Available online at www.sciencedirect.com
ScienceDirect
Schizophrenia Research xx (2007) xxx–xxx
SCHIZOPHRENIA RESEARCH
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Cognition and functional outcome among deaf and hearing people with schizophrenia

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Received 8 December 2006; received in revised form 7 April 2007; accepted 12 April 2007

Abstract

Recent research has highlighted the relationships between impairments in cognitive functioning and poorer functional outcomes among people with schizophrenia (PWS). The purpose of this study was to replicate and extend this work by testing the relationships between cognition and functional outcome among deaf adults with schizophrenia. Empirical findings from deafness-oriented research reveals enhanced abilities in certain aspects of visual–spatial processing compared to hearing people. Sixty-five PWS (34 deaf, 31 hearing) were assessed using measures of verbal and visual memory, attention, and visual processing. The first hypothesis tested whether cognition predicted functional outcome in a similar fashion for both deaf and hearing subjects ($n=63$). For all subjects, higher levels of cognitive ability were associated with higher levels of functional outcome, and the strongest predictors of outcome were verbal memory and visual–spatial memory (recall condition) (VSM recall). However, the deaf and hearing groups did show different patterns of relationships between cognition and functioning when all cognitive variables were examined. The second hypothesis was that deaf subjects would display superior performance in early visual processing, visual–spatial memory (copy condition) (VSM copy), and VSM recall. Deaf subjects displayed superior performance on each task; however, no significant differences emerged. Deaf subjects outperformed hearing subjects in an unexpected domain (word memory/recognition). This study extends prior work in the area of cognition and schizophrenia and indicates that deaf and hearing subjects may benefit from interventions that address different domains of cognition.

Keywords: Schizophrenia; Cognition; Social cognition; Functional outcome; Social functioning; Deafness

1. Introduction

Specific cognitive abilities have been shown to predict functional outcomes among people with schizophrenia (PWS) (Goldberg and Green, 2002; Green, 1996; Green et al., 2000). However, previous studies have been limited to hearing PWS; cognitive functioning in deaf PWS, and its relationship to outcomes, has only rarely been studied. Viggo C. Hansen (1929) conducted the earliest work, and fewer than twenty empirical articles have been published since that date (for reviews see Horton, 2005; Vernon, 1995, 1999).

On the other hand, a sizeable body of knowledge related to nonclinical samples of deaf people has been generated. Natural experiments created by deaf people

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doi:10.1016/j.schres.2007.04.008

born to hearing parents (90% of the deaf population) have led to the extensive research regarding the effect of delayed language acquisition (Emmorey, 1993; Mayberry, 1991, 1992, 1995; Neville et al., 1997; Singleton and Newport, 2004); the relationship between language and spatial cognition (Emmorey, 1993, 2002; Mayberry, 1992; Neville, 1995; Poizner et al., 1987); the attainment of cognitive and linguistic milestones (Bellugi et al., 1990; Chamberlain et al., 2000; Church and Goldin-Meadow, 1986; Goldin-Meadow et al., 1996; Goldin-Meadow and Mylander, 1991; Newport and Meier, 1985); the neural organization of American Sign Language (ASL) (Bellugi et al., 1989; Emmorey et al., 1998, 2002; Neville, 1988, 1995; Neville et al., 1998); and the relationship between language and affect (Corina, 1989; Corina et al., 1999; Reilly et al., 1990a, b). There is evidence that deaf children who have been exposed to a complete language model from birth, as is the case with deaf children born to deaf parents (i.e., native signers or "early language learners"), perform the same as hearing children of hearing parents on many cognitive measures (Marschark, 1993; Marschark and Clark, 1993; Mayberry, 1992).

There are important differences as well as similarities in neural processing between deaf and hearing people. Similarities between signed and spoken language in interhemispheric organization reveal that the left hemisphere (specifically frontal as well as temporoparietal areas of the brain) are responsible for language *independent of the language modality* (Neville et al., 1997, 1998; Petitto et al., 2000). For example, when Broca's area is damaged in a hearing person, orofacial movement deficits related to speech production as well as deficits in written output are evidenced (Broca, 1861, 1865; Mohr et al., 1978). Similarly, deaf subjects with Broca's area damage have movement deficits – in their limbs rather than their mouths – related to the production of ASL (Hickok et al., 1999; Neville et al., 1997). In short, Broca's area controls language motor output, whether orofacial or limb movements are involved in that output.

The differences in neural processing between deaf and hearing groups can be found in specific aspects of spatial cognition. Deaf people have displayed superior mental rotation abilities (McKee, 1987; Talbot and Haude, 1993), greater accuracy in remembering object orientation (Emmorey et al., 1998), and superior copying abilities compared to hearing subjects who do not sign (Emmorey, 1993; Emmorey et al., 1993). Taken together, cognitive data from nonclinical samples of deaf people point to the idea that native signers – whether deaf or hearing – display enhanced visual–spatial processing abilities compared to hearing people who do not know sign language or who learn it later in childhood (Bellugi et al., 1990; Bettger et al., 1997; McCullough and Emmorey, 1997). Native signers include deaf and hearing persons whose first language is ASL. Typically, these are people born to deaf parents and thus exposed to sign language from birth. Rather than deafness per se, it appears that enhancements among native signers are due to experience with a visual–spatial language and are tied to specific linguistic-processing requirements (e.g., interpretation of grammatical facial expressions and perspective transformations) (Emmorey, 1993, p. 153).

The current study tested two hypotheses. The first is that particular domains of cognition (e.g., early visual processing, verbal and visual–spatial memory) will predict levels of functional outcome among deaf PWS just as they have been proven to do among hearing PWS. There are little or no empirical data regarding the relationship between cognition and outcome among deaf PWS; however, a priori there is no reason to assume that the relationship will not manifest. A within-group (deaf) analysis is employed with the goal of replicating data from the (hearing) schizophrenia research literature.

The second hypothesis is that differences between deaf and hearing participants will manifest in levels of cognitive ability. In particular, deaf PWS are expected to outperform their hearing counterparts on measures of early visual processing and visual–spatial memory. A between-group (deaf, hearing) analysis is employed in an attempt to replicate findings from the nonclinical and deafness-oriented psychological literature that deaf people have superior visual processing abilities compared to hearing people. The finding has proven to be particularly strong among deaf compared to hearing people without mental illness.

2. Materials and methods

2.1. Subjects

The study was approved by the University of Chicago Institutional Review Board. PWS were recruited from all deaf and hearing consumers at a psychiatric rehabilitation agency in Chicago (approximately 3000 consumers). In total, 87 people agreed to participate in the study (46 deaf, 41 hearing). A diagnosis of schizophrenia or schizoaffective disorder was determined by the Structured Clinical Interview for DSM-IV Axis I Disorders—Patient Edition (SCID) (First et al., 1997). The SCID was translated into ASL and back-translated into English by the author and a native signer. The author was trained to administer the SCID by an experienced, doctoral-level trainer at the University of Chicago, Department of Psychiatry (the author achieved an interclass correlation of 0.78 against the gold standard trainer). Twenty people did not meet the SCID-based diagnostic inclusion criteria (11 deaf, 9 hearing). In addition, two people, each with a history of head injury, were excluded (1 deaf, 1 hearing).

The final sample included 65 subjects (34 deaf, 31 hearing). Among the 34 deaf subjects, 32 completed all three testing sessions. Of the two who did not participate in the final session, one gave no reason, and the other was not available until after the data collection period ended. For these two deaf subjects, cognitive data are missing.

2.2. Sample characteristics

Table 1 presents demographic information for both deaf and hearing subjects. The groups were similar with respect to gender, race, diagnosis, housing status, employment status, and psychiatric history variables. The mean age of illness onset was 20 years old; the average total number of lifetime hospitalizations was 8; subjects experienced their most recent hospitalizations 6 years prior to the test date; and the average illness duration was 26 years.

In comparing the two groups, the same number of subjects attended and completed college. One meaningful difference was the number within each group who graduated from high school. Of 16 hearing subjects who entered high school, only 2 graduated. Among deaf subjects, 21 entered high school and 17 graduated. The strength of the relationship between education and the dependent variable (functional outcome) was moderate (r=0.442) and thus was statistically controlled in all between-group comparisons.

2.3. Measures

Measures were based on the Measurement and Treatment Research to Improve Cognition in Schizophrenia (MATRICS) initiative (Green et al., 2004). Of the six cognitive domains suggested by the MATRICS consensus battery, four are evaluated in the current project: early visual processing (EVP), vigilance, visual–spatial memory, and verbal memory.

Tests that represent the independent measurement of early visual and attentional abilities – with no working memory demands – are employed in this project (Asarnow et al., 1991; Asarnow and Nuechterlein, 1994; Silverstein et al., 1998). Further, measures used to assess visual–spatial processing that do not overlap with linguistic ability were chosen in order to avoid the possible confounds arising for deaf people who are “late language learners.”

Test instructions and stimuli were administered in sign language for deaf subjects (either ASL or Pidgin Signed English) and spoken English for hearing subjects. A random-number generator was used to order the presentation of measures for each subject.

2.3.1. Early visual processing

Early visual processing (EVP) was measured with the Partial Report Span of Apprehension test ([Span] Asarnow and Nuechterlein, 1994). The Span is a computer-based measure requiring subjects to identify which of two target letters (T or F) appear on the monitor by pressing one of two response buttons as quickly as possible. Because the task uses alphabetic letters as stimuli it is conceptualized as a linguistic-based cognitive task. A measure of reaction time – in milliseconds – represents the length of time it took subjects to respond to the presentation of the stimuli. Two different series of stimuli are displayed randomly: a 3-letter matrix and a 12-letter matrix.

Span-of-apprehension performance among people with schizophrenia increasingly diverges from that of non-mentally ill and psychiatric controls as the number of items to be recalled increases (Suslow, 1998; Asarnow et al., 1991). The testing room specifications established by Asarnow and Nuechterlein (1994) were followed and were also followed for measures of vigilance.

2.3.2. Vigilance

Vigilance was measured with the Degraded Stimulus Continuous Performance Test ([DS-CPT] Nuechterlein and Asarnow, 1999). The DS-CPT has been widely used to measure sustained attentional deficits in schizophrenia. Subjects monitor a random series of single numbers, which are presented continuously at a rate of approximately one per second. Subjects are asked to indicate that they have detected a target event by pressing a response button, and they are to avoid responding to nontarget stimuli. The target stimulus – the number zero – is presented 480 times. Sensitivity A′ (i.e., A-prime) is a nonparametric measure of the subject’s ability (sensitivity) to discriminate between target and nontarget stimuli; the score is reflected as a percentage.

Clear deficits in attention, as measured by continuous performance tests, are found among people with schizophrenia when compared to nonclinical groups for both verbal as well as visual–spatial material (Nuechterlein et al., 1992; Chen et al., 1997; Elvevag et al., 2001).

Table 1
Demographics and clinical variables of study participants ($n=65$)

Variable	Deaf $n=34$	Hearing $n=31$	Significance	Total $n=65$
Mean age (SD)	45 (8.9)	47 (9.2)		46 (9.1)
Sex				
Female	13	9		22
Male	21	22		43
Race				
White	18	12		30
Black	12	15		27
Asian	1	1		2
Latino	3	1		4
Biracial	0	2		2
Education				
No or some HS	4	14		18
HS graduate	17	2	0.000 *	19
Any college	11	11		22
College graduate	2	4		6
Housing status				
Residential or nursing home	15	11		26
Semi-independent	5	10		15
SRO or hotel	0	3		3
Own apartment	14	7		21
Diagnosis				
Schizophrenia	26	24		50
Schizoaffective	8	7		15
Illness severity				
Mild	7	3		10
Moderate	6	10		16
Moderate–Severe	6	12		18
Severe	15	6		21
Employment				
Not employed	25	23		48
Noncompetitive	5	7		12
Competitive	4	1		5
Mean negative symptom rating[a] range 1–7 (SD)	1.90 (1.16)	1.92 (1.16)		1.91 (1.16)
Mean positive symptom rating[b] range 1–7 (SD)	2.13 (1.51)	2.17 (1.65)		2.15 (1.58)
Mean functional outcome score (SD)	59/85 (14)	61/85 (10)		–

SRO — single room occupancy.
[a] BPRS anergia factor including blunted affect, emotional withdrawal, motor retardation and self-neglect.
[b] BPRS thought disorder factor including suspiciousness, unusual thought content and grandiosity.
* Scheffé $p=0.000$.

2.3.3. Visual–spatial memory

Visual–spatial memory was measured by the Complex Figure Test ([CFT] Osterrieth, 1944; Visser, 1970–1973). The CFT uses an intricate stimulus that is asymmetrical in design. Subjects are asked to copy the figure and then draw it again from memory. Three indices are measured: the “strategy” employed to complete the task, perceptual organization (VSP copy), and immediate recall (VSP recall). A 36-point scoring system refers to specific lines and details of the figure to be recalled; points are awarded for each line properly placed. Among people with schizophrenia, retrieval has been shown to be affected more than encoding (McClain, 1983; Paulsen et al., 1995).

2.3.4. Verbal memory

Verbal memory, referred to as word memory, was measured with the Rey Auditory Verbal Learning Test ([AVLT] Rey, 1964), which consists of several lists containing 15 words each. Seven trials test subjects on number of words correctly recalled; the total short-term word memory score is the sum of words recalled correctly on trials 1 through 5 (high score = 75). Long-term word memory is evaluated by asking subjects to recall the original list of 15 words after a 20-min delay. A recognition scale reveals the ability to distinguish between target and nontarget words.

When schizophrenic subjects are asked to recall a list of words after a short delay (i.e., short-term verbal memory), with or without cues, a deficit is almost always observed (Calev et al., 1983; Heinrichs and Zakzanis, 1998; Stirling et al., 1997; Strauss et al., 1990). This is true of immediate and delayed recall tasks for verbal material.

2.3.5. Functional outcome

The Multnomah Community Ability Scale ([MCAS]: Barker et al., 1994a,b) was used to operationalize the outcome. The MCAS is a rating scale developed for use with people with chronic mental illness living in the community. The score across four subscales is summed to create an overall functional outcome rating, hereafter referred to simply as "outcome." Three levels of disability are described by the final score: low (17–47), medium (48–62), and high (63–85). The researcher met with caseworkers individually and completed an MCAS for each participant. Reliability statistics were calculated with Cronbach's alpha ($\alpha = 0.90$, $F = 10.11$, $p = 0.000$).

2.3.6. Illness severity

Illness severity was operationalized by the total score on the Brief Psychiatric Rating Scale ([BPRS]: Ventura et al., 1993). After training, the author achieved an interclass correlation of 0.82 against a gold standard and administered the BPRS to all subjects. Positive and negative symptom clusters were determined by conducting a restricted confirmatory factor analysis (CFA) on the 24 BPRS items. The anergia factor (blunted affect, emotional withdrawal and motor retardation, self-neglect) and the thought disorder factor (unusual thought content, grandiosity, and suspiciousness) were used to represent positive and negative symptom clusters.

2.4. Statistical analyses

To test the first hypothesis, a series of bivariate regressions was employed. The tests evaluated the relationship between cognition and outcome among deaf subjects ($n = 32$). Post hoc analyses of the hearing sample ($n = 31$) and the total sample ($n = 63$) were conducted. To test the second hypothesis, ANCOVAs were used to compare the deaf and hearing subjects' levels of cognitive ability ($n = 63$).

Bonferroni corrections were used to account for sequential testing on the same set of subjects. The alpha level was corrected for each set of hypotheses. The first hypothesis ($n = 31$) entailed five comparisons ($p \leq 0.0102$, t-value for two tails: ≥ 2.744; one tail: ≥ 2.452). The second hypothesis ($n = 61$) also entailed five comparisons ($p \leq 0.0102$, t-value for two tails ≥ 2.657; one tail: ≥ 2.388). Results presented represent two-tailed tests of significance unless otherwise noted.

Level of skew and kurtosis with their standard errors (SE) were analyzed in all variables. An a priori decision was made to transform variables if skew/SE and or kurtosis/SE was greater than ± 2. Three variables were transformed: VSP copy, and the BPRS anergia and thought disorder factors.

Outliers were removed according to a specific guideline: no more than 5% of cases were removed ($n = 3$) from any one analysis (Cohen and Cohen, 1983). A correlation matrix depicting the strength of associations among the primary study variables is presented in Table 2.

3. Results

3.1. Cognition and outcome: deaf subjects

The results of the first research question are presented in Table 3. Data are are ordered from the strongest to the weakest predictor of outcome for deaf subjects. The hypothesis that cognition predicts outcome among deaf PWS was supported.

3.2. Cognition and outcome: hearing subjects

For informative purposes, Table 4 presents the cognitive predictors of outcome for hearing subjects. Table 5 presents a side-by-side analysis of the strongest predictors of outcome for the deaf subjects, hearing subjects, and the total sample.

3.3. Differences in cognitive performance between deaf and hearing PWS

The results of the second research question are displayed in Table 6. An analysis of covariance was used to control for the difference in high school graduation rates among a subgroup of deaf and hearing subjects (see Section 2.2). The hypothesis that differences exist across the deaf and hearing samples on indices of EVP and visual–spatial memory was not supported.

Please cite this article as: Horton, H.K., Silverstein, S.M., Cognition and functional outcome among deaf and hearing people with schizophrenia, Schizophrenia Research (2007), doi:10.1016/j.schres.2007.04.008

Table 2
Correlations (Pearson) between study variables

	Func. out.	Illness sever.	Negative symptom	Positive symptom	VM	VSM copy	VSM recall	Vig. [a]	EVP	Educ.
Func. out.	1.000									
Illness sever.	−0.586**	1.000								
	0.000									
Negative symptom	−0.253*	0.345**	1.000							
	0.043	0.005**								
Positive symptom	−0.256*	0.449	0.000	1.000						
	0.041	0.000	1.000							
VM	0.380**	−0.265*	−0.229	0.019	1.000					
	0.002	0.036	0.071	0.884						
VSM copy	0.278*	−0.055	.061	−0.043	.395**	1.000				
	0.027	0.666	0.633	0.739	0.001					
VSM recall	0.254*	−0.276	−0.015	−0.047	.415**	0.454**	1.000			
	0.045	0.029	0.909	0.714	0.001	0.000				
Vig. [a]	0.180	−0.346**	−0.282*	0.051	0.354**	0.197	0.283*	1.000		
	0.157	0.007	0.029	0.694	0.004	0.121	0.024			
EVP	0.367**	−0.301*	−0.221	−0.123	0.325**	0.360**	0.378**	0.193	1.000	
	0.003	0.017	0.081	0.335	0.009	0.004	0.002	0.131		
Educ.	0.442**	−0.113	0.001	0.113	0.241	0.441*	0.182	0.161	0.027	1.000
	0.000	0.371	0.992	0.373	0.058	0.000	0.154	0.219	0.835	

**p<0.01; *p<0.01.
Func. Out.=MCAS functional outcome; Illness Sever.=BPRS illness severity rating; VM=verbal memory; VSM copy=visual–spatial memory (copy); VSM recall=visual–spatial memory (Recall); Vig.=vigilance (DS-CPT sensitivity A′); EVP=early visual processing (span of apprehension); Educ=years of education.
[a] Three outliers were removed to improve fit.

Post hoc, the remaining domains of cognition were compared across deaf and hearing subjects, and one domain revealed a significant difference (italicized in Table 6). Deaf subjects scored higher than hearing subjects on the word memory/recognition task. This difference was not hypothesized and should be interpreted cautiously.

Table 3
Functional outcome regressed on to cognition: bivariate associations (deaf subjects, $n=32$)

Predictors	Beta standardized	Degrees of freedom	Functional outcome t-statistics	p-value	r^2 (adj.)
VSM (copy) [a]	0.505	28	3.04 **	0.005	0.227
VSM (recall) [b]	0.466	29	2.79 **	0.009	0.189
EVP [a]	0.465	28	2.73 *	0.011	0.187
Vigilance (A′) [a]	0.433	28	2.50 *	0.019	0.157
Word memory	0.386	31	2.29	0.029	0.121

EVP — early visual processing; VSM — visual spatial memory.
[a] Three outliers were removed to gain better fit.
[b] One outlier was removed to gain better fit.
* $p<0.05$, corrected, one-tailed.
* $p<0.05$, corrected.

4. Discussion

This study tested two hypotheses developed from separate domains of inquiry. The research questions are linked by the importance of visual and visual–spatial processing among deaf people. The first question addressed the relationship between cognition and

Table 4
Functional outcome regressed on to cognition: bivariate associations (hearing subjects, $n=31$)

Predictors	Beta standardized	Degrees of freedom	Functional outcome t-statistics	p-value	r^2 (adj.)
EVP	0.499	30	2.71 *	0.011	0.174
Word memory	0.399	30	2.34 *	0.026	0.130
VSM recall [a]	0.334	29	1.87	0.071	0.080
VSM copy	0.283	30	1.59	0.123	0.048
Vigilance (A′)	0.256	30	1.43	0.164	0.033

Note: These relationships were analyzed post hoc and were not subjected to a Bonferroni correction.
EVP — early visual processing; VSM copy — visual–spatial memory (copy); VSM recall — visual–spatial memory (Recall).
[a] Two outliers were removed to gain better fit.
* $p<0.05$.

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Table 5
Strongest predictors of functional outcome by group (Deaf, Hearing)

Deaf ($n=32$)[a]	Hearing ($n=31$)[a]	Total ($n=63$)
VSM copy $p=0.005$	Early visual processing $p=0.011$	Word memory $p=0.002$ VSM recall $p=0.002$
VSM recall $p=0.009$	Word memory $p=0.026$	Early visual processing $p=0.003$
Early visual processing $p=0.011$	VSM recall $p=0.071$	Vigilance $p=0.006$
Vigilance $p=0.019$	VSM copy $p=0.123$	VSM copy $p=0.016$
Word memory $p=0.029$	Vigilance $p=0.164$	

VSM copy — visual–spatial memory (copy); VSM recall — visual–spatial memory (Recall).
[a] The 2 left hand columns (Deaf and Hearing) are reproductions of Tables 3 and 4 respectively.

outcome. It is a common finding in the hearing-oriented schizophrenia literature that cognitive processing is a reliable predictor of outcome. This study replicated that finding among deaf PWS. The strongest predictor of outcome for deaf subjects was VSM copy followed by VSM recall, EVP, and vigilance. The final domain, word memory, was not significant once corrected. The most potent predictors of outcome for the deaf sample include abilities that place less of a demand on linguistic processing and more on visual–spatial processing.

Only two of the five predictors (EVP and word memory) were statistically significant for hearing subjects. VSM recall and VSM copy were weak trends in relation to outcome, while vigilance was not related to outcome in the hearing sample. Overall, and for unknown reasons, cognition was a more potent predictor of outcome for deaf than for hearing subjects. Nonetheless, it was the linguistic-based cognitive abilities that best predicted outcome for the hearing subjects.

The importance of attending to the linguistic and nonlinguistic demands of cognitive tasks was borne out in the current study by the finding that nonlinguistic visual processing mechanisms were the most potent predictors of outcome for deaf subjects (VSM recall and copy) while linguistic-based visual mechanisms (EVP and word memory) were among the weakest predictors of outcome for deaf subjects. For hearing subjects, the opposite was empirically supported. That is, nonlinguistic visual–spatial abilities (VSM recall and copy) had only weak relationships to outcome, and the linguistic-based cognitive tasks (EVP and word memory) were the strongest predictors of outcome.

The relevance of nonlinguistic visual–spatial processing for deaf subjects and, likewise, linguistic-based cognitive processing for hearing subjects is in line with empirical work emphasizing the way in which a lifelong reliance on visual rather than auditory mechanisms for information and linguistic processing influences cognition. The standard method of separating verbal mechanisms from those that are visual–spatial is challenged when considering deaf people because their “verbal” communication domain is visual–spatial. The linguistic and nonlinguistic components of visual–spatial processing must be specifically dissociated from one another, as can be seen by the difference between tasks that require the processing of language (e.g., EVP and word memory) and tasks that require the processing of geometric shapes (e.g., VSM recall and copy). These differences may have implications for rehabilitation efforts for deaf and hearing PWS.

The second question addressed directly the differences in cognitive performance between deaf and hearing subjects. Empirical evidence from the deafness-oriented psychological literature has long revealed that

Table 6
ANCOVAs: levels of cognitive ability (Education as Covariate), deaf and hearing comparisons

Measures of cognition	Deaf mean (SD)	Hearing mean (SD)	F	p-value
Early visual processing	0.70 (0.09)	0.68 (0.12)	0.445	0.507
Early visual processing: reaction time in milliseconds	997 (348)	1066 (357)	0.365	0.548
Visual–spatial memory: strategy[a]	2.22 (1.1)	2.35 (1.0)	0.062	0.804
Visual–spatial memory: copy score	0.80 (0.20)	0.75 (0.19)	0.342	0.561
Visual–spatial memory: recall	0.39 (0.18)	0.32 (0.14)	2.02	0.160
Verbal memory: recognition	0.18 (0.03)	0.16 (0.03)	5.420	0.023 *

[a] Visual–spatial memory strategy scores range from 1 to 3; lower scores represent a higher level of ability.
* $p<0.05$ (uncorrected).

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deaf signers, and especially native signers, have visual–spatial abilities that are superior to those of hearing and deaf people who either learned sign language "late" or had never been exposed to sign language (the definition of "late" varies in the literature). In the current project, differences in certain abilities were found between subjects who learned sign language before, compared to after, their fifth birthdays (results presented in a forthcoming paper).

While the raw data reveal that deaf subjects in the current study performed better than hearing subjects on the VSM copy and recall task, differences were not significant, and there were essentially no differences between deaf and hearing subjects on the measure of EVP. It is perhaps not surprising that differences were not found on the measure of EVP because it represents a linguistic-based processing skill. Future research should compare deaf and hearing subjects on measures of cognition that fall squarely within the domain of nonlinguistic visual and/or visual–spatial processing.

Unexpected significant differences arose with regard to word memory/recognition. Deaf subjects correctly chose target from nontarget words at a higher rate than hearing subjects. Without further hypothesis testing, it is difficult to determine the reasons for such performance. The finding does not correspond to the well-documented delay in other domains of memory among deaf people (especially children). Results in this area of research, however, have been inconsistent (Bebko, 1984; Harris and Moreno, 2004; Arnold and Mills, 2001; Arnold and Murray, 1998).

It is clear that cognition varies with important changes in the outcome and the quality of life (Green et al., 2000; Addington et al., 1998). To contribute to the expansion of theories of social and functional dysfunction among PWS, we must explain the nature of that relationship. That is, how do below average scores on cognitive tasks relate to social and functional competence? The presence of cognitive deficits by themselves is an insufficient explanation of the profound social disabilities associated with schizophrenia (Carter and Flesher, 1995, p. 215). This is especially apparent among PWS who display impoverished social competence along with relatively intact cognition (Heinrichs and Zakzanis, 1998; Heinrichs et al., 2007).

A recent suggestion is that the relationship between cognition and outcome may be mediated by social cognition (e.g., Theory of Mind). Targeting social cognition as a potential mediator addresses concerns regarding the gap between microprocesses such as attention or memory and real-world social and functional behavior. A mediating hypothesis has been suggested in the literature (e.g., Green et al., 2000; Kee et al., 1998) and is tested by the author in a forthcoming paper (see Horton and Silverstein, 2007).

The goals of this study were twofold. The first was to establish that cognition predicts outcomes among deaf people, as we know it does among hearing PWS. Support for the hypothesis was provided and moves towards an understanding of whether pathways to social impairment are distinct across the populations. The second goal was to address the lack of empirical research among deaf people with serious mental illness by providing an empirical foundation for future work. As part of this goal, special attention was paid to visual and visual–spatial processing among deaf people because of their reliance on such mechanisms for information and linguistic processing.

Acknowledgements

We would like to thank the members and staff of Thresholds Psychiatric Rehabilitation Center for their contribution to this research. We are also grateful to R.F. Asarnow and K.H. Nuechterlein for putting at our disposal software packages for neuropsychological testing.

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Please cite this article as: Horton, H.K., Silverstein, S.M., Cognition and functional outcome among deaf and hearing people with schizophrenia, Schizophrenia Research (2007), doi:10.1016/j.schres.2007.04.008