance in schizophrenic patients, 61%–78% of them were impaired in many cognitive domains. Palmer et al. (1997) have provided similar estimates. A recent meta-analysis by Schaefer et al. (2013) confirmed a global cognitive deficit: "Patients with schizophrenia scored significantly lower than controls across all cognitive tests and domains (grand mean effect size, g=-1.03)" with larger impairments in the domains of processing speed and episodic memory. Cognitive impairment has been described in first episode, neuroleptic-naive patients and seems to be stable over time (Albus et al. 2002, meta analyses by Szoeke et al. 2008 and Mesholam-Gately et al. 2009). Because cognitive impairment does not afflict every patient, Allen et al. (2003) have assumed that high premorbid cognitive capacities may buffer against the effects of the disease.

Alternatively, subnormal test performance does not necessarily indicate cognitive impairment, but may result from suboptimal effort. The effect of effort on performance in psychological tests has repeatedly been found larger than the effects of brain injury or neurological illness (Green et al. 2001, 2002; Green 2004; Green and Iverson 2001). The suboptimal effort hypothesis is in accordance with the opinion of Shiffrin and Schneider (1977) who proposed that cognitive deficits in schizophrenia are particularly prominent in tasks considered as "effortful", "attention-demanding" or "requiring controlled processes". Similarly, Nuechterlein and Dawson (1984) have observed that most of the cognitive deficits associated with schizophrenia concern effortful information processing, and others have endorsed this view (Brebion et al. 1997; Holthausen et al. 2003).

Gorissen et al. (2005) have studied the effect of effort on cognitive performance of patients with schizophrenia and found insufficient effort in 72% of the schizophrenia patients as compared to 25% of psychiatric controls. Effort was estimated with the Word Memory Test (WMT, Green 2003) and explained a third of the variance in the test performance. Also, effort measures correlated significantly with negative symptoms. The Word Memory Test presents as a verbal memory task, however, the first three subtests indicate effort rather than memory. (For a further description of the test, see below.) Other psychological effort tests exist, as well as physiological methods. E.g., pupillometry relies on the finding that tasks demanding cognitive effort are associated with pupillary dilation (Hyona et al. 1995). For patients with schizophrenia, a reduced pupillary response has been observed (Granholm et al. 2000, 2006; Minassian et al. 2004).

The current study evaluates the following hypotheses: (A) below standard performance in cognitive tests of patients with schizophrenia is largely explained by lack of effort; (B) in patients deploying sufficient effort performance is impaired in only a few cognitive domains. The study design is a cross-sectional assessment of inpatients with DSM-IV-TR (APA 2000) schizophrenia. Similar to the Gorissen et al. (2005) study the patients were not involved in litigation and there was no apparent gain from the assessment.

Methods

Participants

Seventy patients with schizophrenia according to DSM-IV-TR were examined. They were inpatients of either the psychiatric clinic Christophsbad, Göppingen (51 participants) or the Zentrum für Psychiatrie, Winnenden (19 participants). The patients were residents of the long-term care units (45/70) or referred for acute manifestation of psychosis (25/70). Of the latter group, 13 were first-episode patients. Inclusion criteria were a diagnosis of DSM-IV-TR schizophrenia; attendance to a school in Germany; the ability to understand and state informed consent; age between 18 and 51 years. Exclusion criteria were any other DSM-IV-TR axis I diagnosis, neurological illness, substantial traumatic brain injury or current medication with carbamazepine, anticholinergic drugs or benzodiazepines. Clinical information was obtained from the clinic's medical records. Recruitment occurred via the consultants treating the patients in the respective center. Patients willing to participate were then visited by K.S., who explained the study in detail and obtained informed consent. The study protocol has been approved by the local ethics committee. The descriptors of the sample are represented in Table 1 separately for patients passing and failing the WMT effort tests.

Instruments

All patients completed an extensive battery of psychological tests in one session. These were administered to each participant individually by K.S.

Effort. All patients were given the computerized Word Memory Test (WMT; Green 2003), which has repeatedly demonstrated its validity for diagnosing suboptimal effort (e.g., Gervais et al. 2004; Green et al. 1999, 2001; for a review of the test: Green et al. 2002; Wynkoop and Denney 2005) and was rated favorably in a comparison of different symptom validity tests (Hartmann 2002). On a computer screen, a list of 20 word pairs is presented twice to the patient. After this, the computer displays word pairs containing one of the previously presented words and a foil word. The participant is required to select the word that was part of the original list. Thus, a total of 40 test items are produced in the Immediate Recognition (IR) trial. After a delay of 30 minutes, the same test is repeated with different foil words for the Delayed Recognition (DR) trial. The third effort variable is consistency (CON), the number of words correctly recognized in IR and DR. The WMT is introduced to the participant as a verbal memory test though it is actually designed to measure test effort. The task is much easier than it appears and makes use of the floor effect: it cannot plausibly be failed unless there is a bona fide dementia or moderate or severe aphasia. According to the number of correct responses the participants' performance is classified on grounds of empirically derived cut-off values as FAIL (showing insufficient effort) or PASS (showing sufficient effort). Insufficient effort was defined using the criteria in the WMT test manual (Green 2003). A person failed if he scored below the cut-off (82.5% correct) on any of the three WMT effort measures.

Psychopathology. Two diagnostic interviews were administered: The Mini Diagnostic Interview for Psychiatric Disorders (Mini-DIPS; Margraf 1994) and the schizophrenia part of the Structured Clinical Interview of DSM-IV Axis I Disorders (SCID-I; Wittchen et al. 1997). Schizophrenic symptoms were assessed using the Positive and Negative Syndrome Scale (PANSS; Kay 1987). The scale yields the total score and scores for the categories: negative symptoms, positive symptoms and general psychopathology.

Cognition. Premorbid intelligence was estimated using the Wortschatztest (WST; Schmidt and Metzler 1992), a paper-and-pencil multiple-choice spot-the-word test. Assessment of

Table 1. Demographic data, current medication and psychopathology ratings of the whole sample and for the groups with normal (Pass) and insufficient effort (Fail)

		Whole sample				Pass		Fail	
		n	%	*M (SD)*	Range	*n*	%	*n*	%
Whole sample		70	100			53	74	17	26
Gender	male	47	67			32	60	15	88[a*]
	female	23	33			21	40	2	12
Neuroleptic treatment	1st generation	10	14			6	11	4	24
	2nd generation	33	47			27	51	6	35
	Both	27	39			20	38	7	41
						M (SD)		*M (SD)*	
Age				35.6 (9.3)	18-51	35.2 (9.2)		36.7 (9.9)	
Years of education				10.7 (1.9)	8-15	10.8 (1.9)		10.4 (1.8)	
Age at onset of illness				25.1 (8.7)	9-48	25.3 (9.5)		24.6 (6.0)	
Duration of illness (years)				10.7 (8.3)	0-30	10.1 (8.4)		12.3 (7.9)	
Hospitalizations				6.5 (8.8)	1-64	6.9 (9.8)		5.4 (4.6)	
PANSS scores						(*n*= 52)		(*n*=17)	
Positive symptoms				14.9 (5.5)	5-30	14.6 (5.6)		15.8 (5.2)	
Negative symptoms				15.6 (5.5)	7-32	15.3 (5.2)		16.7 (6.5)	
General psychopathology				30.8 (7.5)	18-49	30.2 (7.5)		32.8 (7.3)	
Total score				61.3 (16.1)	37-101	60.1 (16.1)		65.2(16.0)	

*p< 0.05
[a]= Pearson´s Chi-Square (χ^2), 1 *df*.

attention was done with the subtest "Sustained Attention" (SA) of the computerized Tests for Attentional Performance (TAP; Zimmermann and Fimm 1994). Verbal Memory was assessed with the subtests "Multiple Choice" (MC), "Paired Associates" (PA), "Free Recall" (FR) and "Long Delayed Free Recall" (LDFR) of the WMT. Visual memory was tested with the subtest "Visual Memory" (VM) of the Visual and Verbal Memory (Schellig and Schächtele 2001), a paper-and-pencil test. Executive functions were assessed with the Wisconsin Card Sorting Test (WCST-CV; Heaton 2004) and the Trail Making Test Part B (TMT-B; Reitan 1992). Working memory was assessed with the "Digit Span" (DS, a paper-and-pencil test) and the "Block Tapping" test (BT), subtests of the Wechsler Memory Scale-Revised (Wechsler 1987). Mental speed was measured using the Digit Symbol Substitution test (DSS, a paper-and-pencil test) (Tewes 1991), the Trail Making Test Part A (TMT-A; a paper-pencil test) (Reitan 1992) and the subtest "Alertness" (ALERT) of the Tests for Attentional Performance of the TAP.

Data analyses

Data were entered into a database and evaluated using SPSS® 14 (SPSS Inc, Chicago). Hypothesis a) was evaluated using a principal component analysis with oblimin rotation. Comparisons between groups were done with either parametric statistics (MANOVA and MANCOVA) or non-parametric Mann-Whitney U-tests. The dependent variables for test performance were entered as z-scores, derived from the normative tables. The between-subject factor was effort (FAIL, PASS). For the sustained attention there are currently no published age-corrected norms. Therefore, raw data (SA: means for the number of correct answers and mistakes) were entered. Years of education and age were covariates. All dependent variables passed tests for approximate normal distribution (Kolmogorov-Smirnov), except for TMT-A, TMT-B and WCST number of categories. Significance was assumed for $p < 0.05$.

Results

Prevalence of incomplete effort

Of the 70 patients, 53 (74%) were classified as PASS according to the effort measures of the WMT, and 17 (26%) as FAIL. Of the 13 first-episode patients, 4 failed. The likelihood of being classified as FAIL was not associated with the status (first episode vs. chronic), type of current neuroleptic medication (1st vs. 2nd generation or both) or years of education (chi-square tests). Female patients were less likely to fail the effort tests ($\chi^2 = 8.2$, df = 1, p=<0.05). The groups PASS and FAIL did not differ with respect to age at examination, duration of illness and PANNS scores (t-tests), neither with respect to number of hospitalizations and age at illness onset (Mann-Whitney U-tests). Spearman rank correlation coefficients revealed no significant associations between effort scores and demographic or clinical variables.

Table 2. Factor analysis

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Effort	**0.68**[a]	- 0.34	- 0.49	0.07	- 0.18
Education (years)	0.17	- 0.08	- 0.16	0.06	- 0.13
Duration of illness	- 0.24	0.15	0.23	**0.85**	- 0.16
PANSS-negative symptoms	- 0.09	0.18	0.07	- 0.10	**0.88**
Vocabulary	0.39	- 0.17	- 0.36	0.36	- 0.05
Trail Making - A	- 0.41	0.41	**0.89**	0.30	0.16
Alertness - simple RT[b]	- 0.33	**0.88**	0.29	0.20	0.31
Alertness - cued RT	- 0.24	**0.85**	0.16	0.24	0.32
Digit Symbol	**0.61**	- 0.55	- 0.54	- 0.05	- 0.14
Sustained Attention - RT	- 0.25	**0.74**	0.00	- 0.04	- 0.07
Sustained Attention - omissions	- 0.38	**0.68**	0.34	- 0.23	0.15
Sustained Attention - errors	- 0.25	- 0.01	**0.86**	0.03	0.00
Trail Making - B	- 0.48	**0.69**	**0.62**	0.27	0.29
Spatial Span	0.18	- 0.34	- 0.56	- 0.04	- 0.46
WCST - perseverative errors	- 0.51	0.19	**0.76**	0.40	0.41
WCST - categories	0.49	- 0.23	- 0.43	- 0.45	- 0.55
Visual Memory	0.57	- 0.25	- 0.35	- 0.17	- 0.48
WMT - Multiple Choice	**0.88**	- 0.23	- 0.39	- 0.09	0.01
WMT - Paired Associates	**0.91**	- 0.34	- 0.27	- 0.19	- 0.07
WMT - Free Recall	**0.90**	- 0.30	- 0.24	- 0.13	- 0.13
WMT - Long Delayed Free Recall	**0.87**	- 0.34	- 0.26	- 0.18	- 0.32

[a]Factor loadings >0.60 are printed bold; [b] reaction time.

Figure 1. A comparison of cognitive performance of patients who passed the effort test with those who failed. The symbols indicate average performance of the respective groups, the bars SEM. Fig. 1 includes only tests for which z-scores are available

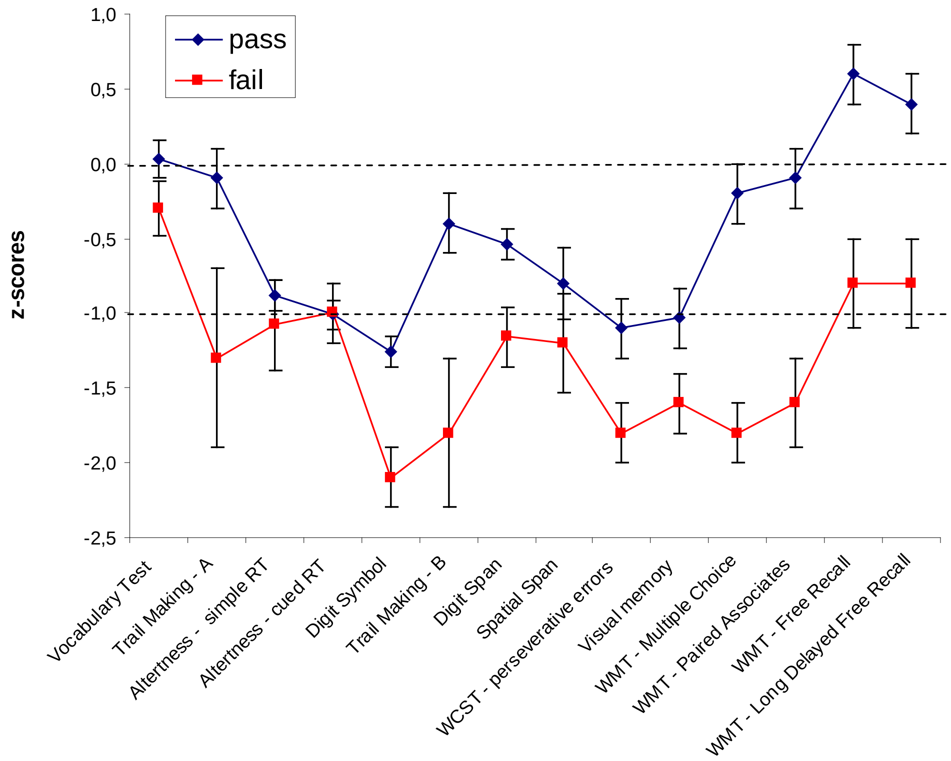

Table 3. Comparison of the on-test performance between the groups Pass and Fail

Tests	Pass		Fail		*F* (effort)
	M (SD)	*n*	*M (SD)*	*n*	
Trail Making – A	-0.1 (1.2)	53	-1.3 (2.5)	17	*F*(1,64)=10.5**
Alertness – simple RT[a]	-0.9 (1.0)	53	-1.1 (1.1)	17	*F*(1,64)=1.6
Alertness – cued RT	-1.0 (0.8)	53	-1.0 (1.0)	17	*F*(1,64)=0.3
Digit Symbol	-1.3 (0.9)	53	-2.1 (0.9)	17	*F*(1,64)=16.7**
Trail Making – B	-0.4 (1.5)	53	-1.8 (2.2)	17	*F*(1,64)=10.8**
Digit Span	-0.5 (0.9)	53	-1.2 (1.0)	17	*F*(1,64)=8.1**
Spatial Span	-0.8 (1.2)	53	-1.2 (1.1)	17	*F*(1,64)=1.8
Visual Memory	-1.0 (1.2)	53	-1.6 (0.9)	17	*F*(1,64)=4.5*
Sustained Attention – RT[d]	601.9 (126.8)	52	639.7 (190.1)	15	*F*(1,62)=1.2[b]
Sustained Attention – omissions[d]	13.8 (9.0)	52	19.5 (13.3)	15	*F*(1,62)=2.2[b]
Sustained Attention – errors[d]	7.5 (11.4)	52	14.4 (28.0)	15	*F*(1,62)=2.2[b]
WCST – categories[d]	3.41 (2.3)	51	2.31 (1.9)	16	*U*=300.5[c]
WCST – perseverative errors	-1.1 (1.5)	51	-1.8 (0.9)	16	*F*(1,61)=3.5
WMT – Multiple Choice	-0.2 (1.1)	53	-1.8 (1.0)	17	*F*(1,64)=28.4**
WMT – Paired Associates	-0.1 (1.2)	53	-1.6 (1.3)	17	*F*(1,64)= 21.2**
WMT – Free Recall	0.6 (1.2)	53	-0.8 (1.1)	17	*F*(1,64)= 20.5**

**p*< 0.05, ***p*< 0.01, [a]Reaction Time, [b]MANCOVA, [c] Mann Whitney U-Test, [d]raw-scores

Cognitive Performance and Effort

A factor analysis over all cognitive tests including WMT scores, demographic and clinical variables yielded a three-factor solution, explaining 55% of the total variance. The first factor explained 37% of the variance and was composed of the variables WMT effort (factor loading=0.68), the Digit Symbol Test (factor loading=0.61) and the memory indices of the WMT (WMT-MC, factor loading=0.88, WMT-PA, factor loading=0.91, WMT-FR, factor loading=0.90, and WMT-DFR, factor loading=0.87). Factor one may thus be conceptualized as a motivational factor. Factor 2 explained 9.5% of the variance and was characterized by five variables: Alertness reaction time (factor loading=0.88), Cued Alertness reaction time (factor loading=0.85), Sustained Attention reaction time (factor loading=0.74), TMT-B time (factor loading=0.69) and Sustained Attention omissions (factor loading=0.68). Factor 2 thus may represent a psychomotor speed factor. Factor 3 explained 9% of the variance, loading on TMT-A time (factor loading=0.89), Sustained Attention errors (factor loading=0.85), WCST-perseverative errors (factor loading=0.76) and TMT-B time (factor loading=0.62). This factor may be interpreted as executive functioning. However, WMT effort scores loaded prominently also on both factor 2 (factor loading=-0.34) and factor 3 (factor loading=-0.49). Contrary to intuition, duration of illness and PANSS negative symptom score showed only modest loadings on factors 1-3. The results show that effort explains the biggest part of variance in test performance of the schizophrenia patients. Table 2 represents the results of the principal component analysis.

We then compared cognitive performance of the groups FAIL and PASS. There was a significant main effect for effort on overall test performance (F11,54 =3,386, $p<0.01$, partial η^2=0.41). Post-hoc tests indicated significant effects of effort on TMT-A, TMT-B, DSS, DS, BS and on the memory subtests of the WMT (see Table 3). Vocabulary and Delayed Free Recall (DFR) performance were not included in the analysis because 14 subjects had ceased working on these tasks. There was no significant effect of effort on Alertness reaction time, Sustained Attention reaction time, Visual memory, WCST-perseverative errors and categories. Influence of the covariate age was significant only for Sustained Attention omission errors. Figure 1 shows standardized test performance (z-scores) for the groups FAIL and PASS.

The type of the association between cognitive performance and effort was explored by inspecting scatter plots, which suggested an unidirectional linear relationship. This may indicate that effort predicts performance but not vice versa. Spearman rank correlation coefficients revealed significant associations between effort and performance for all tests with the exception of Block Span, Cued Alertness reaction time and the Sustained Attention measures (Table 4).

Discussion

The main finding is that effort explains the largest share of variance in cognitive performance of patients with schizophrenia, and more than any other parameter related to course, severity of treatment of the disorder. Thus, hypothesis a) is confirmed by the data and in so far replicates and confirms the result of Gorissen et al. (2005). However, the estimated prevalence of insufficient effort in patients with schizophrenia was much lower (26%) than reported by Gorissen et al. (72%).

Insufficient effort was in both studies (Gorissen et al. and the present one) considerably more prevalent than has been reported in non-litigating healthy adults (0%), in non-litigating patients with neurological disease (0%: Green 2005; Merten et al. 2007; 10%: Gorissen et al. 2005), in bona fide patients with depression (0%: Rohling et al. 2002, Green 2005, Patton et al. 2004) and in non-litigating pain and rheumatoid arthritis patients (0%: Gervais et al. 2001b, Green 2005). It is, however, lower than in patients involved in litigation (30-80%: Mittenberg et al. 2002; Stevens et al. 2008; Green 2005; Gervais et

Table 4. Bivariate correlations of effort with cognitive tests

Test	Rho	*n*
Vocabulary	.34**	60
Trail Making – A	- .34**	70
Alertness - simple RT[a]	- .25**	70
Alertness - cued RT	- .10	70
Digit Symbol	.50**	70
Sustained Attention - RT	- .10	67
Sustained Attention - omissions	- .19	67
Sustained Atttention - errors	- .05	67
Trail Making – B	- .30*	70
Digit Span	.25*	70
Spatial span	.20	70
WCST - perseverative errors	- .44**	67
WCST - categories	.35**	67
Visual memory	.45**	70
WMT-Multiple Choice	.75**	70
WMT-Paired Associates	.67**	70
WMT-Free Recall	.59**	70
WMT-Delayed Free Recall	.58**	68

$^*p < 0.05$, $^{**}p < 0.01$, [a] reaction time

al. 2001a; Chafetz 2008). Among non-litigating psychiatric patients, only those with dementia showed comparably high failure rates in the WMT, which has been explained by very poor memory performance (Patton et al. 2004; Dean et al. 2009). Thus, insufficient effort may not be a common feature of psychiatric illness but seems specific for schizophrenia.

The observed rate of insufficient effort in the present study is considerably below the 72% reported by Gorissen et al. (2005). One explanation may be that the patients in the Gorissen et al. study were explicitly referred for evaluation of suspected cognitive deficits, thus a negative selection bias may have been present. Moreover, median duration of illness was 15 years in the Gorissen et al. study, but only 10 years in the present one. However, no correlation between the duration of illness and test performance has been observed in either study. In other respects, our study is quite similar to the Gorissen et al. report, because the same effort test (WMT) was used, education levels, age and gender distribution were similar. Current medication was not reported by Gorissen et al.. Mendella and Sandre (2008) described insufficient WMT effort in 19% of a sample of schizophrenia spectrum disorder patients, similar to our study. Severity of psychosis was moderate in the present sample with an average PANSS total score of 61. However, this is well within the range reported for therapeutic trials in chronic schizophrenia (Durham et al. 2005; Lieberman et al. 2005). Also, median age of onset was typical in our study with 23 years.

It is unclear what accounts for insufficient effort in schizophrenia. As described above, there was no significant association with any of the descriptors related to the illness. A type II error (overlooking a true effect) seems unlikely, because the study is powered enough to detect effects of medium size. Effort measures correlated with most of the cognitive tests, with a few exceptions: Alertness reaction time, Sustained Attention reaction time, Visual memory, WCST-perseverative errors and categories. Thus, some executive functions seem dissociable from test motivation, which is in agreement with Lezak's (1995) concept that volition, planning, purposive action and effective performance are different facets of goal-directed behavior. Contrary to expectation, lack of effort was not correlated to PANSS negative symptom scores. Also, negative symptom scores did not predict test performance as well as effort scores did.

One may contest the notion that WMT failure in schizophrenia signifies lack of effort and assert that failure in the WMT effort tests results from authentic memory impairment. Then, the failures would be "false positives". This assumption seems unlikely for several reasons. First, patients with severe dementia fail not only the validity tests of the WMT but also the more demanding subtests MC, PA and FR, which pattern allows to distinguish them from subjects with poor effort ("dementia profile", Patton et al., 2004, Green, 2006). Of note, those studies reporting false positives with the WMT employed only the validity, but not the memory subtests (Merten et al. 2007, Gorissen et al. 2005). Second, patients with complete loss of the hippocampus (Goodrich-Hunsaker & Hopkins 2009) and 8 year-old children with a verbal IQ below 68 have been shown to pass the WMT effort tests (Green and Flaro 2003), which is further evidence that the effort subtests are quite reliable until there is severe cognitive impairment. Third, the performance of the group FAIL in the real memory subtests of the WMT as well as the other cognitive tasks is quite above that expected in true dementia and the scores for the most difficult memory tasks (Free Recall and Delayed Free Recall) are even in the normal range. Thus, the risk of misclassifying bona fide performing patients seems low, provided that the entire WMT profile is considered.

The debate whether cognitive underperformance in schizophrenia is organic (true cognitive impairment) or motivational is by no means new. It has been raised by Watson et al. (1968) and the following passage is taken from Goldstein (1978, page 166): "The attentional-motivational model would be quite attractive if it could in fact be shown that the apparent thinking and perceptual disorders of the schizophrenic can be unequivocally attributed to failures of concentration or lack of appropriate test-taking motivation, while deficits affecting the brain-damaged patient can be unequivocally attributed to some structural CNS defect." However, the distinction between organic and motivational deficits seems artificial, because every behavior, including motivated behavior has a biological basis (Hare et al. 2008). The amount of effort invested into a task will depend upon the rewards expected. Of note, those brain areas involved in reward and goal-directed behavior, the striate and amygdaloid complex, the prefrontal brain areas and the ventral tegmental area (VTA) and the neurotransmitter dopamine have all been implicated in schizophrenia (Gold et al. 2008). Motivation may be intrinsic (the person enjoys to perform well), extrinsic (e.g. a prize is earned by performing well) or distorted (some reward is associated with a failed performance, such as compensation or exemption from work). The WMT, similar to other measures of effort, indicates only the level of effort deployed. It can neither indicate whether the motivational system and the neurotransmitters involved are intact nor does it allow any conclusions about the reward expected by the testee.

Another important issue is whether the WMT actually measures effort. There are several arguments supporting the view that it does. The WMT uses several techniques to estimate effort. One is the floor effect, which means that the effort subtests, which are by objective standards easy, cannot be plausibly failed unless there is either quite severe cognitive impairment or lack of effort. As already cited above, non-litigating psychiatric patients and mentally retarded children pass the effort tests. In addition, the WMT uses a profile analysis, comparing the performance in the easy effort subtests with the more difficult "true" memory tests. Patients with genuine memory impairment usually pass the effort subtests but show reduced performance in the memory tests (Green 2006, Brockhaus and Merten 2004, Green et al. 2002, Green and Flaro 2003, Goodrich-Hunsaker and Hopkins 2009). Another argument relies on the consistent correlation of WMT effort scores with performance in most psychological tests (Green 2006, Stevens et al. 2008, Rohling et al. 2002). Finally, studies examining healthy controls and non-litigating patients in a repeated measures design (instructing them to vary effort) have shown that a lowered effort level was associated with low scores on the WMT effort subtests as well as decreased performance in cognitive tests. Analyzing these arguments, Hartmann (2002) has concluded in his critical review that the WMT reliably measures effort.

Hypothesis b), assuming that patients who passed the effort test only a few cognitive impairments are found, was partly confirmed. Of the 54 patients who showed good effort 44 (81%) performed in at least one of the 14 cognitive test variables below the 1.0 S.D. limit indicating subnormal test performance. However, the likelihood of sub-normal achievement in at least one test rises with the number of tests taken. Therefore, a correction based on the number of tests and their empirically derived correlation (composite r=0.3) was applied (Crawford et al. 2007). Still the percentage of patients with abnormally low scores in at least one test was well above the 45% predicted by Bayes' theorem. Thus, even provided good effort, evidence remains for cognitive impairment in patients with schizophrenia. Moreover, inspection of Figure 1 shows that the cognitive profiles of the groups FAIL and PASS are similar. This suggests that there is common cognitive profile in both groups, distorted by insufficient effort in the group FAIL. In schizophrenia, verbal memory has been reported as most affected relative to other cognitive domains (Heckers 2002; Buchanan et al. 2005). In the present study, however, this applied only to the participants showing insufficient effort. In the group showing good effort, performance was impaired in WCST, Visual Memory and Digit Symbol Substitution. Thus, a genuine cognitive deficit involving functions associated with the prefrontal areas of the brain may be assumed.

There are several limitations to the study: First, the sample size (n=70) is small, which increases the risk of type II errors and reduces the reliability of the factor analysis. Certainly, a replication study will be required to show whether the factor solution is stable. Also, there was only one effort measure employed, while other tests, especially non-verbal tests may have added to the reliability of the findings.

In summary, insufficient effort seems to be more prevalent in schizophrenia than in other psychiatric and neurologic disorders. The underlying cause is unknown, since there was no association with either negative symptoms or executive performance in general. Lack of effort in schizophrenia may be conceptualized as a motivational deficit not well captured by the PANSS negative symptom score. It explains the largest share of variance in cognitive performance, however fails to account for the cognitive deficits entirely.

Tentatively, an evaluation of motivation and effort may be useful also in clinical settings: Similar to its impact on test-taking behavior motivational deficits may compromise treatments requiring active participation of the patient. Knowledge of motivational deficits could induce strategies how these, for example feelings insufficiency and irrelevance, could be overcome. Further studies could focus on the relationship between effort and long-term course.

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