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Research paper

Motivation and engagement during cognitive training for schizophrenia spectrum disorders

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A B S T R A C T

Background: Motivation and engagement are important factors associated with therapeutic outcomes in cognitive training for schizophrenia. The goals of the present report were to examine relations between objective treatment engagement (number of sessions attended, amount of homework completed) and self-reported motivation (intrinsic motivation and perceived competence to complete cognitive training) with neurocognitive and functional outcomes from cognitive training.

Methods: Data from a clinical trial comparing two cognitive training approaches in schizophrenia-spectrum disorders were utilized in the current report (n = 38). Relations were examined between baseline intrinsic motivation, perceived competence, homework completion, and session attendance with improvements in neurocognition, functional competence, and community functioning.

Results: Number of sessions attended (r = 0.38) and time doing homework (r = 0.51) were significantly associated with improvements in neurocognition. Homework completion was associated with change in community functioning at a trend-level (r = 0.30). Older age was associated with greater treatment engagement (β = 0.37) and male biological sex was associated with greater self-reported motivation (β = 0.43). Homework completion significantly mediated the relationship between session attendance and neurocognitive treatment outcomes.

Conclusions: Objective measures of treatment engagement were better predictors of treatment outcomes than subjective measures of motivation. Homework completion was most strongly related to treatment outcomes and mediated the relationship between session attendance and treatment outcomes, suggesting continued engagement with cognitive stimulation may be an especially important component of cognitive remediation programs. Future research should examine methods to improve homework completion and session attendance to maximize therapeutic outcomes.

1. Introduction

Neurocognitive impairments are a core and ubiquitous feature of schizophrenia (Keefe et al., 2005). Broad neurocognitive impairments in most domains are consistently found (Heinrichs and Zakzanis, 1998) and this generalized neurocognitive impairment is associated with functional disability (Green, 1996). Notably, neurocognitive impairments are better predictors of functional abilities than positive or negative symptomatology (Bowie et al., 2006) and this relationship persists regardless of severity of other psychiatric symptoms (Best et al., 2014).

Cognitive remediation (CR) is a psychological treatment designed to enhance neurocognitive abilities with the ultimate goal of improving community functioning. CR approaches vary widely but typically utilize computerized cognitive training as a core component. Computerized training may target lower-order perceptual abilities (Fisher et al., 2009) or higher-order executive function abilities (Best et al., 2019a; Best et al., 2019b). For a review of various approaches see Best and Bowie (2017). Regardless of the approach taken, meta-analyses suggest moderate effect size improvements in neurocognition from CR (d = 0.41–0.45; McGurk et al., 2007; Wykes et al., 2011); however, generalization to community functioning is less consistent.

Despite the effectiveness of CR interventions, engaging individuals with schizophrenia-spectrum disorders in treatment is a well-documented challenge due to motivational difficulties (Medalia and Saperstein, 2011) and limited insight (McEvoy et al., 1989). While some individuals may engage in treatment due to external pressures (such as family, service-providers, or courts), individuals who engage in treatment of their own volition tend to have better therapeutic outcomes (Sheldon et al., 2003). Intrinsic motivation, which can be defined as motivation to engage with a task because of an appreciation for its inherent value rather than external reward, is the form of motivation most closely associated with cognitive remediation outcomes (Saperstein and Medalia, 2015).

In an experimental study, Choi and Medalia (2010) randomized individuals with schizophrenia to either a cognitive training program designed to increase intrinsic motivation or a control training program. The intrinsically motivating program contained personalized elements,

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individual choices, and a more visually stimulating environment. Individuals randomized to the intrinsically motivating condition demonstrated significantly greater intrinsic motivation and perceived competency for the training task, in addition to improved attentional and arithmetic skill. Furthermore, in a comparison of two different approaches to cognitive remediation, a program with goal setting procedures, designed to increase motivation, and opportunities to rehearse everyday living skills resulted in greater treatment retention (Bowie et al., 2017). Lastly, Fiszdon et al. (2016) provided two sessions of motivational interviewing prior to beginning a cognitive training program which resulted in improved engagement and session attendance. Thus, the motivating nature of the training environment appears to be important for both treatment engagement and neurocognitive outcomes.

While self-reported motivation represents one method of measuring motiveation to engage in cognitive training, session attendance represents an objective behavioural measure of engagement. Greater attendance during cognitive remediation has been associated with better neurocognitive outcomes (Choi and Medalia, 2005; Medalia and Richardson, 2005), and higher therapeutic dose (100 h vs. 50 h) of auditory cognitive training has been associated with greater neurocognitive improvements (Fisher et al., 2010). Some cognitive remediation programs also assign homework for participants to complete in between treatment sessions to increase treatment dose. Only one study to date has examined the role of homework completion during cognitive remediation and found that individuals with treatment-resistant depression who completed more homework experienced better neurocognitive outcomes (Bowie et al., 2013).

The present report examines the role of engagement in cognitive training with neurocognitive and functional outcomes. This is the first report to examine both subjective motivation (i.e., self-reported motivation and perceived competence) and objective engagement (i.e., session attendance and homework completion) in individuals with schizophrenia-spectrum disorders. We hypothesized that greater subjective intrinsic motivation, perceived competence, session attendance, and homework completion would be associated with better cognitive and functional outcomes from cognitive training. We also hypothesized that older age and greater time since diagnosis would be associated with better motivation and engagement in cognitive training. Lastly, we hypothesized that a significant relation between attending treatment sessions and treatment outcomes would be mediated by continued practice of cognitive training exercises between sessions.

2. Method

Data for the current report were drawn from a clinical trial comparing cognitive training that targets perceptual abilities to cognitive training that targets executive function abilities (Best et al., 2019b; clinicaltrials.gov Identifier: NCT03024203). Participants completed eight sessions over six weeks of computerized cognitive training with assessments at baseline, post-treatment, and 3-month follow-up. Change between baseline and 3-month follow-up was examined because this is where the largest treatment effect was observed in the original trial (Best et al., 2019b). Because the variables analyzed in the present study (motivation, perceived competence, and treatment adherence) would be expected to affect treatment outcomes in both conditions, the two interventions were combined in order to maximize statistical power.

2.1. Participants

Seventy outpatients between the ages of 18–65 diagnosed with schizophrenia-spectrum disorders were recruited from outpatient clinics in Kingston, Ontario, Canada. Exclusion criteria included active substance abuse within the past 12 months, history of acquired brain injury, developmental disability, neurocognitive disorder, participation in cognitive remediation within the past 6 months, and non-English language speaking. Analyses for the current report were conducted on participants who completed treatment and provided data at the 3-month follow-up assessment ($n = 38$).

2.2. Measures

2.2.1. Demographic and clinical variables

The reading subtest of the Wide Range Achievement Test (WRAT; Wilkinson and Robertson, 2006) was used as an estimate of premorbid intelligence. The Brief Psychiatric Rating Scale (Overall and Gorham, 1962) was used to measure psychiatric symptoms in five factors (affect, positive, negative, resistance, and activation; Shafer, 2005).

2.2.2. Motivation

The Intrinsic Motivation Inventory for Schizophrenia Research (IMI; Choi et al., 2010) was administered at the end of the first treatment session as a measure of intrinsic motivation to complete the cognitive training exercises. The IMI demonstrated good reliability (Cronbach's alpha = 0.88). Higher scores indicate greater intrinsic motivation. The Perceived Competence Scale (PCS; Williams and Deci, 1996) was similarly administered at the end of the first treatment session and measured perceived ability to complete the cognitive training exercises. The PCS demonstrated excellent reliability (Cronbach's alpha = 0.94). Higher scores indicate greater perceived competence. The IMI and PCS scores were also standardized and averaged to create a single composite measure of motivation.

2.2.3. Engagement

Objective treatment engagement was calculated in two ways: the number of treatment sessions that individuals attended, and the number of minutes that participants spent completing the computerized cognitive training exercises for homework. Participants had access to the two cognitive training software (happyneuronpro.com; brainhq.com) at home in-between treatment sessions and were encouraged to complete 40 min of homework per day (both training software were used in both treatment conditions). The online training software monitored participant activity and recorded the number of minutes that participants engaged in cognitive training outside of sessions. The number of treatment sessions attended and time spent completing homework were standardized and averaged to create a single composite measure of objective treatment engagement, and were examined independently in the mediation analyses.

2.2.4. Neurocognition

Neurocognitive performance was assessed using the Measurement and Treatment Research to Improve Cognition in Schizophrenia Consensus Cognitive Battery (MATRICS MCCB; Nuechterlein and Green, 2006). However, the Mayer-Salovey-Caruso Emotional Intelligence Test and the Mazes test were omitted. The Towers Test from the Delis-Kaplan Executive Function System (Delis et al., 2001) was used to assess problem-solving, and the Trail Making Test B (Reitan, 1992) was included to assess set-shifting ability. Age, gender, and education corrected z-scores were calculated for domains of processing speed, attention, learning/memory, and working memory as outlined in the MATRICS MCCB manual. An additional domain of executive functioning was calculated from the Towers Test Total Achievement score and the ratio of the Trail Making Test B to Trail Making Test A performance (Martin et al., 2003). A total neurocognitive composite score was then calculated as the mean of the standardized domain scores (Cronbach's Alpha = 0.83). Higher scores indicate better neurocognition.

2.2.5. Functional competence

Functional competence, the skills required for independent community functioning, was assessed using the Canadian Objective

Assessment of Life Skills – Brief (COALS; McDermid Vaz et al., 2013). The COALS is a performance-based assessment of functional skills in domains of Time Management, Domestic Activities, and Trip Planning. A total functional competence score was calculated by summing the domain scores across functional domains and converted to age corrected *z*-scores based on normative data (McDermid Vaz et al., 2013). Higher scores indicate better functional competence.

2.2.6. Community functioning

Real-world community functioning was rated on the Specific Levels of Functioning Scale (Schneider and Struening, 1983) by participants' case manager or psychiatrist who was blind to treatment allocation and not involved in any other assessment procedures. The scale yields domain scores of Interpersonal Relationships, Daily Activities, and Work Skills that were averaged to form a total Community Functioning score and transformed to a percentage of maximum total score. The total score had excellent internal consistency (Cronbach's alpha = 0.91). Higher scores indicate better community functioning.

2.3. Data analysis

Change scores for neurocognition, functional competence, and community functioning were calculated as the standardized residual when 3-month follow-up score was regressed on baseline score. Correlations were conducted between baseline intrinsic motivation and perceived competence with change scores in global neurocognition, functional competence, and community functioning. Correlations were also conducted between objective engagement variables (number of sessions attended and time spent on homework in minutes) and each of change scores in global neurocognition, functional competence, and community functioning. One participant was excluded due to completing far more homework than average (> 10 standard deviations above the mean).

Predictors of self-reported motivation and objective treatment engagement were examined using separate stepwise regression analyses. Age, gender, years of education, time since diagnosis, baseline neurocognition, and baseline community functioning were entered into stepwise regression analyses to predict motivation and engagement in cognitive training. Additionally, a mediation analysis, using the PROCESS macro for SPSS (Hayes, 2016), was conducted to examine whether the relationship between number of treatment sessions attended and treatment outcomes was mediated by the amount of homework completed.

3. Results

3.1. Participants

Demographic and clinical characteristics of the sample are presented in Table 1. Descriptive statistics of intrinsic motivation, perceived competence, treatment adherence, neurocognitive outcomes, functional competence outcomes, and community functioning outcomes are presented in Table 2.

3.2. Relations between subjective motivation and objective engagement

Intrinsic motivation and perceived competence were significantly associated, $r = 0.48$, $p = .003$, as were number of sessions attended and amount of homework completed, $r = 0.78$, $p < .001$. Intrinsic motivation was not significantly associated with either number of sessions attended, $r = -0.01$, $p = .926$, or amount of homework completed, $r - 0.09$, $p = .607$. Perceived competence was similarly not significantly associated with number of sessions attended, $r - 0.21$, $p = .218$, or amount of homework completed, $r = -0.10$, $p = .577$.

Table 1
Demographic and clinical characteristics of the sample.

	M		SD
Age	37.36		16.30
Gender (%; Male: Female)		78.6: 21.4	
Years of education	13.17		2.08
Living Independently (%; Yes: No)		49.3: 50.7	
Age at First Hospitalization	21.15		7.52
Duration Since Diagnosis (years)	10.81		13.45
Diagnosis (%)			
Schizophrenia		55.7	
Schizoaffective Disorder		14.3	
Delusional Disorder		1.4	
Psychotic Disorder NOS		21.4	
Bipolar I with Psychotic Features		4.3	
Substance Induced Psychosis		1.4	
Schizophreniform		1.4	
WRAT Total t-score	47.57		8.98
BPRS			
Affect	2.75		1.40
Positive	1.86		1.13
Negative	2.51		1.18
Resistance	1.73		0.85
Activation	1.36		0.55

WRAT = Wide Range Achievement Test – Reading Subtest; BPRS = Brief Psychiatric Rating Scale.

Table 2
Descriptive statistics.

	M	SD
Baseline IMI	5.62	0.69
Baseline PCS	5.62	1.34
# Sessions Attended	4.40	3.15
Homework (mins)	204.80	117.33
Baseline Neurocognitive Composite	−1.18	0.88
Follow-Up Neurocognitive Composite	−0.96	0.87
Baseline Functional Competence	−2.00	1.88
Follow-Up Functional Competence	−1.34	1.68
Baseline Community Functioning	82.23	10.09
Follow-Up Community Functioning	84.35	13.00

IMI = Intrinsic Motivation Inventory.
PCS = Perceived Competence Scale.
Neurocognitive and Functional Competence scores are presented as z-scores (M = 0, SD = 1). Community Functioning scores represent percent of maximum score.

3.3. Relations between motivation/engagement with treatment outcome

3.3.1. Neurocognition

Neither baseline intrinsic motivation nor perceived competence was significantly associated with neurocognitive outcomes. Number of treatment sessions ($r = 0.38$) and number of minutes of homework completed ($r = 0.51$) were significantly associated with change in the neurocognition composite score (Table 3).

3.3.2. Functional Competence

Lower intrinsic motivation to complete the computerized exercises at baseline was associated with significantly better outcomes on the functional competence task ($r = -0.37$). Perceived competence, session attendance, and homework completion were not significantly associated with change in functional competence. Results are presented in Table 3.

3.3.3. Community functioning

Intrinsic motivation and perceived competence for the cognitive training exercises were not significantly associated with treatment outcomes in community functioning. More time spent practicing the computerized exercises for homework was associated with better

Table 3
Correlations of motivation, perceived competence, and treatment adherence with neurocognitive and functional outcomes.

	Neurocognition		Functional competence		Community functioning	
	r	p	r	p	r	p
Baseline IMI	0.14	0.447	**−0.37**	**0.033**	0.17	0.377
Baseline PCS	−0.01	0.966	−0.14	0.440	0.01	0.997
# Sessions attended	**0.38**	**0.017**	−0.03	0.871	0.15	0.402
Homework (mins)	**0.51**	**0.002**	0.11	0.522	*0.30*	*0.096*

Bold values indicate significant relationships ($p < .05$). Italicized values indicate trend-level relationships ($p < .10$).
IMI = Intrinsic Motivation Inventory.
PCS = Perceived Competence Scale.

community functioning outcomes at a trend level ($r = 0.30$). Results are presented in Table 3.

3.4. Predictors of motivation and engagement

In a stepwise regression analysis, the objective engagement composite score was only significantly predicted by age, $\beta = 0.37$, $p = .004$. Older age was associated with better session attendance and homework completion while sex, years of education, time since diagnosis, neurocognition, and community functioning did not predict objective engagement.

Subjective motivation was significantly predicted by only participant sex, $\beta = 0.43$, $p = .008$. Male participants reported greater motivation and perceived competence to complete the cognitive training exercises; however, age, years of education, time since diagnosis, neurocognition, and community functioning did not predict motivation.

3.5. Homework mediating relation between session attendance and outcomes

The mediation analysis was only conducted on neurocognitive outcomes since this was the only domain of treatment outcomes that demonstrated a significant relationship with objective measures of treatment engagement. The relation between session attendance and neurocognitive outcomes was fully mediated by homework completion (Fig. 1). Specifically, the model indicated that the relation between sessions attended and change in neurocognition, $\beta = 0.38$, $p = .017$, was no longer significant after homework completion was specified as a mediator, $\beta = 0.19$, $p = .682$.

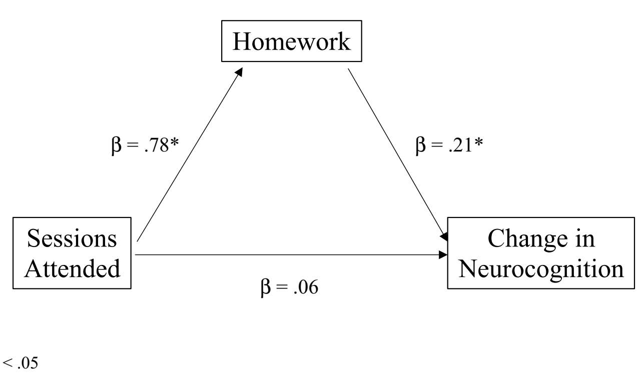

Fig. 1. Mediation analysis examining the mediating role of homework in the relationship between session attendance and improvements in neurocognition.

4. Discussion

The current report utilized data from a clinical trial comparing cognitive training approaches to examine relations between subjective motivation and objective treatment engagement with neurocognitive and functional outcomes. Subjective reports of intrinsic motivation and perceived competence were generally unrelated to neurocognitive and functional outcomes. The exception was a significant negative relationship, in the direction counter to hypotheses, between intrinsic motivation and functional competence. In contrast, objective indicators of engagement were associated with both neurocognitive and functional outcomes. Number of treatment sessions attended and number of minutes of homework were significantly associated with neurocognitive outcomes and there was a trend-level relationship between number of minutes of homework and community functioning outcomes. Additionally, there were no significant relationships between the subjective measures of motivation and the objective measures of engagement, suggesting that they represent distinct constructs. Older age was associated with greater objective engagement and male sex was associated with higher self-reported motivation in cognitive training. Lastly, homework completion mediated the relationship between session attendance and neurocognitive treatment outcomes.

Objective measures of treatment engagement may be more valid than subjective measures of motivation and competence in predicting treatment outcomes. Similarly, we previously reported in this sample that subjective measures of motivation and perceived competence did not predict treatment attrition (Best et al., 2019a, 2019b). The objective measures of engagement were strongly associated with the proximal outcome domain of neurocognition, similar to previous studies that found a relation between session attendance and neurocognition (Choi and Medalia, 2005; Medalia and Richardson, 2005). The less robust relation observed with community functioning, compared to neurocognition, could be a result of functioning being a more distal outcome. Future research could examine the ideal dose of CR to produce functional improvement and whether there is a threshold of homework completion, above which continued homework engagement produces diminishing returns.

The significant mediation analysis suggests that initial engagement in treatment sessions may result in greater completion of homework, which in turn is associated with better treatment outcomes. Causality is challenging to interpret here, but we suggest increasing engagement during treatment sessions may result in better homework completion and produce better treatment outcomes. Financial incentives have proven insufficient to increase treatment engagement (Kotwicki et al., 2017). However, psychotherapeutic techniques such as motivational interviewing may represent a more client-centered method through which session attendance can be improved (Fiszdon et al., 2016). It will also be important for future research to determine whether less intrinsic motivation is a function of illness-related factors or task demands of the cognitive training environment. Mechanisms underlying low motivation are likely to be critical to understanding treatment engagement. Lastly, continued cognitive stimulation outside of treatment sessions appears to be important for improving neurocognitive outcomes and future research could examine whether cognitive stimulation from sources other than computerized training exercises is similarly effective.

Relations between subjective and objective indicators of treatment engagement will be important to examine in future research as subjective measures of cognition and functioning have been found to be counter-intuitive in other studies. For example, Kurtz and Tolman (2011) examined relationships between neurocognition and subjective quality of life and found that better neurocognition was associated with worse subjective quality of life, which is opposite to the relation typically found with objective measures (Tolman and Kurtz, 2012). It was hypothesized that perhaps greater neurocognitive abilities allow individuals to have greater insight into their functional impairments which reduces subjective quality of life (Kurtz and Tolman, 2011). Additionally, previous research has found little concordance between objective measures of neurocognition and subjective reports of neurocognitive impairment (Medalia et al., 2008). Similarly, self-assessment of functional abilities in schizophrenia is unrelated to history of achieving functional milestones (Gould et al., 2013). Thus, subjective reports generally may not be valid indicators in schizophrenia and it may be important for future research to examine discrepancies between self-reported motivation to engage in treatment and objective measures of treatment engagement.

Older individuals and individuals of male biological sex demonstrated greater engagement in cognitive training. This suggests that developing more engaging methods for younger individuals and females may be important for cognitive enhancement techniques to improve outcomes more broadly. Mixed qualitative and quantitative methods may be especially useful in this endeavor to provide critical information for improving engagement in these individuals.

The current results should be interpreted in light of several considerations. First, given that the current sample consisted of individuals experiencing relatively mild psychiatric symptomatology, it is unclear how the observed relations will generalize to other samples, particularly those with prominent negative symptoms or inpatients. Second, the sample was not large enough to examine differential engagement between the perceptual training and executive training conditions; however, it is possible that different training approaches may have different motivational characteristics. As personalized approaches to CR become more feasible (Medalia et al., 2018), it may be important to examine whether discussing individualized cognitive profiles with participants increases motivation and engagement specialized CR. The measures of treatment engagement examined in the current study focused on amount of training completed, however, future studies could also examine performance-based measures of training efficiency such as the number of levels completed per training day. Lastly, the measures of intrinsic motivation and perceived competence were specific to the cognitive training exercises. Future research could also examine general intrinsic motivation and perceived competence.

5. Conclusions

Higher session attendance and homework completion were associated with better neurocognitive and functional outcomes; however, intrinsic motivation and perceived competence were generally not associated with treatment outcomes. Older and male participants demonstrated the greatest engagement in treatment, and homework completion significantly mediated the relationship between session attendance and neurocognitive outcomes. Exploring ways in which to improve treatment adherence in cognitive remediation programs is an avenue of future research that holds great promise to ultimately improve efficacy and broaden treatment accessibility.

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Declaration of Competing Interest

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References

Best, M.W., Bowie, C.R., 2017. A review of cognitive remediation approaches for schizophrenia: from top-down to bottom-up, brain training to psychotherapy. Expert. Rev. Neurother. 17 (7), 713–723. https://doi.org/10.1080/14737175.2017.1331128.

Best, M.W., Gupta, M., Bowie, C.R., Harvey, P.D., 2014. A longitudinal examination of the moderating effects of symptoms on the relationship between functional competence and real world functional performance in schizophrenia. Schizophr. Res. Cogn. 1 (2), 90–95. https://doi.org/10.1016/j.scog.2014.03.002.

Best, M.W., Gale, D., Tran, T., Haque, M.K., Bowie, C.R., 2019a. Brief executive function training for individuals with severe mental illness: effects on EEG synchronization and executive functioning. Schizophr. Res. 203, 32–40. https://doi.org/10.1016/j.schres.2017.08.052.

Best, M.W., Milanovic, M., Iftene, F., Bowie, C.R., 2019b. A randomized controlled trial of executive functioning training vs. perceptual training for schizophrenia-spectrum disorders: effects on neurophysiology, neurocognition, and functioning. Am. J. Psychiatry 176 (4), 297–306.

Bowie, C.R., Reichenberg, A., Patterson, T.L., Heaton, R.K., Harvey, P.D., 2006. Determinants of real-world functional performance in schizophrenia subjects: correlations with cognition, functional capacity, and symptoms. Am. J. Psychiatry 163 (3), 418–425. https://doi.org/10.1176/appi.ajp.163.3.418.

Bowie, C.R., Gupta, M., Holshausen, K., Jokic, R., Best, M.W., Milev, R., 2013. Cognitive remediation for treatment-resistant depression: effects on cognition and functioning and the role of online homework. J. Nerv. Ment. Dis. 201 (8), 680–685.

Bowie, C.R., Grossman, M., Gupta, M., Holshausen, K., Best, M.W., 2017. Action-based cognitive remediation for individuals with serious mental illnesses: effects of real-world simulations and goal setting on functional and vocational outcomes. Psychiatr. Rehabil. J. 40 (1), 53–60. https://doi.org/10.1037/prj0000189.

Choi, J., Medalia, A., 2005. Factors associated with a positive response to cognitive remediation in a community psychiatric sample. Psychiatr. Serv. 56 (5), 602–604. https://doi.org/10.1176/appi.ps.56.5.602.

Choi, J., Medalia, A., 2010. Intrinsic motivation and learning in a schizophrenia spectrum sample. Schizophr. Res. 118 (1–3), 12–19. https://doi.org/10.1016/j.schres.2009.08.001.

Choi, J., Mogami, T., Medalia, A., 2010. Intrinsic motivation inventory: an adapted measure for schizophrenia research. Schizophr. Bull. 36 (5), 966–976. https://doi.org/10.1093/schbul/sbp030.

Delis, D.C., Kaplan, E., Kramer, J.H., 2001. Delis-Kaplan Executive Function System (D-KEFS): Examiner's Manual: Flexibility of Thinking, Concept Formation, Problem Solving, Planning, Creativity, Impulse Control, Inhibition. Pearson.

Fisher, M., Holland, C., Merzenich, M.M., Vinogradov, S., 2009. Using neuroplasticity-based auditory training to improve verbal memory in schizophrenia. Am. J. Psychiatry 166 (7), 805–811. https://doi.org/10.1176/appi.ajp.2009.08050757.

Fisher, M., Holland, C., Subramaniam, K., Vinogradov, S., 2010. Neuroplasticity-based cognitive training in schizophrenia: an interim report on the effects 6 months later. Schizophr. Bull. 36 (4), 869–879. https://doi.org/10.1093/schbul/sbn170.

Fiszdon, J.M., Kurtz, M.M., Choi, J., Bell, M.D., Martino, S., 2016. Motivational interviewing to increase cognitive rehabilitation adherence in schizophrenia. Schizophr. Bull. 42 (2), 327–334. https://doi.org/10.1093/schbul/sbv143.

Gould, F., Sabbag, S., Durand, D., Patterson, T.L., Harvey, P.D., 2013. Self-assessment of functional ability in schizophrenia: milestone achievement and its relationship to accuracy of self-evaluation. Psychiatry Res. 207 (1–2), 19–24.

Green, M.F., 1996. What are the functional consequences of neurocognitive deficits in schizophrenia? Am. J. Psychiatry 153 (3), 321–330. https://doi.org/10.1176/ajp.153.3.321.

Hayes, A., 2016. The Process Macro for SPSS and SAS.

Heinrichs, R.W., Zakzanis, K.K., 1998. Neurocognitive Deficit in Schizophrenia: A Quantitative Review of the Evidence 12 (3), 426–445.

Keefe, R.S.E., Eesley, C.E., Poe, M., 2005. Defining a cognitive function decrement in schizophrenia. Biol. Psychiatry 57, 688–691.

Kotwicki, et al., 2017. Measuring and facilitating client engagement with financial

incentives: implications for improving clinical outcomes in a mental health setting. Community Ment. Health J. 53 (5), 501–509.
Kurtz, M.M., Tolman, A., 2011. Neurocognition, insight into illness and subjective quality-of-life in schizophrenia: what is their relationship? Schizophr. Res. 127 (1–3), 157–162. https://doi.org/10.1016/j.schres.2010.12.004.
Martin, T.A., Hoffman, N.M., Donders, J., 2003. Clinical utility of the trail making test ratio score. Appl. Neuropsychol. 10 (3), 163–169.
McDermid Vaz, S.a., Heinrichs, R.W., Miles, A.a., Ammari, N., Archie, S., Muharib, E., Goldberg, J.O., 2013. The Canadian Objective Assessment of Life Skills (coals): a new measure of functional competence in schizophrenia. Psychiatry Research 206 (2–3), 302–306. https://doi.org/10.1016/j.psychres.2012.10.020.
McEvoy, J.P., Freter, S., Everett, G., Geller, J.L., Appelbaum, P., Apperson, L.J., Roth, L., 1989. Insight and the clinical outcome of schizophrenic patients. J. Nerv. Ment. Dis. 177 (1), 48–51.
McGurk, S.R., Twamley, E.W., Sitzer, D.I., McHugo, G.J., Mueser, K.T., 2007. A meta-analysis of cognitive remediation in schizophrenia. Am. J. Psychiatr. 164 (12), 1791–1802. https://doi.org/10.1176/appi.ajp.2007.07060906.A.
Medalia, A., Richardson, R., 2005. What predicts a good response to cognitive remediation interventions? Schizophr. Bull. 31 (4), 942–953. https://doi.org/10.1093/schbul/sbi045.
Medalia, A., Saperstein, A., 2011. The role of motivation for treatment success. Schizophr. Bull. 37 (Suppl. 2). https://doi.org/10.1093/schbul/sbr063.
Medalia, A., Thysen, J., Freilich, B., 2008. Do people with schizophrenia who have objective cognitive impairment identify cognitive deficits on a self report measure? Schizophr. Res. 105 (1–3), 156–164. https://doi.org/10.1016/j.schres.2008.07.007.
Medalia, A., Saperstein, A.M., Hansen, M.C., Lee, S., 2018. Personalised treatment for cognitive dysfunction in individuals with schizophrenia spectrum disorders. Neuropsychol. Rehabil. 28 (4), 602–613. https://doi.org/10.1080/09602011.2016.1189341.
Nuechterlein, K.H., Green, M.F., 2006. MATRICS Consensus Cognitive Battery Manual. MATRICS Assessment Inc., Los Angeles, CA.
Overall, J.E., Gorham, D.R., 1962. The brief psychiatric rating scale. Psychol. Rep. 10, 799–812.
Reitan, R.M., 1992. Trail Making Test: Manual for Administration and Scoring. (Reitan Neuropsychology Laboratory).
Saperstein, A.M., Medalia, A., 2015. The role of motivation in cognitive remediation for people with schizophrenia. Curr. Top. Behav. Neurosci. https://doi.org/10.1007/7854.
Schneider, L.C., Struening, E.L., 1983. SLOF: a behavioural rating scale for assessing the mentally ill. Soc. Work Res. Abstr. 19 (3), 9–21.
Shafer, A., 2005. Meta-analysis of the brief psychiatric rating scale factor structure. Psychol. Assess. 17 (3), 324–335. https://doi.org/10.1037/1040-3590.17.3.324.
Sheldon, K., Williams, G., Joiner, T., 2003. Self-Determination Theory in the Clinic: Motivating Physical and Mental Health. Yale University Press, New Haven.
Tolman, A.W., Kurtz, M.M., 2012. Neurocognitive predictors of objective and subjective quality of life in0020individuals with schizophrenia: a meta-analytic investigation. Schizophr. Bull. 38 (2), 304–315. https://doi.org/10.1093/schbul/sbq077.
Wilkinson, G.S., Robertson, G.J., 2006. Wide Range Achievement Test. (Psychological Assessment Resources).
Williams, G., Deci, E., 1996. Internalisation of biopsychosocial values by medical students: a test of self determination theory. J. Pers. Soc. Psychol. 70 (4), 767–779.
Wykes, T., Huddy, V., Caroline, C., McGurk, S.R., Czobor, P., 2011. A meta-analysis of cognitive remediation for schizophrenia: methodology and effect sizes. Am. J. Psychiatr. 168, 472–485. https://doi.org/10.1176/appi.ajp.2010.10060855.