What are the cognitive characteristics of poor learners?

Cognitive characteristics of poor learners distinguished by the dynamic WCST in a clinical sample of patients with acquired brain injury.

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Abstract

In this study learning potential (LP) of patients with acquired brain injury (ABI) was assessed using the dynamic Wisconsin Card Sorting Test (dWCST). Dynamic assessment, a method to determine the ability to improve by training, has been used frequently to asses LP in patients with schizophrenia or schizoaffective disorder. However, only one study assessed LP with the dWCST in patients with ABI. Since LP seems essential for rehabilitation, this study aimed to identify different levels of LP in patients with ABI (i.e, low; moderate; high) and to relate these to cognition. Expected was that level of LP had a positive relation with cognition, especially with memory. 54 inpatients with ABI at a rehabilitation centre were included and the dWCST was administered in a pre-test-training-post-test fashion. Results showed that different levels of LP can be identified in patients with ABI resulting in a low, moderate and high LP group. These groups differed in cognition, the low LP group showed a poorer performance on verbal memory and executive functioning in comparison to the high LP group.

Clinical message

Dynamic assessment like the dWCST could have implications for use in rehabilitation as an addition to the standard neuropsychological assessment, reflecting not only static measures but also the ability to learn by guidance. In this manner patients with low LP can be detected easily and provided with therapy programmes tailored to their specific learning capacities.

Keywords: Learning potential, Dynamic Assessment, WCST, Rehabilitation, Cognition, Acquired Brain Injury

Introduction

Each year, 60.511 people are affected by acquired brain injury (ABI) in the Netherlands (Hersenstichting, 2011). Many patients with ABI are referred to a rehabilitation centre. A primary criterion for referral to a rehabilitation centre is having sufficient learning potential (LP) (Versenso, 2012; Gresham et al, 1997). LP is important for referral since LP is identified as an important factor in the course and success of rehabilitation (Boosman, Visser-Meily, Winkens & van Heugten, 2011).

A method to assess LP is dynamic assessment. Dynamic assessment is designed to determine the current level of functioning and the ability to improve test performance by training (Griogorenko, & Sternberg, 1998). A commonly used test for dynamic assessment is the dynamic Wisconsin Card Sorting Test (dWCST) (Green, Satz, Ganzell & Vaclav, 1992; Hake, Hamera, & Rempfer, 2007; Wiedl, 1999). The dWCST consists of a pre-test followed by a training in which guidance is provided. Subsequently, a post-test, identical to the pre-test, is administered. LP can be assessed by comparing the scores on the pre-test and post-test. These scores can be categorized into different learner categories (e.g. high vs. moderate vs. low LP) or can be interpreted as a continuous variable using for example a gain score (Wiedl, 1999; Sergi, Kern, Mintz, & Green, 2005).

The dWCST has been used particularly to measure LP in patients with schizophrenia or schizoaffective disorder (Green et al., 1992; Wiedl, 1999; Vaskin et al., 2009). Some of these studies related LP to several aspects of the rehabilitation process. Wiedl (1999), for example, supported the idea that LP is a predictor of readiness for rehabilitation as measured by the performance on skills training. Another study reported that patients with high LP generally benefitted more of a vocational rehabilitation programme, showing for example, improved work-related learning and a better vocational integration than patients with low LP (Watzke, Brieger, Kuss, Schöttke, & Wiedl, 2008). In short, all these studies indicated that high LP has advantages over having low LP. In addition to this several studies indicated a relation between cognition and LP (Rempfer, Hamera, Brown, & Bothwell, 2006; Kurtz & Wexler, 2006). Both studies reported a positive relationship between LP and verbal memory. The latter study also showed that high LP is positively related with divided attention.

Although LP is assumed to be important for rehabilitation, there has been limited research on the association between LP and ABI. Only one study assessed LP using the dWCST in this group and assumed having higher learning potential predicts a better outcome, concerning social integration (leisure activities and socializing) following brain injury. Additionally, a positive relation between cognition (attention and working memory) and LP was found, meaning that patients with higher LP showed better attention and working memory performance than people with low LP (Uprichard, Kupshik, Pine, & Fletcher, 2009).

Multiple cognitive skills are required to learn. First, a positive relation between LP and memory is likely since the capacity to learn and remember new information is seen as an important criterion for the ability to learn in stroke rehabilitation (NIP, 2010). Moreover, to apply learned skills in a new situation intact executive functioning, such as flexibility is required (Van Heugten, van de Sande, Beers, 2006).

The aim of the current study was to explore if patients with ABI have different levels of LP (i.e., low, moderate and high LP) and if these levels correspond to cognitive characteristics.

Defining the cognitive characteristics underlying the LP group could give us more insight in the concept of LP and possible methods to increase LP. It is expected that ABI patients will have distinct levels of LP (high vs. moderate vs. low). These levels of LP are expected to have a positive relation with cognition with memory showing the strongest relationship.

Methods

Participants

In total, 54 inpatients with ABI at rehabilitation centre De Hoogstraat were included.

Inclusion criteria were the following; (1) 18 years or older, (2) sufficient mastery of the Dutch language, (3) written informed consent, (4) expected clinical hospitalization of at least 4 weeks, (5) no progressive or degenerative condition, (6) no pre-morbid psychiatric condition or substance abuse for which hospitalization was necessary, (7) no severe aphasia, (8) no active participation in another research project, (9) no reduced consciousness and (10) no post-traumatic amnesia .

The following personal characteristics are collected out of the patients' files: date of admission; date of the dWCST assessment; gender; age; marital status; education and type of brain injury. The Barthel Index for functional independence at admission and discharge was also collected for all patients.

The study has been approved by the medical ethics committee of the Utrecht University Medical Centre Utrecht and De Hoogstraat Rehabilitation centre.

Task and Stimuli

Learning potential assessment:

A dynamic version of The Wisconsin Card Sorting Test (WCST) as used in Wiedl (1999) was used. The dynamic version of the WCST included 3 phases.

Pre-test

During the pre-test, a baseline measurement following the standard WCST procedures (compromising 64 cards) was administered. Patients were asked to match 64 cards correctly to 4 target cards. There are three sorting rules namely colour, shape or number. Patients were not told which sorting rule to follow. When 10 consecutive cards were sorted correctly, the sorting rule changed from colour to shape, shape to number or from number to colour. By using feedback about the correctness of the match the patients were ought to unravel the sorting principles.

Training

During the training the sorting principles were fully explained to the patient. The training followed the protocol used by Wiedl (1999) translated into Dutch. At this point the patient was asked to complete the task again but with instruction of the sorting rules (i.e., colour, shape or number) and explanation of the nature of their errors ("That is wrong, we are not matching to the number of objects, we must be matching to colour or shape'') and correct responses (''That's right, we are matching to colour''). After the first correctly sorted card in a category patients were told that the sorting principle changed when they sorted ten consecutive cards correctly (e.g., "That's right we are matching to colour, when you sort 10 consecutive cards right the sorting principle will change to either shape or number").

Post-test

After the completion of the training the post-test started. In this phase the patient was asked once again to complete the task (i.e., match the 64 cards to the 4 key cards) and was only provided with feedback whether the match was correct or incorrect.

Neuropsychological tests

Cognitive tasks have been selected depending on the availability in patients' files. Because the cognitive screening was administered in clinical practice every screening was individually composed resulting in different neuropsychological tests per patient. For every cognitive domain a cognitive task was selected, tasks completed by more than 25 patients were included.

To measure verbal memory the Rey Auditory Verbal Learning Task (RAVLT; Rey, 1962) was used. During the RAVLT a list of 15 nouns was read aloud 5 times, after each time the patient was asked to recall as many words as possible. After 20 minutes the patient was asked again to recall as many words as possible. Subsequently, a list consisting of 30 nouns (including 15 distracters) was presented to assess delayed recognition. Furthermore a learning slope was computed using the number correctly recalled words of the first and 5th list using the following formula (List 5-List 1)/(15-List1). Outcome measures were: immediate recall, delayed recall, delayed recognition and learning slope.

To assess visuo-spatial construction the direct copy of the Rey-Osterrieth Complex figure (Osterrieth, 1944; Rey, 1941) was included. During this task the patient was asked to copy a complex figure.

The Trail Making Test A and B (Reitan, 1992) were included to measure psychomotor speed (Trails A) and cognitive flexibility (Trails B). In trails A the patient was asked to draw lines to connect subsequent numbers. In trails B the patient was required to connect alternating letters and numbers. In both conditions the patient was asked to complete the test as fast as possible and without lifting the pencil from the paper. The time in seconds needed to complete part A and part B were used as the outcome measures.

Digit Symbol-Coding of the WAIS-III (Wechsler, 1997) was included as a measure of psychomotor performance. During this test the patient received a piece of paper with 9 digit-symbol pairs, followed by a list of digits. The patient was required to write down the corresponding symbol under each digit as fast and accurate as possible. The outcome measure used was the total amount of correct responses within 120 seconds.

The Delis-Kaplan executive function system (D-KEFS) tower test (Delis, Kaplan, & Kramer, 2001) was used as a measure of planning. During the tower test the patient was required to move 5 coloured discs across 3 pegs to create a certain (given) combination using as least moves as possible. From all the cognitive tasks the raw scores were used.

Procedure

The patients were informed about the research project by their physiatrist. After one week, the patients were asked whether they would be willing to participate in the research project. If the patient decided to participate the protocol started.

The learning potential assessment took place at the rehabilitation centre and lasted about 50 minutes. The cognitive tasks were conducted by a psychological assistant.

Analyses

Learning potential on the dWCST was computed using the total number correct of the pre-test (T1) and post-test (T3). A gain score, as proposed by Weingartz, Wiedl & Watzke (2008), was used. This score calculated the gain of a person by dividing the actual gain by the potential gain following this formula; ((T3-

T1)/(64-T1)) with 1.00 displaying maximum gain and <0 displaying negative gain, resulting from a decreased performance on the post-test.

The gain scores were categorized in 3 LP categories namely (1) low LP, compromising gain scores lower than .33; (2) moderate LP, gain scores ranging from .33 to .66 and (3) high LP, with gain scores between .67 and 1. These values were chosen to create equal groups.

Descriptive statistics were provided for the low, moderate and high LP groups. These characteristics were checked for significant between-group differences using Chi-square or Kruskall-Wallis analysis. Since type of ABI and educational level could not be compared on the LP groups, the influence of these characteristics was checked on group-level using a Kruskall-Wallis analysis.

Since the data was not normally distributed, non-parametric tests were conducted to explore the relationship between the scores on the cognitive tasks and LP gain score groups. Kruskall-Wallis analyses have been conducted to explore between group differences. If significant post-hoc Mann-Whitney U tests have been conducted to further investigate the differences between the groups. A Bonferroni correction was applied to correct for type I error, the critical level of significance has been set at .015.

Results

Demographic and type of brain injury characteristics

In total 54 patients with ABI were included with an age ranging from 19 to 80 years old, the mean age was 52.2 years. 42.9% of the sample was male.

The type of injury was classified in 4 groups, see table 1, the *other* group consisted of a variety of diagnoses (i.e., out of hospital cardiac arrest, herpes encephalitis).

Time since diagnosis showed significant differences between the groups with the low LP group having had more time between the diagnosis and the LP assessment (X^2 (2) = 8.29, p = .016). The LP groups did not differ on age, gender, marital status and Barthel index, see table 1.

The groups could not be compared on type of ABI and educational level since the groups did not compromise enough patients per condition. However, the whole group was compared on type of ABI and educational level, no significant effects were detected (H(4) = 4,52, p = .341, respectively; H(4) = 4.40, p =.111).

Table 1. *Descriptive characteristics of the ABI sample and differences between categories.*

	Total Group (n = 54)	LP category			
		Low LP (n = 14)	Moderate LP (n = 13)	High LP (n = 27)	P
Age					
Median in years	52.2	58.0	50.0	55.0	.484b
Gender					
% Male	42.9	42.9	46.2	59.3	.544a
Educational level					
%Low	16.7	28.6	23.1	7.4	*
%Moderate	57.4	50.0	53.8	63.0	
%High	24.1	14.3	23.1	29.6	
% Missing	1.9	7.1	0	0	
Marital status					.293a
% Living with partner	53.7	64.3	46.2	51.9	
% Living alone	42.6	21.4	53.8	48.1	
% Missing	3.7	14.3	0	0	
Time since diagnosis[1]					
Median in days	51.5	82.0	49.0	49.0	.016b
Type of ABI					
% Ischemic Stroke	38.9	28.6	46.2	40.7	*
% Haemorrhagic stroke	13.0	28.6	7.7	7.4	
% Subarachnoid haemorrhage	3.7	7.1	7.7	0	
% Traumatic	25.9	14.3	23.1	33.3	
% Other	18.5	21.4	15.4	18.5	
Barthel Index					
Admission median[2]	18.0	18.0	17.0	20.0	.086b
Discharge median[3]	20.0	20.0	20.0	20.0	.215b

a. Chi-square Test. b .Kruskal Wallis Test. Significance was tested at p <.05 (two-tailed).

* sign. levels were tested for the whole sample, see text.

1). 6 missings (low lp, 1; moderate lp, 2; high lp, 3). 2). 11 missings (low lp, 5; moderate lp, 4; high lp, 2).

3).7 missings (low lp, 2; moderate lp, 3; high lp, 2).

Gain score

The gain scores of the patients were calculated with the formula as proposed by Weingartz, Wiedl & Watzke (2008). The gain scores ranged from -1.21 to 1.00 (Median .675) as visualized in Figure 1.

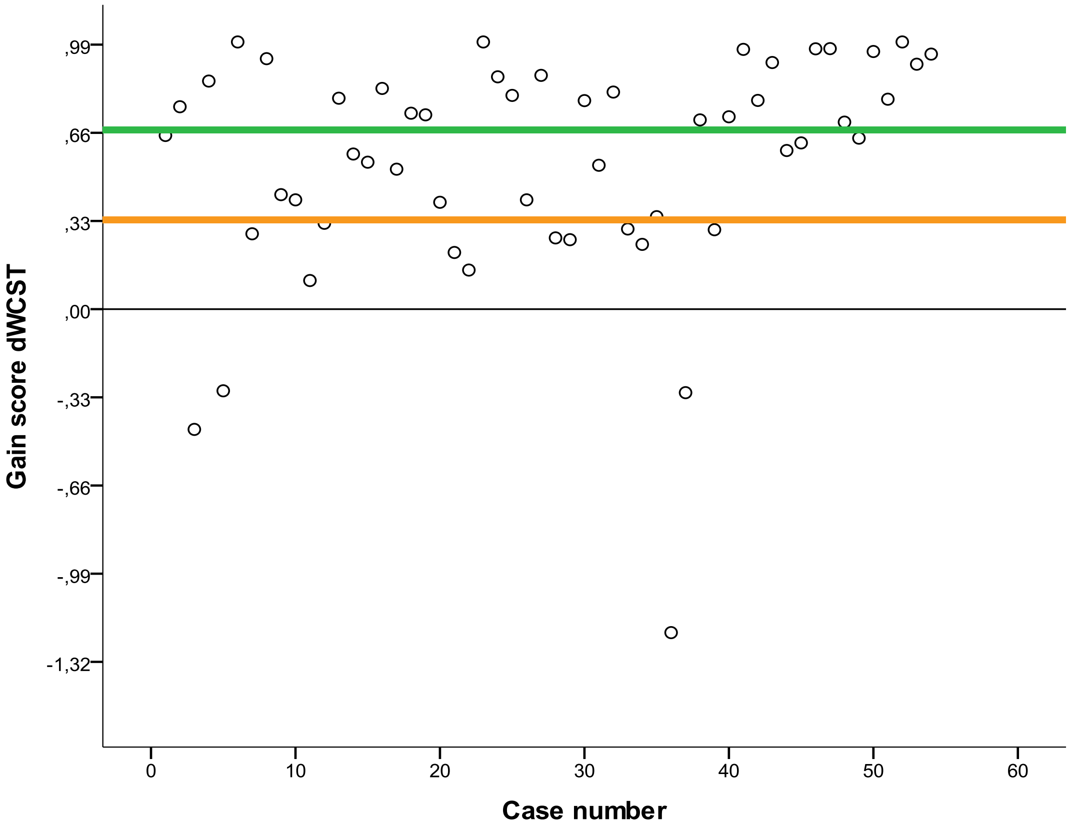

Figure 1. dWCST gain scores displayed per patient.

The displayed gain between pre- and post-test was significant for the whole group (T = 9, p = <.001). Per LP group there was significant gain in the high (T = 0, p = <.001) and moderate (T = 0, p = .001) LP group. But not in the low LP group (T = 41.5, p = .489). 4 patients showed a negative gain, thus did not benefit from the training.

Learning Potential Categories

The group division was justified since the LP groups differed significantly on degree of gain (H(2) = 44.74, p = <.001). The low LP group displayed significantly less gain (Median = .227) than the moderate (median = .538) and the high (median = .853) LP group (U = 0, p = <.001; U = 0.00, p = <.001). The high LP group also showed significantly more gain than the moderate group (U = 0, p = <.001).

Neuropsychological tests

Table 2 shows the neuropsychological test scores for the three LP groups.

The three LP groups differed significantly on the RAVLT immediate recall (H(2) = 9.04, p =.011) and learning slope (H(2) = 11.53, p =.003). The low LP group showed a significantly lower immediate recall compared to the high LP group (U = 50.00, p = .005) and a flatter learning slope than the moderate (U = 16.00, p = .004) and the high LP group (U = 35.05, p = .002). For the RAVLT delayed recall and recognition no significant between group differences were found (H(2) = 3.76, p =.152; H(2) = 2.68, p =.262).

On the TMTa time the three LP groups showed a significant difference (H(2) = 7.17, p = .028). The High LP group needed less time to complete the TMTa in comparison to the moderate LP group (U = 35.50, p = .009) no differences for LP group were found between the moderate and high LP group and between the low LP and high LP group (respectively; U = 39.50, p = 110; U = 50.00, p = 110).

The three LP groups also significantly affected the time needed on TMTb (H(2) = 13.13, p = .001). The high LP group needed less time to complete the TMTb in comparison to the low LP (U = 25.00, p = .009) or moderate LP group(U = 22.50, p = <.015) no differences were found between the moderate and low LP group (U =37.00, p = .790).

On the Figure of Rey, WAIS-III symbol digit coding and the D-KEFS Towertest no significant differences were found between the low, moderate and high LP group (respectively; H(2) = 3.69 p = .158; H(2) =1.34, p = .512 ; H(2) = 1.84, p = .398).

Table 2. Neuropsychological performance categorized per LP group.

	LP category						Between-group differences			
	Low LP (1)		Moderate LP (2)		High LP (3)					
							1,2,3a	1,2b	2,3b	1,3b
Neuropsychological tests	N	Median	N	Median	N	Median	P	P	P	P
RAVLT										
Immediate Recall	11	24.00	12	34.50	23	39.00	.011**	.131	.105	.005**
Delayed Recall	11	4.00	12	6.00	23	7.00	.152	-	-	-
Recognition	11	27.00	12	25.00	23	28.00	.262	-	-	-
Learning slope	10	.23	12	.42	23	.40	.003**	.004**	.590	.002**
Figure of Rey copy	9	32.00	9	33.00	18	34.00	.158	-	-	-
Trail Making Test										
TMT-A	9	56.00	10	62.50	18	36.50	.028*	.653	.009**	.110
TMT-B	8	160.00	10	150.00	18	77.50	.001**	.790	.001**	.009**
WAIS-III Digit Symbol Coding	6	46.50	7	50.00	13	59.00	.512	-	-	-
D-Kefs towertest	6	14.00	8	13.00	16	17.00	.398	-	-	-

a Kruskal Wallis Test . b Mann-Whitney U Test. * = significant at .05 level (two-tailed) ** = significant at .015 level (two-tailed)

Discussion

The present study aimed to explore if patients with ABI have different levels of LP (i.e., low, moderate and high) and to reveal the corresponding cognitive characteristics in patients with ABI. Three different LP groups (low; moderate; high) were defined and compared on several neuropsychological measures. The low LP group displayed poorer verbal short-term memory, a flatter learning slope and poorer mental flexibility in comparison to the high LP group.

The division in 3 LP groups based on dWCST performance is in line with Uprichard et al., (2009). Although this study used a different method to distinguish 3 learner groups, the LP groups distribution can be somewhat compared to our LP groups. The groups in the former study were equally distributed, in contrast to our LP groups in which the high LP group compromised more patients than the low and moderate group. A possible explanation could be sought in the nature of the sample and the different method to categorise LP. In our sample all participants were inpatients. In Uprichard's sample not all participants were inpatients in a rehabilitation centre, this might have affected the time since injury. In addition to this, the difference in categorisation method could have led to different groups. Although differences in group distribution were found, our 3 LP groups differed significantly on degree of gain, justifying our group division.

Concerning neuropsychological characteristics, our results nicely agree with earlier findings on mental flexibility. With the low LP group displaying poorer performance, as reported by Uprichard (2009). However, concerning verbal memory they reported no significant differences, but the low LP group did show poorer performance than expected. An explanation for the relation with verbal memory could be sought in the nature of the instructions, whereas these are verbal. Therefore the relationship between verbal memory and LP seems plausible.

The difference in steepness of the learning slope between the low LP group and the high LP group is in agreement with Lezak's idea (2004, p. 428) that the presence of a learning slope demonstrates some ability to learn, whereby the difference in the steepness might reflect the speed of learning. The high LP group showed a steeper learning slope than the low LP group and more immediate recall and mental flexibility.

The test scores for the low LP group were not significantly lower on planning, psychomotor abilities, visuo-spatial construction, long-term memory and recognition compared to the high LP group. Uprichard also showed no significant differences between the LP groups on long-term memory, the other domains were not included in their study. However, taking in consideration that understanding and remembering the verbal instruction is a prerequisite for better performance it seems plausible that planning, psychomotor ability, delayed recognition and visuo-spatial construction are not directly related to showing more or less LP.

Nevertheless, the high and moderate LP group showed significant gain, implying that these patients have been correctly referred to rehabilitation. The patients from the low LP group did not benefit significantly from the training, an explanation for this could be found in mental or physical condition (i.e. motivation or fatigue). These factors could be controlled in future research.

Several limitations of the study should be mentioned. First, since a neuropsychological screening was not a part of the study the neuropsychological tests had to be collected out of the patients files, resulting in no consistent screening with at least 2 tests per cognitive domain per patient. Second, various methods have been used in literature ranging from categorization based on an algorithm to gain-scores. There is no consensus about the best possible method and the comparability of these LP measure. In our sample the gain-score method was chosen because of its capacity to display LP per individual, this method could be easily applied in current clinical practice.

Future research may provide data concerning rehabilitation outcome to investigate if patients with higher LP do have a better rehabilitation outcome than patients with low LP. Secondly, future research could be directed towards the comparison of different LP tasks to validate if LP measured with for example the dWCST can be generally applied, or is only applicable to executive functioning.

In conclusion, the current study showed that different levels of LP can be identified in patients with ABI. The degree of LP reflects a difference in cognition with low LP leading to poorer performance on verbal memory and executive functioning in comparison to high LP. Learning potential assessment like the dWCST can possibly be used in rehabilitation additional to the standard neuropsychological assessment, reflecting not only static measures but also the ability to learn by guidance.

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References

Boosman H., Visser-Meily, J. M. A., Winkens, I., & van Heugten C. M. (2011). The why, what and how of learning ability in brain injury rehabilitation: a clinicians view. *Nederlands Tijdschrift voor Revalidatiegeneeskunde 33* (5), 38.

Delis, D., Kaplan, E. & Kramer, J. (2001). *Delis–Kaplan Executive Function System*, San Antonio, TX : The Psychological Corporation, Harcourt Brace & Co.

Green, M. F., Satz, P., Ganzell, S. & Vaclav, J. F. (1992). Wisconsin Card Sorting Test Performance in Schizophrenia: Remediation of a Stubborn Deficit. *American Journal of Psychology, 149*, 62-67.

Gresham G. E., Alexander, D., Bishop D. S., Giuliani, C., Goldberg, G., Holland, A., Kelly-Hayes, M., Linn, R. T., Stason, W. B., & Trombly, C. A. (1997). Rehabilitation. *Stroke 28*(7), 1522-1526.

Griogorenko, E. L., & Sternberg, R. J. (1998) Dynamic testing. *Psychological Bulletin 24*(1), 75-111.

Hake, D. L., Hamera, E., & Rempfer, M. (2007). Self-report of Cognitive Functioning and Learning in Schizophrenia. *Journal of the American Psychiatric Nurses Association, 13*(2), 93-100.

Hersenstichting (brain association) (2011). retrieved via https://www.hersenstichting.nl/allesoverhersenen/hersenaandoeninge /beroerte.html on 09/10/2012.

Kurtz, M. M., & Wexler, B. E. (2006). Differences in performance and learning proficiency on the Wisconsin Card Sorting Test in schiphrenia: Do they reflect distinct neurocognitive subtypes with distinct functional profiles? *Schizophrenia Research (81)*, 167-171.

Lezak, M. D., Howieson, D. B., & Loring, D. W. (2004). *Neuropsychological assessment*. Oxford University Press, USA.

NIP (Dutch institute for psychologists) (2010). Richtlijn voor een kort neuropsychologisch onderzoek bij patiënten met een beroerte NIP: sectie Revalidatie en sectie Neuropsychologie. Retrieved via www.nip.nl

Osterrieth, P. A. (1944). Le test du copie d'une figure complexe. *Archives of Psychology, 30*, 206-356.

Reitan, R. M. (1992). Trail Making Test. Reitan neuropsychology laboratory, Tuscon.

Rempfer, M., Hamera, E., Brown, C., & Bothwell, R. J. (2006). Learning proficiency on the Wisconsin Card Sorting Test in people with serious mental illness: What are the cognitive characteristics of good learners? *Schizophrenia Research, 87*, 316-322.

Rey, A. (1941). L'examen psychologique dans les cas d'encephalopathie traumatique. *Archives of Psychology, 28*, 286-340.

Rey, A. (1962). L'examen Clinique en Psychologie. Universitaires de France, Paris.

Sergi, M. J., Kern, R. S., Mintz, J., & Green, M. F. (2005). Learning Potential and the Prediction of Work Skill Acquisition in Schizophrenia. *Schizophrenia Bulletin, 31* (1), 67–72.

Uprichard, S., Kupshik, G., Pine, K., & Fletcher, B. (2009). Dynamic assessment of learning ability improves outcome prediction following acquired brain injury. *Brain Injury*, *23*(4), 278-290.

Van Heugten, C., Van de Sande, P., & Beers, K. (2006) Over leerbaarheid, hersenletsel en revalidatie. *Tijdschrift voor de neuropsychologie*, *1*(3).

Vaskinn, A., Sundet, K., Friis, S., Ueland, T., Simonsen, C., Birkenaes, A. B., Engh J. A., Jónsdóttir, H., Opjordsmoen, S., Ringen, P. A., & Andreassen, O. A. (2009). Using the Wisconsin Card Sorting Test to assess learning potential in normal IQ schizophrenia: Does it have potential? *Nord J Psychiatry, 63* (5), 405-411.

Verenso (2012). *Triage instrument revalidatiezorg* retrieved via www.verenso.nl on 17/10/2012.

Wechsler, D. (1997). WAIS-III/WMS-III technical manual. *San Antonio, TX: The Psychological Corporation*.

Watzke, S., Brieger, P., Kuss, O., Schöttke, H. & Wiedl, K. H. (2008). A Longitudinal Study of Learning Potential and Rehabilitation Outcome in Schizophrenia. *Psychiatric Services, 59* (3), 248-255.

Weingartz, S., Wiedl, K. H., & Watzke, S. (2008). Dynamic Assessment of Executive Functioning:(How) Can We Measure Change?. *Journal of Cognitive Education and Psychology*, *7*(3), 368-387.

Wiedl, K. H. (1999). Rehab Rounds: Cognitive Modifiability as a Measure of Readiness for Rehabilitation *Psychiatric Services, 50* (11), 1411-1419.