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A two-factor structure of first rank symptoms in patients with a psychotic disorder

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ABSTRACT

Kurt Schneider defined 'first rank symptoms' (FRS) of psychosis. Previous research found two clusters of FRS: 'loss of ego bound' symptoms (e.g., delusions of external control) and auditory hallucinations (e.g, commenting voices). In patients with a psychosis we investigated whether FRS are a separate cluster within the group of positive symptoms, consisting of two underlying factors that are stable over time. We conducted a principal axis factor analysis (PAF) at baseline (n = 857) and a confirmative factor analysis (CFA) at three-year follow-up (n = 414) on (FRS) symptom score. Also, we investigated the stability of the two-factor structure of FRS over the interval. PAF on 16 items representing positive symptoms at baseline revealed two factors with eigenvalues >1. FRS-delusional self experience (thought withdrawal, thought broadcasting, thought insertion, and beliefs that impulses and/or actions are controlled by an outside force) clustered in one factor and FRS-auditory hallucinations (auditory hallucinations, conversational voices, and voices commenting on one's actions) in the second factor. Furthermore, CFA on the FRS-items at follow-up confirmed the two-factor structure of FRS. FRS delusional self experience and FRS-auditory hallucinations at baseline were significantly associated with the same factors at three-year follow-up (FRS-delusional self experience: r = 0.38; FRS-auditory hallucinations r = 0.47). Hence, our findings confirm a two-factor structure of first rank symptoms, i.e. FRS-delusional self experience and FRS-auditory hallucinations, with a moderate to large internal coherence within each factor and relative stability over time. Future studies on self-processes may contribute to our understanding of the pathophysiology of first rank symptoms.

1. Introduction

Current diagnostic models of schizophrenia are under debate because of their inability to identify homogeneous patient groups (Korver-Nieberg et al., 2011). Over the years different models of schizophrenia have been proposed and one of the most prominent models has been the concept of 'first rank symptoms' (FRS). FRS were introduced by Kurt Schneider in the 1960s and rapidly became popular as a pragmatic diagnostic tool. Schneider described FRS as follows: auditory hallucinations (audible thoughts, conversational voices, and voices commenting on one's actions), different types of abnormal perception and delusions that can be conceptualized as "loss of ego bound", i.e., a deficit in the barrier separating self from the environment (thought withdrawal, thought broadcasting, thought insertion, and beliefs that impulses and/or actions are controlled by an outside force), and delusional perception (a normal percept which is interpreted with delusional meaning) (Mellor, 1970; Carpenter et al., 1973; Carpenter and Strauss, 1974). Findings on the prevalence and prognostic value of FRS however have been widely inconsistent. The concept of delusional perception has even somewhat fallen in oblivion in contemporary research on FRS (Rossi Monti, 1998; Waters et al., 2009; Waters and Badcock, 2010; Rosen et al., 2011). Evidence suggests that FRS symptoms are not specific for schizophrenia, making the concept not applicable for diagnostic purposes (Carpenter et al., 1973; Peralta and Cuesta, 1999; Nordgaard et al., 2008; Rosen et al., 2011). For research purposes though a well defined cluster of symptoms is helpful as unravelling its underlying mechanisms might help us understand the pathophysiological mechanisms of schizophrenia and other psychotic disorders.

Some have suggested that FRS are merely a 'chance cluster' of symptoms (Crichton, 1996), without a theory or presupposed aetiology. A

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critical review (Nordgaard et al., 2008) of the FRS literature pointed out that because of inconsistencies in the operationalization the (diagnostic) specificity of FRS remains unclear. It was suggested that FRS should not be considered as “atomic symptoms” but as two groups of phenomena, albeit with an overlap between them (Nordgaard et al., 2008). Previous research indeed found indications for such a two-factor structure (Loftus et al., 2000). In a group of 103 sibling pairs the first factor consisted of different types of abnormal perception (thought insertion, reading, withdrawal and broadcasting) and delusions of alien control, while the second factor grouped third person voices, thought echo and commentary voices together (Loftus et al., 2000). Peralta and Cuesta (1999) found a similar factor structure, although the factor with hallucinations also included delusion perception. However, 1-factor (Kimhy et al., 2005) and 5-factor models (Ceccherini-Nelli and Crow, 2003) have also been suggested. These contradicting findings can be explained by the number and type of symptoms that were included in the factor analyses. Kimhy et al. (2005) only included delusional symptoms while Ceccherini-Nelli and Crow (2003) included only FRS and no other psychotic symptoms.

The aim of the current study was three-fold. First we evaluated whether the cluster of FRS symptoms described by Loftus et al. (2000) can be identified within the group of all positive symptoms. Our second aim was to answer the question if a two-factor structure is underlying FRS as was previously found by Loftus et al. (2000) in a large sample of patients with a psychotic disorder. Thirdly we investigated the stability of a two-factor structure of FRS over time.

2. Methods

2.1. Population

Participants took part in the Genetic Risk and Outcome of Psychosis (GROUP) study, a naturalistic follow-up study in which 1120 patients, 1057 of their siblings, 919 of their parents and 590 healthy controls were included. Patients were selected from geographical areas in The Netherlands and Belgium and were identified by representative clinicians whose caseload was screened for inclusion criteria. Subsequently a group of patients presenting consecutively at these services either as out-patients or in-patients were recruited for the study. For the current study we only used the patient sample. Inclusion criteria for patients were I) age between 16 and 50 years, II) a diagnosis of non-affective psychotic disorder according to DSM-IV (American Psychiatric Association, 2000; 1992), and III) good command of the Dutch language. An exclusion criterion was first contact with psychiatric care for psychosis more than 10 years before study entrance. Further details on in- and exclusion criteria, procedure of recruitment and population characteristics of the GROUP study have been described in detail elsewhere (Korver et al., 2012). An additional inclusion criterion for the current study was the presence of data acquired by the Comprehensive Assessment of Symptoms and History interview (CASH) (Andreasen et al., 1992). At follow-up measurement one site replaced the CASH by the Schedules for Clinical Assessment for Neuropsychiatry (SCAN) (Wing et al., 1990) thus from this site only the baseline data was used.

2.2. Instruments

2.2.1. CASH

The Comprehensive Assessment of Symptoms and History interview (CASH) is developed to provide information about the current and past symptoms of psychotic disorders in the affective and schizophrenia spectrum (Andreasen et al., 1992). For the purpose of this study only data gathered via Sections 6 and 7 was used; in these sections the type and severity of positive psychotic symptoms were assessed. In Section 6 the following type of delusions are described: paranoid, jealousy, guilt, grandiosity, religious, somatic, reference, alien body control and the following abnormal perception phenomena thought reading, thought broadcasting, thought insertions and thought withdrawal. The latter five symptoms are defined as part of First Rank Symptoms (FRS). Section 7 describes auditory hallucinations (including audible thoughts), voices commenting and conversational voices, somatic, tactile, olfactory and visual hallucinations. The first three symptoms are defined as being part of FRS. The presence of each positive symptom in the last months is indicated on a six point Likert scale from 0 (absent) to 5 (severe). Trained psychiatrists and psychologists administered the CASH. The CASH (Andreasen et al., 1992) unfortunately does not measure delusional perception and therefore delusional perception is not included in our analyses.

2.2.2. PANSS

The Positive and Negative Syndrome Scale (PANSS) (Kay et al., 1987) is a 30-item rating scale. Items are rated on a 7-point scale (1 = absent, to 7 = extremely severe). The PANSS consists of three subscales: Positive Scale, Negative Scale and General Psychopathology. The items were rated by trained psychiatrists and psychologists after a semi-structured interview.

2.3. Data analyses

2.3.1. Characteristics of the sample & selection bias at follow-up

Baseline characteristics were compared between subjects who participated in the follow-up assessment and those who did not, to investigate possible selection bias in the sample. At baseline one-way multiple analysis of variance (ANOVA) and χ^2 tests were performed to assess potential differences in age, gender, diagnosis, duration of illness, education (ranging from 1 = primary school to 8 = university), cannabis dependency and positive, negative and general psychopathology symptom scores on the PANSS between patients who participated in the follow-up assessments and those who did not.

2.3.2. Structure of FRS

First all positive symptom items rated on the CASH at baseline were subjected to an exploratory principal axis factor analysis (PAF) using SPSS version 19, considering only components with an eigenvalue exceeding 1. A PAF was the rightful exploratory factor analysis, due to the skewed distribution of the data (Costello and Osborne, 2005). To facilitate the interpretation of components oblique rotation (OBLIMIN) was performed. The Kaiser–Meyer–Oklin measure of sampling adequacy should exceed the value of 0.6 (Kaiser, 1970, 1974) and the Bartlett's test of sphericity should be significant ($p < 0.05$) for the PAF to be considered appropriate (Bartlett, 1954).

Confirmatory factor analysis (CFA) was conducted on the follow-up symptom scores of only FRS, in order to confirm the theoretical two-factor model. MPLUS version 5.1 statistical modelling program was used to perform CFA. The eight items representing FRS in the CASH interview were included in the CFA with the categorical responses 0 (absent), 1 (doubtful), 2 (mild), 3 (moderate), 4 (considerable) and 5 (severe). Because of the categorical character of the items and the expected correlation between the factors, parameter estimation was performed using Weighted Least Squares Means and Variance adjusted estimator (WLSMV). Two models with respectively one and two factors of FRS were submitted to CFA analyses. We tested a two-factor model with factor one comprising the items ‘delusion of alien body control’, ‘thought insertion’, ‘thought broadcasting’, ‘thought reading’ and ‘thought withdrawal’ and ‘auditory hallucinations’, ‘conversational voices’ and ‘commenting voices’ in the second factor. Due to large sample size type I error can be expected and therefore fit indices Comparative Fit Index (CFI), Tucket–Lewis Index (TLI) and Root Mean Square Error of Approximation (RMSEA) are applied (Yu, 2002). The CFI and TLI > 0.95 and a RMSEA < 0.08 indicated an adequate fit to the data (Yu, 2002) and were used as a rule of thumb in this study. Accordingly, the model with a two-factor solution was nested in the one-factor solution. The goodness-of-fit of nested models is evaluated by hierarchic likelihood ratio (χ^2) tests. Specifically, the χ^2 statistic is computed by taking twice the difference between the log-likelihood of the full model and the log-likelihood of a reduced model. The associated degrees of freedom are computed as the difference in degrees of freedom between the two hierarchic models. As model parameters were estimated with WLSMV, a slightly adjusted test has been programmed in Mplus and this test was used in the present paper (Muthén and Muthén, 1998–2010; Yu, 2002).

Individual factors scores were calculated in both the baseline and longitudinal sample in Mplus.

2.3.3. Stability

To assess stability of factor scores we used Spearman Rank correlations between the individual baseline and longitudinal factor scores.

3. Results

3.1. Characteristics of the sample

3.1.1. Baseline

The GROUP baseline sample consisted of 1119 patients with a psychotic disorder. We excluded 262 patients who had 20% or more positive symptom items on the CASH missing. Analyses were performed on the 857 patients who participated at baseline. Additionally a subsample of 414 patients with at least 80% of the CASH items present was available at three-year follow-up. At baseline, DSM-IV-TR diagnoses of the patients were as follows: schizophrenia (DSM-IV 295.1/295.2/295.3/295.6/295.9, $n = 596$, 69.5%), other psychotic disorders (DSM-IV 297/298.8/298.9, $n = 109$, 12.7%), schizoaffective disorder (DSM-IV 295.7, $n = 102$, 11.9%), schizophreniform disorder (DSM-IV 295.4, $n = 29$, 3.4%), bipolar disorder (DSM-IV 296.0/296.7, $n = 15$, 1.8%) and psychotic disorder induced by a substance (DSM-IV 292.11/292.12, $n = 7$, 0.8%).

3.1.2. Follow-up

Table 1 shows that no significant differences on age, gender or cannabis dependency were found between those patients who did and did not participate at follow-up. Drop-out was highest in the group of patients with a schizophrenia diagnosis. Patients who did not take part at follow-up measurements had shorter average illness duration and more patients reached only primary school as an educational level. Baseline scores on the PANSS scales were significantly lower for patients who completed follow-up assessments compared to patients lost to follow-up. The mean interval between baseline and follow-up was 2.96 (s.d. = 0.43) years with a range of 1 to 5 years. At follow-up, patients had lower mean scores on all PANSS scales relative to the baseline measurement (Table 2).

3.2. Structure of positive symptoms and FRS

3.2.1. Exploratory factor analysis

A principal axis factor analysis (PAF) was performed on all 16 CASH items that represent presence and severity of positive symptoms during the last month in 852 patients to identify FRS as a separate cluster (or clusters) within all positive symptoms. Prior to performing PAF the suitability of the data for factor analysis was checked. The Kaiser–Meyer–Oklin value was 0.86, exceeding the recommended value of 0.6 indicating small partial correlation among the variables. The Bartlett's test of sphericity reached statistical significance in the baseline sample, supporting the factorability of the correlation matrix. PAF revealed the presence of five components with an eigenvalue exceeding 1. After performing OBLIMIN rotation there was evidence for two components of FRS with eigenvalues exceeding 1 as presented in Table 3.

The first factor consisted of delusions of alien control and delusions of thought reading, broadcasting, insertion and withdrawal, further referred to as FRS-delusional self experience. The second factor consisted of auditory hallucinations (including audible thoughts), commenting and conversational voices, referred to as FRS-auditory hallucinations. The two factors explained respectively 27.5% and 6.4% of variance. A screeplot revealed a clear break at the second factor, indicating each successive factor is explaining less of the total variance (Fig. 1). Internal consistency of the FRS-delusional self experience and FRS-auditory hallucinations factor was indicated by Cronbach's α index of 0.81 and 0.85, respectively.

3.2.2. Confirmatory factor analysis

At follow-up measurement (n = 414), the CASH scores on items belonging to the cluster(s) of FRS from the PAF analysis were submitted to a confirmatory factor analysis (CFA) testing models with respectively a one- and two-factor solution. The fit indices CFI, TLI and RMSEA are shown in Table 4. The one-factor solution showed unsatisfactory results concerning the CFI, TLI and RMSEA, which indicated an inadequate fit to the data. The two-factor solution however revealed excellent fit indices. Furthermore the χ^2 difference test confirmed the better fit of the two-factor solution ($\Delta\ \chi^2 = 42.1$, $p < 0.001$). Factor loadings for the two-factor solution are shown in Table 5. The correlation between the factors was high and significant ($\rho = 0.7$, $p < 0.001$).

3.3. Stability

To investigate stability of FRS over time the CFA was repeated for the baseline data. The individual factor scores on factor 1 and 2 were saved for each patient at both assessments. Spearman Rank correlations between the factor scores of FRS-auditory hallucinations and FRS-delusional self experience were high (rho ≥ 0.90), both on baseline and at follow-up. Moderate but highly significant associations between the factor scores at baseline and three-year follow-up

Table 1
Baseline demographic and clinical variables of those without (n = 443) and with (N = 414) follow-up measurement.

	Total baseline sample N = 857			
	Without follow-up (*n = 443)*	With follow-up (*n = 414)*	Test statistics	*p*
Mean age, years (S.D.)	27.5 (7.8)	27.7 (7.9)	F(1,855) = 0.19	0.66
Gender, % male/female	79/21%	75/25%	χ2(1) = 1.42	0.26
Diagnosis, % schizophrenia	71.7	67.6	χ2(22) = 39.57	0.01
Mean duration of illness, months (S.D) [range]	4.1 (3,6) [0.02–23.16]	4.6 (4.1) [0.09–41.07]	F(1,855) = 4.10	0.04
Education, % lowest (% highest)	17.2 (3.2)	10.0 (6.1)	χ2(8) = 26.87	<0.01
Cannabis dependency %	24.4	26.3	χ2(3) = 5.84	0.12
Mean PANSS* positive scale (S.D.) [min-max]	2.00 (0.81) [1.00–5.14]	1.68 (0.73)[1.00–5.29]	F(1,833) = 36.32	<0.01
Mean PANSS* negative scale (S.D) [min-max]	2.16 (0.88) [1.00–5.43]	1.85 (0.86) [1.00–5.43]	F(1,833) = 27.35	<0.01
Mean PANSS* psychopathologic scale (S.D) [min-max]	1.88 (0.56) [1.00–4.06]	1.62 (0.48) [1.00–3.31]	F(1,833) = 50.80	<0.01

df, Degrees of freedom; S.D, standard deviation.
* Of 22 patients no PANNS scores were available.

Table 2
PANSS mean scores at baseline and follow-up measurement.

	Baseline ($n = 412$)	Follow-up ($n = 403$)	F(df)	p
Mean PANSS positive scale (S.D) [min–max]	1.68 (0.73) [1.00–5.29]	1.57 (0.66) [1.00–4.14]	4.70 (1,813)	0.03
Mean PANSS negative scale (S.D) [min–max]	1.85 (0.86) [1.00–5.43]	1.63 (0.75) [1.00–5.57]	14.64 (1,813)	<0.01
Mean PANSS psychopathologic scale (S.D) [min–max]	1.62 (0.48) [1.00–3.31]	1.48 (0.45) [1.00–3.50]	17.66 (1,813)	<0.01

df, Degrees of freedom; S.D., standard deviation.

($p < 0.001$) were found, as presented in Table 6. FRS-auditory hallucinations and FRS-delusional self experience at baseline also showed a moderate, but highly significant association with FRS-auditory hallucinations at three-year follow-up and FRS-delusional self experience at three-year follow-up, respectively.

4. Discussion

In a large sample of patients with a psychotic disorder we confirmed the presence of a two-factor structure within FRS, indicating that FRS are not just a 'chance cluster' of symptoms as has previously been suggested (Crichton, 1996). The two clusters have a high internal coherence between the symptoms within each factor and between the two factors. Our factor solution is in line with earlier reports showing a two-factor structure of FRS (Peralta and Cuesta, 1999; Loftus et al., 2000). The first factor consisted of thought insertion, reading, withdrawal, broadcasting and delusions of alien control. The second factor consisted of auditory hallucinations (including audible thoughts) and third person voices. Finally, we found that the presence of FRS-delusional self experience and/or FRS-auditory hallucinations was relatively stable over time. Previous research on the stability of symptoms in schizophrenia patients reported a similar finding. Reichenberg et al. (2005) showed that, correlations between baseline and follow-up factor loadings of psychotic symptoms ranged from 0.24 to 0.60, suggesting stability over time in the structure of psychotic symptoms in schizophrenia (Reichenberg et al., 2005).

Although the concept of FRS might no longer be relevant for diagnosis (Peralta and Cuesta, 1999; Nordgaard et al., 2008; Rosen et al., 2011) a well-defined cluster of symptoms is necessary to understand the underlying mechanisms of these symptoms. Over the years several studies have tried to unravel cognitive mechanisms associated with individual symptoms. There are relatively few studies on FRS-delusional self experience but among those, delusions of alien control were most often investigated. Usually such studies focussed on 'Sense of Agency' (SoA), which can be defined as the experience of being the initiator of one's own actions and thoughts (Synofzik et al., 2010; de Vries et al., 2013). Disturbances in the ability to attribute own actions or thoughts to oneself have been suggested to underlie delusions of control. Several studies showed that patients with delusions of alien control perform worse compared with healthy controls or patients without such delusions on tasks that measure the ability to discriminate own actions from actions of other's (Frith, 1987; Daprati et al., 1997; Frith et al., 2000; Synofzik et al., 2010; Waters and Badcock, 2010) The model that is often used to explain these findings is the forward model (Frith et al., 2000), which suggests that disturbed SoA in schizophrenia patients is linked to deficits in matching internal sensory-motor predictions with the actual sensory consequences of one's actions (Frith, 2005; Voss et al., 2010; Waters and Badcock, 2010).

An alternative explanation might be that delusions of control are the result of a disruption of the 'embodied cognition'. This concept suggests that all cognitive aspects of the human mind are imbedded in sensory-motor experiences, i.e. a happy facial expression is associated with the emotion happiness and generates changes in the autonomic nervous system (Niedenthal, 2007). By expressing and recognizing facial expressions and bodily gestures, own mental states and that of others are being represented in one's mind, this is called 'embodied cognition' (Niedenthal et al., 2005; Brunet-Gouet and Decety, 2006; Niedenthal, 2007). When the embodied involvement is disturbed, which is the case in patients with schizophrenia (Fuchs and Schlimme, 2009), disturbance of perceived emotions, mental state and sense of agency may occur (Brunet-Gouet and Decety, 2006; Fuchs and Schlimme, 2009). Moreover, results of neuroimaging studies have shown that schizophrenia patients have trouble in differentiating between their own mental state and that of others (Brunet-Gouet and Decety, 2006). This can be explained by a mechanism in which perception of another person's mental state resemble one's own mental state, in order to have effective social interaction. When their own mental state is disturbed however, this mechanism no longer operates sufficiently (Brunet-Gouet and Decety, 2006). It is hypothesized that this deficit in combination with a disturbed sense of agency explains the presence

Table 3
Principal axis factor analysis; rotated component matrix. Items most loading on a given factor are in bold.

	Baseline ($n = 857$)				
	Factor1	Factor 2	Factor 3	Factor 4	Factor 5
Eigenvalue	4.94	1.14	0.88	0.64	0.43
% Variance accounted for	27.5	6.4	4.9	3.5	2.4
Persecution delusion	−.04	−.21	**.66**	.02	.03
Jealousy delusion	.05	.07	.19	.06	.01
Guilt delusion	−.01	−.05	.20	.04	.25
Grandiosity delusion	.13	.13	.15	−.05	**.55**
Religious delusion	.03	−.04	−.03	−.01	**.65**
Somatic delusion	.07	.05	.17	**.40**	−.04
Reference delusion	.06	−.17	**.60**	−.06	.16
Alien control delusion	**.46**	−.08	.05	.14	.13
Thought reading	**.59**	−.02	.18	.05	.03
Thought broadcasting	**.49**	−.08	.13	−.00	.04
Thought insertion	**.78**	−.04	−.09	.03	−.04
Thought withdrawal	**.83**	−.00	−.10	−.07	.01
Auditory hallucinations	.03	**−.83**	.05	.01	.07
Commenting voices	.07	**−.82**	.06	.02	−.03
Conversational voices	.11	**−.65**	.03	.06	−.04
Somatic tactile hallucinations	.00	−.09	−.06	**.80**	−.06
Olfactory hallucinations	.02	−.05	−.05	**.32**	.19
Visual hallucinations	.03	−.21	−.06	.22	**.32**

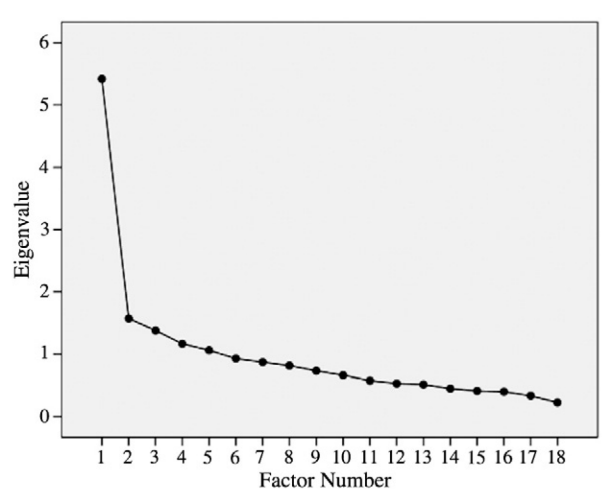

Fig. 1. Screeplot principal axis factor analysis.

Table 4
Goodness-of-fit indices of the 1 and 2 factor solution of FRS.

	Follow-up ($n = 414$)	
	1-factor solution	2-factor solution
RMSEA	0.18	0.02
CFI	0.98	1.00
TLI	0.98	1.00

Table 5
Confirmatory factor analysis; 2-factor solution factor loadings.

	Follow-up ($n = 414$)	
	FRS-delusional self experience	FRS-auditory hallucinations
Control delusion	0.86	–
Thought reading	0.86	–
Thought broadcasting	0.94	–
Thought insertion	0.93	–
Thought withdrawal	0.94	–
Auditory hallucinations	–	0.98
Commenting voices	–	0.98
Conversational voices	–	0.91

of FRS-delusional self experience of alien control (Brunet-Gouet and Decety, 2006).

Interestingly, also auditory hallucinations have been linked to disturbed self-processes (Waters et al., 2012a,b). Research on potential mechanisms underlying FRS-auditory hallucinations suggest that specific anomalies in speech production and speech monitoring brain areas might be responsible (Allen et al., 2008; Fisher et al., 2008; Daalman et al., 2011). Deficits in the forward models (i.e., a deficit in comparing predicted sensory consequences of one's intended actions and the actual sensory events) have also been suggested to underlie FRS-auditory hallucinations, which is in this context often referred to as abnormal "self-monitoring" (Fu et al., 2008). Impairment in identifying oneself as the source of speech causes inner speech to be confused with speech coming from an external source (Fisher et al., 2008; Badcock and Hugdahl, 2012; Waters et al., 2012a). In addition, the inability to recognize thoughts or language as self-generated might lead to inadequate inhibition of verbal associations which consequently lead to auditory hallucinations (Daalman et al., 2011).

Based on the above one could argue that processes related to 'self', e.g. sense of self-agency, self recognition, self monitoring, might explain at least part of the pathophysiology of FRS. This is not surprising as the presence of FRS-delusional self experience and FRS-auditory hallucinations was highly associated at both measurements ($\rho_{baseline} = 0.90$, $\rho_{follow\text{-}up} = 0.96$). However given the evidence for the presence of two separate FRS symptom clusters it is not unlikely that each of the clusters are, in addition, associated with specific cognitive abnormalities. Possibly, the abnormalities in language related functions in combination with disturbed self-processes are specific for patients with FRS-auditory hallucinations (Allen et al., 2008; Fisher et al., 2008; Waters et al., 2012a,b). In contrast, patients with FRS-delusional self experience might have deficits in representing their own and other peoples' mental states in combination with difficulties in differentiate accurately between themselves and others (Brunet-Gouet and Decety, 2006; Fuchs and Schlimme, 2009).

Our findings need to be interpreted in light of some limitations. Unfortunately, we lost half of our patient sample at the follow-up measurement. Among others, this was due to one site not using the CASH at follow-up measurement. Furthermore, we have evidence to suggest that those patients with lower levels of education, a shorter duration of illness before inclusion, with the diagnosis of schizophrenia, and with more severe psychotic and negative symptoms at baseline measurement were more likely to drop-out at follow-up. However, despite this selection bias, we found the two-factor structure of FRS in both the larger baseline sample and in the smaller follow-up sample. Finally, Schneider defined auditory hallucinations, delusional perception and ego boundary disturbances as being part of FRS (Scheinder, 1959; Mellor, 1970). We were unable to include delusional perception into the factor-analysis (Scheinder, 1959; Mellor, 1970; Rossi Monti, 1998) as this symptom is not measured in the CASH. Loftus et al. (2000) also omitted delusional perception from the analysis as very few patients experienced such delusional perceptions. In previous studies, delusional perception was part of the FRS-auditory hallucinations factor (Peralta and Cuesta, 1999). So far, it remains unclear whether a two or a three factor structure can explain the concept of Schneiders' first rank symptoms.

Using data from a large sample of patients with a psychotic disorder representative for those in clinical care and the use of both principal axis factor analysis (PAF) and confirmatory factor analysis (CAF) are strengths of our study.

In conclusion, we showed that first rank symptoms represent separate clusters within the group of positive symptoms, and consist of two underlying clusters of symptoms, which is in line with the original proposal by Kurt Schneider. Both symptom clusters are relatively stable over time within individuals. We believe that evaluating the development of symptom patterns is more fruitful then using diagnostic categories alone, since psychosis can be perceived as a syndrome with heterogenic symptomatology. Knowledge on the development of symptom patterns may contribute to our understanding of how clinical phenomena link with underlying cognitive mechanisms irrespective of diagnostic category. Furthermore, ongoing research evaluating the influence of sense of agency, self-recognition, self-monitoring on both FRS-delusional self experience and FRS-auditory hallucinations, may contribute to understanding of the pathogenesis of these symptom clusters.

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Table 6
Correlations between individual factor scores on baseline and follow-up measurement.

	FRS-delusional self experience *baseline*	FRS-auditory hallucinations *baseline*	FRS-delusional self experience *FU*	FRS-auditory hallucinations *FU*
FRS-delusional self experience *baseline*	1			
FRS-auditory hallucinations *baseline*	0.90 *	1		
FRS-delusional self experience *FU*	**0.38***	0.40*	1	
FRS-auditory hallucinations *FU*	0.40*	**0.47***	0.96 *	1

The correlations in bold represent the correlation between baseline and follow-up measurement of a particular FRS.
* $p < 0.001$.

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Contributors

Author HDH designed the study managed the literature searches and analyses, and wrote the first draft of the manuscript. Author EMD adviced on the statistical analysis, and authors NEMH and CM supervised the analyses and the writing of the paper. All authors contributed to and have approved the final manuscript.

Conflict of interest

All authors declare to have no conflicts of interest.

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