Psychometric Properties of the Revised Physical and Social Anhedonia Scales in Non-Clinical Young Adults

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Anhedonia, a central dimension within the schizotypy construct, has been considered to be a promising vulnerability marker for schizophrenia-spectrum disorders. The Revised Physical Anhedonia Scale (RPhA) and Revised Social Anhedonia Scale (RSAS) are two self-reports widely used in the assessment of anhedonia; however, they psychometric characteristics have been scarcely investigated in Spanish population. The objective of the current work was to study the psychometric properties of the Revised Physical and Social Anhedonia Scales in non-clinical young adults. The sample was composed of 728 college students with a mean age of 20.1 years (SD=2.5). The data indicated that the scales showed adequate psychometric characteristics. The Cronbach alpha was 0.95 (RSAS) and 0.92 (RPhA) respectively. The confirmatory factor analysis carried out on the matrix of tetrachoric correlations showed that both scales presented an essentially unidimensional solution. The Revised Physical and Social Anhedonia Scales seem to be adequate for psychosis-risk assessment in non-clinical populations. Future research should further investigate the construct validity in other populations and cultures as well as study its relation to emotional aspects and cognitive endophenotypes.
Keywords: schizotypy, psychosis proneness, social anhedonia, physical anhedonia, reliability, validity, adaptation.

La anhedonia ha sido considerada como un marcador prometedor de vulnerabilidad a los trastornos del espectro esquizofrénico siendo una dimensión central dentro del constructo de esquizotipia. La *Revised Physical Anhedonia Scale (RPhA)* y *Revised Social Anhedonia Scale (RSAS)*, son dos autoinformes ampliamente utilizados para la evaluación de la Anhedonia, sin embargo sus propiedades psicométricas han sido escasamente investigadas en población española. El objetivo de este trabajo fue estudiar las propiedades psicométricas de las Escalas Revisadas Anhedonia Física y Anhedonia Social en jóvenes adultos no clínicos. La muestra estuvo compuesta por 728 participantes con una edad media de 20,1 años (DT=2,5). Los datos indicaron que las escalas presentaron un comportamiento psicométrico adecuado. El alfa de Cronbach ascendió a 0,95 (RSAS) y 0,92 (RPhA) respectivamente. El análisis factorial confirmatorio llevado a cabo sobre la matriz de correlaciones tetracóricas indicó en ambas escalas la presencia de una solución factorial esencialmente unidimensional. Las Escalas Revisadas de Anhedonia Social y Anhedonia Física parecen ser pruebas adecuadas para la evaluación del riesgo de psicosis en población no clínica. Futuras investigaciones deberían seguir investigando la validez de constructo en otras poblaciones y culturas así como observar su relación con aspectos emocionales y endofenotipos cognitivos.
Palabras clave: esquizotipia, propensión a la psicosis, anhedonia social, anhedonia física, fiabilidad, validez, adaptación.

The study of negative symptoms, and more specifically of anhedonia, has increased considerably in the last few decades. The decrease in the capacity to experience pleasure in a physical and social domain seems to play an important role in the theories regarding the etiology of schizophrenia (e. g., schizotypy and schizotaxia) (Lenzenweger, 2006; Meehl, 1962), where it is considered a promising vulnerability indicator for schizophrenia-spectrum disorders (Collins, Blanchard, & Biondo, 2005).

This renewed interest for anhedonia has favored in the field of schizophrenia the development of a variety of strategies for its assessment (Horan, Kring, & Blanchard, 2006). The Chapman and colleagues' (Chapman, Chapman, & Kwapil, 1995) Revised Physical Anhedonia Scale (RPhA) (Chapman, Chapman, & Raulin, 1976) and Revised Social Anhedonia Scale (RSAS) (Eckblad, Chapman, Chapman, & Mishlove, 1982) stand out among the most widely used questionnaires. The RSAS and RPhA, based on Meehl's theory (1964), assess a series of symptoms and traits which seem characteristic of pre-schizophrenic conditions. Their psychometric properties have been extensively investigated

(Fonseca-Pedrero et al., 2008; Kwapil, Barrantes Vidal, & Silvia, 2008) (See Table 1). These scales are, at the same time, the base for other more comprehensive measures for schizotypy assessment (Fonseca-Pedrero et al., 2009; Mason & Claridge, 2006; Paino, Fonseca-Pedrero, Lemos-Giráldez, & Muñiz, 2008) and have shown their predictive validity in independent longitudinal studies (Gooding, Tallent, & Matts, 2005; Kwapil, 1998).

Regarding Physical Anhedonia, previous research shows that: a) it has recently been validated as a stable vulnerability marker for schizophrenia (Horan et al., 2008); b) high scores were found on this characteristic in both patients with schizophrenia (Burbridge & Barch, 2007; Clementz, Grove, Katsanis, & Iacono, 1991; Horan, Green, Kring, & Nuechterlein, 2006; Katsanis, Iacono, & Beiser, 1990; Schürhoff et al., 2003) and their biological relatives (Clementz et al., 1991; Franke, Maier, Hardt, & Hain, 1993; Glatt, Stone, Faraone, Seidman, & Tsuang, 2006; Grove, Lebow, Clementz, & Cerri, 1991; Katsanis et al., 1990), which allow us to successfully distinguish between non-psychotic relatives and controls (Katsanis et al., 1990); c)

Table 1

Main studies on the Revised Social Anhedonia Scale and Revised Physical Anhedonia Scale

Reference	Scales*	Sample**	Topic/Objective
(Horan, Reise, Subotnik, Ventura, & Nuechterlein, 2008)	PAS; MIS; RPhA	72 patients; 54 CC	Validity in patients with schizophrenia
(Kwapil et al., 2008)	MIS; PAS; RSAS; RPhA	6137 university students	Schizotypy dimensional structure
(Burbridge & Barch, 2007)	PhA; RSAS	49 patients with schizophrenia; 47 CC	Emtional experience and anhedonia
(Horan, Brown, & Blanchard, 2007)	RSAS; MIS	40 high schizotypy; 39 CC	Social anhedonia, affective traits, stress and coping
(Rawlings, Williams, Haslam, & Claridge, 2008)	PAS; MIS; SoA, RPhA	1073 non-clinical adults	Taxometric analysis
(Lewandowski, Barrantes-Vidal, Nelson-Gray, Clancy, Kepley, & Kwapil 2006)	PAS; MIS; RSAS; RPhA	1258 university students	Anxiety and depression symptoms
(Cohen, Leung, Saperstein, & Blanchard, 2006)	PAS; MIS; RSAS;	87 CC; 85 high schizotypy	Neuropsychological functioning
(Wuthrich & Bates, 2006)	PAS; MIS; RSAS; SPQ	1059 university students	Confirmatory factor analysis
(Kerns, 2006)	PAS; MIS; RSAS; SPQ	261 university students	Emotional processing and cognitive control
(Gooding, Tallent et al., 2005)	PAS; MIS; RSAS; PhA	91 high schizotypy; 44 CC	Follow up study
(Camisa, Bockbrader, Lysaker, Rae, Brenner, & O'Donnell, 2005)	PAS; MIS; RSAS	140 patients and non-clinical adults	Personality in the schizophrenia spectrum
(Horan, Blanchard, Gangestad, & Kwapil, 2004)	PAS; MIS; RSAS	1560 university students	Taxometric analysis

* The scales related to schizotypy are shown: SPQ: Schizotypal Personality Questionnaire; PAS: Perceptual Aberration Scale; MIS: Magical Ideation Scale; SoA: Social Anhedonia Scale; RSAS: Revised Social Anhedonia Scale; RPhA: Revised Physical Anhedonia Scale. **CC: Controls.

however, it has not been proved to be an effective predictor of psychosis in psychometric high-risk longitudinal studies (Chapman et al., 1995); d) the New York high-risk Project pointed its role as a possible risk factor enhanced in relation to attention deficits (Erlenmeyer-Kimling, Cornblatt, Rock, Roberts, Bell, & West, 1993; Freedman, Rock, Roberts, Cornblatt, & Erlenmeyer-Kimling, 1998); and e) lastly, it seems to be a stable dimension, independent from depression, negative symptoms and symptomatology in patients with chronic schizophrenia (Blanchard, Mueser, & Bellack, 1998; Herbener & Harrow, 2002; Herbener, Harrow, & Hill, 2005; Loas, Noisette, Legrand, & Boyer, 2000).

With respect to social anhedonia, it has received comparatively more attention, being considered by several authors as a promising risk marker for schizophrenia-spectrum disorders (Cohen et al., 2006; Horan et al., 2007). The relevance of social anhedonia can be synthesized in the following points: a) longitudinal studies show that 24% of participants with high scores on the RSAS exhibited schizophrenia-spectrum disorders compared to only 1% of the controls (Kwapil, 1998), as well as a higher proportion of participants diagnosed with schizoid, paranoid and schizotypal personality disorders (Gooding, Tallent et al., 2005), suggesting that it is possible that the RSAS identifies individuals at specific risk for the development of schizophrenia-spectrum disorders (Kwapil, 1998); b) likewise, high scores on social anhedonia have been found in patients with schizophrenia and schizophrenia-spectrum disorders (Blanchard et al., 1998; Burbridge & Barch, 2007; Camisa et al., 2005; Schürhoff et al., 2003), and in their relatives (Katsanis et al., 1990; Kendler, Thacker, & Walsh, 1996); c) subjects with high scores on the RSAS present a series of deficits (cognitive, emotional, attention, etc.) similar to those found in patients with schizophrenia (Collins et al., 2005; Gooding, Matts, & Rollmann, 2006; Gooding, Shea, & Matts, 2005; Gooding & Tallent, 2003; Horan et al., 2007); d) finally, in the same vein as the works by Meehl (1962; 1990), associability seems to be a structure of a taxometric nature (Horan et al., 2004).

The psychosis-proneness scales RSAS and RPhA have been translated into different languages and they have been used in their adaptation to Catalonian language (Barrantes-Vidal, Fañanás, Rosa, Caparrós, Riba, & Obiols, 2002; Muntaner, García-Sevilla, Fernández, & Torrubia, 1988); however, they have not yet been adapted into Spanish following international standards (Muñiz & Bartram, 2007), nor have the structure and nature of the dimensions conforming them been investigated. The present work attempts to conduct the study of the psychometric properties of the Revised Social Anhedonia Scale and Revised Physical Anhedonia Scale in non-clinical Spanish young adults. The adaptation and translation of these scales contribute to the availability of valid and reliable instruments with the aim of making inferences with the maximum psychometric guarantees and the possibility of identifying subjects with higher theoretical vulnerability towards developing schizophrenia-spectrum disorders.

Method

Participants

The sample studied was composed of 728 participants enrolled in 8 different careers at the University of Oviedo: Law (*n*=28, 35.7% men), Psychology (*n*=229, 21.8 % men), Education (*n*=314, 22% men), Languages (*n*=36, 27.8% men), Philosophy (*n*=29, 37.9 % men), Tourism (*n*=49, 26.5% men), Mathematics (*n*=12, 25% men), and Speech Therapy (*n*=31, 32.3% men). Five hundred and fifty two were women (75.8%). The mean age of the participants was 20.1 (*SD*=2.5). The average years of education was 16.5 (*SD*=2.3).

Measurement instruments

Revised Social Anhedonia Scale (RSAS) (Eckblad et al., 1982). The RSAS is composed of 40 items in a True/False format which measure: schizoid indifference, associability, lack of social enjoyment and indifference towards others. The internal consistency of the scale ranges from .81 to .89, and its test-retest reliability from .75 to .84. The validity of the RSAS has been empirically sustained (Chapman et al., 1995; Fonseca-Pedrero et al., 2008; Kwapil et al., 2008).

Revised Physical Anhedonia Scale (RPhA) (Chapman et al., 1976). The RPhA consists of 61 items in a True/False format, which measure the inability to experience pleasure from pleasant physical stimuli such as touching, smelling or listening to music. The internal consistency of the RSAS ranges from .77 to .86, and its test-retest reliability from .65 to .84. The construct, convergent, divergent, predictive and criterion-related validities have been widely investigated. The correlation between the RPhA and the RSAS falls around .40 (Chapman et al., 1995; Fonseca-Pedrero et al., 2008; Kwapil et al., 2008).

In addition, the *Infrequency Scale* (INFS) (Chapman & Chapman, 1983) has also been administered. This scale consists of 13 items in a True/False format. The objective is to detect those participants who respond randomly, pseudorandomly or dishonestly to the questionnaire. Those participants with 3 or more randomly answered items were eliminated from the final sample. The INFS has also been used in other studies on schizotypy (Kerns, 2006; Kwapil et al., 2008).

Procedure

The administration of the questionnaire was conducted in a collective manner in groups of 25 to 50 participants. They were at all times reminded of the confidentiality of their answers and of the voluntary character of their participation. Participants did not receive any type of incentive for their participation in the study.

Translation and adaptation scales

The translation and adaptation of both scales was carried out using the *back translation* procedure following international guidelines (Balluerka, Gorostiaga, Alonso-Arbiol, & Haranburu, 2007; Muñiz & Bartram, 2007). The English original version was translated into Spanish by an expert in the subject matter. Subsequently, this version was translated into English by another bilingual researcher familiar with English culture. Finally, a third researcher compared both English versions (original and translated).

Data Analysis

After checking the normality and sphericity assumptions, the mean scores, standard deviations, asymmetry and kurtosis indices were calculated for each item as well as the total score of both scales. Additionally, different confirmatory factorial analyses (CFA) were carried out to test the unidimensional model. The method of Estimation for RSAS items was Diagonally Weighted Least Squares. Since the item scores were non-normally distributed ordinal variables, the CFA was conducted on the tetrachoric correlation matrix (Jöreskorg & Sörbom, 1993). Five fit statistics were considered (Kline, 2005): the chi-square, the adjusted goodness-of-fit index (AGFI), the root mean square of approximation (RMSEA), the comparative fit index (CFI) and non-normed fit index (NNFI). An item parcelling was performed for the study of the RPhA scale and convergent validity between both scales, according to Little, Cunningham, Shakar & Widaman (2002) suggestions. It is recommended to conduct item parcels either when the number of items is too large or when a normal distribution is not observed. The covariation of measurement errors was never allowed. Maximum-Likelihood (ML) estimation was the method employed in both cases. Cronbach's alpha coefficient was calculated for ordinal data. SPSS 13.0, FACTOR (Lorenzo-Seva & Ferrando, 2006) and LISREL 8.7 (Jöreskorg & Sörbon, 1993) were used for all data analysis.

Results

a) Descriptive statistics of the scales

The mean score of the RSAS was 5.9 (*SD*= 4.6) whereas that of the RPhA was 15.2 (*SD*= 6.7). The descriptive statistics mean and standard deviation, for the items in both scales are presented in Table 2 and Table 3.

b) Confirmatory factor analysis

b.1) Revised Social Anhedonia Scale. The fit indices corresponding to the unidimensional model were: χ^2 =3184.48, *df*=740, *p*<.001; RMSEA=.067 [90% C.I.: .065-

.069]; AGFI=.91; CFI=.92 and NNFI=.95. The standardized coefficients were statistically significant, ranging from .88 to .29. Table 2 shows the standardized coefficients. In addition, large positive and negative standardized residuals were found. Most of the fit indices were adequate, except for χ^2, showing a reasonable goodness-of-fit and parsimony of the unidimensional model.

Table 2

Descriptive statistics and standardized factorial loadings for the Revised Social Anhedonia Scale

Items	Mean	SD	Standarized coefficients
1	0.04	0.21	0.83
2	0.06	0.24	0.79
3	0.02	0.15	0.62
4	0.12	0.33	0.39
5	0.35	0.48	0.47
6	0.09	0.29	0.47
7	0.08	0.27	0.59
8	0.05	0.21	0.73
9	0.01	0.12	0.84
10	0.30	0.46	0.44
11	0.04	0.21	0.53
12	0.21	0.40	0.40
13	0.37	0.48	0.48
14	0.27	0.44	0.51
15	0.04	0.19	0.83
16	0.16	0.36	0.46
17	0.09	0.29	0.71
18	0.15	0.35	0.47
19	0.04	0.19	0.82
20	0.23	0.42	0.52
21	0.21	0.41	0.26
22	0.25	0.44	0.44
23	0.27	0.44	0.48
24	0.11	0.31	0.50
25	0.02	0.14	0.57
26	0.07	0.26	0.72
27	0.39	0.49	0.39
28	0.05	0.22	0.90
29	0.15	0.36	0.27
30	0.27	0.45	0.29
31	0.21	0.41	0.32
32	0.06	0.23	0.70
33	0.40	0.49	0.07*
34	0.08	0.27	0.58
35	0.10	0.30	0.60
36	0.10	0.30	0.66
37	0.24	0.43	0.11*
38	0.09	0.28	0.67
39	0.07	0.25	0.67
40	0.11	0.31	0.49

*Statistically non-significant

b.2) Revised Physical Anhedonia Scale. Once four parcels of items were created, by means of random allocation, fit indices corresponding to the unidimensional model were: $\chi^2=3.11$, $df=2$, $p=.21$; RMSEA=.028 [90% C.I: .00-.083]; AGFI=.99; CFI=.99 and NNFI=.99. The standardized coefficients were statistically significant, ranging from .73 to .74. Large positive and negative standardized residuals were also found. As can be observed, the value of the χ^2 leads us to accept the null hypothesis. The remaining indices adopted values which were adequate, showing a reasonable fit to the unidimensional model.

c) The study of internal consistency of the scales

The internal consistency reliability estimates for the RSAS and the RPhA were excellent. The internal consistency of the RSAS was .95. The internal consistency of the RPhA was .92.

Table 3

Descriptive statistics for the Revised Physical Anhedonia Scale

Item	Mean	SD	Item	Mean	SD
1	0.08	0.27	31	0.11	0.31
2	0.46	0.50	32	0.47	0.50
3	0.54	0.50	33	0.07	0.25
4	0.68	0.47	34	0.09	0.29
5	0.11	0.31	35	0.26	0.44
6	0.40	0.49	36	0.22	0.41
7	0.08	0.27	37	0.32	0.47
8	0.10	0.30	38	0.11	0.31
9	0.06	0.24	39	0.09	0.28
10	0.06	0.24	40	0.14	0.35
11	0.40	0.49	41	0.44	0.50
12	0.16	0.37	42	0.32	0.47
13	0.12	0.32	43	0.04	0.19
14	0.22	0.41	44	0.31	0.46
15	0.05	0.22	45	0.38	0.48
16	0.05	0.22	46	0.29	0.45
17	0.15	0.36	47	0.22	0.41
18	0.09	0.29	48	0.09	0.29
19	0.10	0.30	49	0.24	0.43
20	0.36	0.48	50	0.26	0.44
21	0.15	0.36	51	0.05	0.21
22	0.54	0.50	52	0.68	0.47
23	0.51	0.50	53	0.67	0.47
24	0.09	0.29	54	0.22	0.41
25	0.05	0.21	55	0.19	0.39
26	0.31	0.46	56	0.36	0.48
27	0.53	0.50	57	0.08	0.27
28	0.26	0.44	58	0.38	0.49
29	0.05	0.22	59	0.22	0.41
30	0.43	0.50	60	0.38	0.48
			61	0.26	0.44

d) Convergent validity

The correlation between RSAS and RPhA total scores was .30. Finally, a confirmatory factorial analysis of the items parcels of both scales was performed using ML estimation. Two models were tested: an unidimensional model, supposing that only one general dimension underlie both scales, and a bidimensional model (for physical and social anhedonia, respectively). The fit indices corresponding to the unidimensional model were: $\chi^2=502.3$, $df=14$, $p<.001$; RMSEA=.24 [90% C.I: .22-.26]; AGFI=.62; CFI=.78 and NNFI=.69; but the fit indices corresponding to the bidimensional model were: $\chi^2=36.92$, $df=14$, $p<.001$; RMSEA=.05 [90% C.I: .03-.07]; AGFI=.97; CFI=.99 and NNFI=.98. Likewise, standard coefficients in this model ranged from .69 to .77, and square multiple correlation coefficients were higher than 0.48. The results indicated that a bidimensional solution was the most adequate.

Discussion

The inability to experience pleasure is considered to be a promising risk marker for schizophrenia and related disorders constituting a central dimension within the schizotypy-schizotaxia theories. Anhedonia can be measured through several self-reports among which the Revised Social Anhedonia Scale (RSAS) and the Revised Physical Anhedonia Scale (RPhA) stand out. The aim of this investigation was to conduct the study of the psychometric properties of the psychosis-proneness scales RSAS and RPhA in Spanish non-clinical young adults. The early detection of participants with an increased liability for the development of schizophrenia-spectrum disorders solely based on self-report measures only makes sense if it is conducted using valid and reliable instruments, as well as adequate adaptations (Muñiz & Bartram, 2007). The results of this study reveal that the RSAS and the RPhA show adequate psychometric characteristics for the assessment of physical and social anhedonia in non-clinical samples.

In general terms, the data found in this study regarding reliability and construct validity are similar to those found in the literature (Fonseca-Pedrero et al., 2008; Kwapil et al., 2008; Kwapil, Crump, & Pickup, 2002). The levels of internal consistency for both scales were adequate, converging with previous studies (Kwapil et al., 2008; Kwapil et al., 2002; Lewandowski et al., 2006). Recently, Kwapil and colleagues (2008) found internal consistency coefficients which ranged from .81 to .85 for the RSAS, and from .79 to .86 for the RPhA. With regard to factorial validity, the results point out that, for both scales, an unidimensional model is essentially the most parsimonious solution; as adjustment indices and standardized loadings are adequate and statistically significant. Likewise, the Physical Anhedonia Scale explain a low percentage of the

total variance of a large number of items, indicating that a brief version of the scale could possibly be derived with those items providing more information. Concerning the relationship between both scales, the correlation found was .30, being about .40 in previous studies (Fonseca-Pedrero et al., 2008). In our confirmatory factor analysis, the data indicate that a solution with two latent variables underlie Physical and Social Anhedonia. However, comparison with some other studies is not easy, since confirmatory factor analyses are not usually done only with Anhedonia scales, but with all Chapman's psychosis proneness scales. In this study, a covariation of items covariance errors was not allowed, being true that a better data adjustment could be obtained when such a covariation is permitted, as it was done in some other studies (Kwapil et al., 2008). Likewise, it must be considered that an item parcelling was performed, a procedure with some shortcomings (Little et al., 2002).

The assessment of schizotypy, and more specifically of anhedonia, by means of the psychometric high-risk paradigm, permits a series of advantages compared to other assessment methods (i.e. neuroimaging), as it is a valid, reliable and noninvasive method of rapid application and easier administration, scoring and interpretation; in addition, its subsequent objective is detection and intervention with prophylactic psychological treatments in high-risk subjects (Gooding, Tallent et al., 2005; Kwapil et al., 2008). Moreover, in the seventies, the Chapmans already pointed out the promising role the RPhA can play in research in the field of schizophrenia (Chapman et al., 1976). Despite not having received the same interest as Social Anhedonia, recent studies highlight its relevance in the study of schizophrenia and schizotypy (Horan et al., 2008).

The results found in this study should be interpreted in the light of some possible limitations. Firstly, the sample was exclusively composed of college students and thus may not be representative of healthy population at large. Also, there were a greater number of females than males in current study; however similar ratios were reported in previous studies. Secondly, schizotypy is a psychological construct with a multidimensional nature (Fonseca-Pedrero, Muñiz, Lemos-Giráldez, García-Cueto, Campillo-Álvarez, & Villazón García, 2007; Fonseca-Pedrero, Lemos-Giráldez. Paino, Villazón-García, & Muñiz, 2009), and in the present study the RSAS and RPhA, which assess only the negative dimension of schizotypy (physical and social anhedonia), were used. Thirdly, it is also important to point out the limitations inherent to any type of self-report, even more so in these scales of a certain syntactic complexity. Lastly, schizotypy is a psychological construct which is intrinsically neutral with respect to the result; in this sense, subjects with schizotypy would need the conjunction or interaction of multiple biopsychological risk factors, for example, genetic, pre/peri-natal insults or psychological stressors (Claridge, 1997; Fonseca-Pedrero, Lemos-Giráldez, Paino, Sierra-Baigrie, Villazón-García, & Muñiz, 2009; Palomar, 2008).

Currents models of the etiology of schizophrenia an related disorders assume that there are a neurodevelopmental continuum schizophrenia-like adjustment referred to as schizotypy (Lewandowski et al., 2006).

Future research could focus on the longitudinal study of those participants with anhedonia in order to determine the psychological processes and the dimensions which are involved in the development of frank psychosis in high-risk individuals. It is essential to further research the role played by anhedonia, both physical and social, in genetic, prodromic and psychometric high-risk studies, examining its relation with other neuropsychological and brain characteristics (Orlova et al., 2007). Lastly, taxometric analyses with a view to determine the dimensional or categorical nature of schizotypy (anhedonia) in adolescent samples and their application in conjunction with endophenotypes are also interesting lines of research for the near future.

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