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ASSESSMENT OF ESSENTIAL COMPONENTS OF SCHIZOTYPY USING NEUROCOGNITIVE MEASURES

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Schizotypy is not a unitary set of traits, but consists rather of several reliably identifiable components, not all of which are equally important in predicting risk of disorders from the spectrum of schizophrenia. The aim of this study was to verify that the negative factor of schizotypy is the most important and useful element in the prediction of risk, as it is consistently and differentially related to several frontal cognitive deficits, by comparison with other elements. Data were obtained from a total of 82 adolescent subjects (46 males and 36 females), with a mean age of 12.7 years. Participants were administered a battery of neuropsychological tests selected to assess the functioning of the prefrontal lobe, and the Multidimensional Schizotypal Traits for Young Adolescents (MSTQ) (Rawlings & MacFarlane, 1994) was used to assess schizotypy dimensions. Subjects scoring in the upper and lower 30 and 20 percent, respectively, of the MSTQ subscales distribution were compared in neuropsychological data. Results confirm that negative schizotypy (social anhedonia, flat affect and social isolation) is the only factor significantly related to high incidence of cognitive deficits.

*La esquizotipia no representa un conjunto unitario de rasgos sino que consta de varios componentes cuya importancia es desigual en la predicción del riesgo de desarrollar trastornos del espectro esquizofrénico. El objeto de este estudio es el comprobar que el factor negativo de la esquizotipia es el componente más importante y útil como predictor de riesgo, en la medida en que guarda una relación específica y estable con diversos déficit cognitivos frontales, comparativamente con otros factores. Los datos han sido obtenidos de 82 adolescentes (46 varones y 36 mujeres), de una media de edad de 12,7 años, a quienes se les ha administrado una batería de pruebas neuropsicológicas que exploran el funcionamiento del lóbulo prefrontal y el Multidimensional Schizotypal Traits for Young Adolescents (MSTQ) (Rawlings & MacFarlane, 1994), para valorar las dimensiones de esquizotipia. Se han seleccionado a los sujetos situados en los extremos de la distribución de las subescalas del MSTQ (30 ó 20 por ciento superior e inferior) y se compararon sus rendimientos neuropsicológicos. Los resultados confirman que la esquizotipia negativa (anhedonia social, ausencia de emociones y aislamiento) es el único factor que guarda relación significativa con más déficit co*gnitivos.

The schizotypal personality was initially defined by Rado (1953, 1960), on identifying the following characteristics, supposedly caused by genetic dispositions a) an integrative pleasure deficiency (or anhedonia); b) proprioceptive diathesis, manifested in the form of an aberrant consciousness of the body, causing the appearance of distortions in the perception of body schema; c) motivational deficit; and d) inability to organise goal-oriented activities. For Rado, the supposed diathesis constituted an origin common to schizotypy and schizophrenia, so that there would be a degree of etiological unity of these two clinical conditions. Meehl (1962, 1990) defined schizotypy in a similar way, highlighting among its basic signs and symptoms the following: a) cognitive slippage (a mild form of thought disorder); b) interpersonal aversiveness (social phobia); c) anhedonia or deficit in ability to experience pleasure; and d) ambivalence.

Subsequently, the definition of schizotypy was reformulated on the basis of two different lines of research, one based on the observation of some behavioural characteristics of the relatives of schizophrenic patients and another based on the transitory and subclinical psychotic experiences observed in people with no family history of schizophrenia (Kendler, 1985). The result of these observations was the operative description that appeared in the DSM-IV, which is based on the following signs and symptoms: ideas of reference, odd beliefs, unusual perceptual experiences, odd thinking and and speech (e.g., vague, circunstantial, metaphorical, overelaborate or stereotyped), suspiciousness, inappropriate or constricted affect, odd behaviour, lack of close

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friends, and social anxiety (American Psychological Association, 1994).

There remain, however, several inadequately answered questions with regard to schizotypal disorder, referring to how it is related to schizophrenia, to its structure and the factors making it up, to its essential components, to its genetic or environmental determinants, to measurement processes, and to the identification of early markers of risk and possible protective factors, among other aspects. Attempts to respond to these questions have given rise to several explanatory hypotheses, which form the basis of various theoretical models. The *risk*, *latent risk* and *schizotaxia* models on the relationship between schizotypy and schizophrenia, formulated by Holzman (1995), are examples of these.

In recent years, for example, it has been revealed that schizotypy is not a unitary entity, but rather a multifactorial one that includes, as is the case of schizophrenia, sets of positive, negative and disorganisational signs and symptoms (Liddle, 1987; Liddle and Barnes, 1990; Liddle and Morris, 1991). The positive and negative symptoms have been widely confirmed in factorial analyses, made on the basis of a variety of scales and questionnaire items created for that purpose. There is less agreement, however, on the third factor, whose content refers to behaviours of impulsive social non-conformity or social deterioration, as well as to characteristics of cognitive disorganisation.

Thus, the factors of schizotypy are to some extent in parallel with the three recognised subgroups of schizophrenic symptoms (Andreasen and Olsen, 1982; Arndt, Alliger and Andreasen, 1991). Considering the results in general, the factorial analyses can be seen to show the existence of at least two clearly distinguishable dimensions in schizotypy. The first can be called "distortion of reality", and appears to be related to positive aspects of schizophrenic symptomatology; the second corresponds to the negative symptoms, and can be considered as the "anhedonia" dimension. The third dimension, which includes characteristics of cognitive disorganisation and social anxiety, does not appear consistently, a fact that may be partly due to the nature and range of the schizotypy scales used in the different studies. It is also possible that this dimension incorporates simultaneously both positive and negative characteristics of schizotypy, but that the use of different measures in the factorial studies has prevented it from being defined in a precise way.

Consequently, although research carried out on the measurement and structure of schizotypy appears to confirm the multidimensional character of this syndrome, there is uncertainty as to which factor or factors constitute its essential component. For a large number of researchers, the negative symptoms of the schizotypal personality (anhedonia, social isolation and restricted affect) are the most important, while anomalies of perception and thought do not exceed the clinical thresholds established for hallucinations or delusions. Thus, compared to schizophrenia, the schizotypal personality could be defined essentially by negative symptoms, which may be even more accentuated than in schizophrenia, and by the presence of relatively subtle positive symptoms, so that the main distinguishing factor between the two syndromes is the intensity of the positive signs.

The tendency to experience hallucinatory phenomena is not only found in clinical disorders of a psychotic nature, but may also be present in subjects that show personality anomalies, not related to odd or eccentric behaviour; that is, not belonging to cluster A (López Rodrigo, Paíno Piñeiro, Martínez Suárez and Lemos Giráldez, 1996). Claridge and Beech (1995) point out in this regard that the tendency to present experiences that make up the positive factor is not exclusive to disorders from the schizophrenic spectrum, these experiences being necessary but not sufficient characteristics of schizophrenia. Therefore, other components of schizotypy, such as cognitive disorganisation, anhedonia and social problems, may be much more important in the definition of the syndrome. This view is shared by other authors (Clementz, Grove, Iacano and Sweeney, 1992; Siever, 1992).

On the basis of the evidence of a significant relationship between the negative symptoms of schizophrenia and various neuropsychological deficits (Andreasen, Flaum, Swayze, Tyrell and Arndt, 1990; Braff et al., 1991), particularly those related to pre-frontal executive functions (Seidman et al., 1995) and to other brain metabolism measures, which reinforce the relationship between negative symptoms and hypofrontality (Merriam, Kay, Opler, Kushner and Van Praag, 1990; Wolkin et al., 1992), our aim in this study is to test empirically the hypothesis that the essential components of schizotypy are the negative symptoms, whose value as predictive markers for risk of schizophrenia may be particularly important.

From an operative point of view, the following specific objectives were set: 1) bearing in mind that the schi-

zotypy concept is multifactorial, and that it is possible to distinguish between at least three components (*positive*, *negative* and *impulsive nonconformity*), to discover which factors of schizotypy are most closely associated with cognitive deficits, which may be useful as early markers of risk; and 2) in order to establish more precisely the cognitive features of schizotypy, to compare the level of psychometric schizotypy and certain neuropsychological functions (particularly executive functions, i.e., operations that require effort) in two samples of the population: a normal group and a group with higher theoretical risk of developing psychopathological alterations.

METHOD

Subjects

82 children and adolescents (46 males and 36 females) aged between 8 and 18 years (Mean=12.71; SD=1.78), selected at random from supposedly differentiated populations, thus allowing the formation of two groups:

Normal control group, made up of 55 primary school children, average age 12.6 years (SD=0.76), of whom 58.2% were males (n=32) and 41.8% females (n=23).

Risk group, made up of 27 residents from a children's home, average age 12.93 years (SD=2.93), of whom 51.9% were males (n=14) and 48.1% females (n=13).

From a theoretical point of view, it is assumed that the two groups of subjects might be different in terms of risk of developing psychological disorders, if we take into account the psychosociological background, particularly higher family psychiatric morbidity and a greater number of environmental stressors, of the so-called risk group. Nevertheless, the two groups are relatively similar in terms of educational level and type of school attended (all state schools).

There were no significant differences between the two groups in terms of either age (t=0.78, p=0.44) or gender distribution (chi- square=0.29, p=0.64).

Instruments

1. As a measure of psychometric schizotypy we used the Multidimensional Schizotypal Traits Questionnaire (MSTQ) (Rawlings and MacFarlane, 1994), in its experimental adaptation by Lemos. This questionnaire comprises 74 items that must be answered Yes or No. Recently, Martínez, Ferrando, Lemos, Inda, Páino and López (1997), all members of this research team, carried out a new factorial analysis of the items making up the scale, obtaining the following three subscales of schizotypy: a) *Positive schizotypy*, which refers to characteristics of reality distortion, such as magical ideas, unusual perceptions and referential ideas; b) *Negative schizotypy*, referring to patterns of social isolation, anhedonia and restricted affect; and c) *Impulsive nonconformity*, referring to characteristics of impulsive-type personality, social anxiety and maladjusted behaviours.
2. Two neuropsychological tests for assessing frontal executive functions: concepts formation, mental flexibility and planning, in the versions included in the STIM software package (provided by NeuroScan Technical Center, Inc.):
   a) *Stroop Test* (Stroop, 1935), which consists of the successive random presentation of 100 verbal stimuli in the form of words denoting four colours ("red", "yellow", "green" and "blue"), written in any one these four colours. There are two presentation possibilities: the word may be written in the colour it denotes, or it may be written in one of the other three colours. If the word and the colour coincide (congruent stimuli), subjects should press the right button of the mouse; in the opposite case (incongruent stimuli), they should press the left button. Presentation of stimuli was carried out with a duration for each stimulus of 200 ms and a 1-second interstimulus interval. Four measures were obtained: number of correct responses, number of time outs, reaction time for congruent stimuli and reaction time for incongruent stimuli.
   b) *Wisconsin Card Sorting Test* (WCST) (Grant and Berg, 1948; Heaton, Chelune, Talley, Kay and Curtiss, 1981). The test begins with a start-up screen showing four different cards from a pack, which vary in number, colour and form. At the same time, another card is presented in the lower part of the screen, and this must be paired with one of the other four according to the criterion the subject considers most appropriate. The difficulty of the task lies in the fact that there are three different sorting criteria maintained in 3 series of 10 stimuli each, and that the programme keeps changing. The subject must discover by trial and error the current sorting criterion, which may be the colour, form or number of images on the card. The programme provides auditory and visual feedback informing the subject of success or fai-

lure in each response selected. Measures recorded are number of correct responses, number of errors and number of categories completed.

3. We also used a sustained attention task, which was also included in the STIM package referred to above: *Continuous Performance Test* (CPT). This consists of a visomotor task in which the response must be contingent on the appearance of two successive letters. These types of test have traditionally been used for the assessment of attentional processes (Rosvold, Mirsky, Sarason, Bransome and Beck, 1956), and they have shown themselves to be particularly sensitive as cognitive markers of schizophrenia (Ruiz-Vargas, 1991). In the version used, the subject is presented with 400 letters (4 blocks of 100 letters each) in random order, with a duration for each stimulus presentation of 50 ms and an interstimulus interval of 1 sec. Subjects were told to respond only when there appeared on the screen the letter P (signal stimulus) followed by the letter T (target stimulus). On some occasions only the P appeared, as a false alarm, with no T appearing after it; this increased the risk of committing errors. The measures obtained were number of correct responses (or errors of omission, if the difference is obtained with respect to total possible correct responses); errors of commission (false alarms); the sensitivity measure *a-prime*, which refers to subject's ability to discriminate the signal stimulus from the rest of the contextual stimuli; the measure of the response criterion *beta*, whose high values indicate a tendency to present a conservative pattern of responses and whose low values a liberal or risky pattern; and reaction times expressed in milliseconds (all values obtained for each of the four blocks and for the total of the test).
4. Two specific memory tasks:
   a) *Word Recognition Test* (Test de Reconocimiento de Palabras, TRP), developed by this research team. The test is based on the concept of reality monitoring, an experimental paradigm related to self-awareness and described by Johnson and Raye (1981). This paradigm, which refers to those processes the individual uses for discriminating between an internal stimulus source and an external source, was used by Bentall, Baker and Havers (1991) in patients with hallucinations and delusions, and later by Frith (1992), who found that people that present hallucinatory experiences are more likely to attribute internal stimuli or experiences to an external source. The use of this paradigm is supported by the assumption that schizotypal people may also have a tendency to make attributional errors of this type.

   The task comprises two distinct phases: in the first, a series of 30 words is presented on the computer screen and the subject is asked to write, for each one, another word conceptually related to it, thus forming a pair (for example, family-father). The subject must write the word on the keyboard, but without visual feedback of it on the screen as s/he writes it. Carrying out this task without this visual feedback, demanding that the person simply stores the memory at a central, self-awareness level, has been shown to be an experimental condition that hinders its execution in schizophrenic patients (Frith and Done, 1989; Malenka, Angel, Hamptom and Berger, 1982).

   In the second phase, which takes place approximately 30 minutes after completion of the first, without prior warning all the words (those generated by the computer programme and those generated by the subject) are presented successively in random order, and the subject is asked to identify their origin (external or internal).

   Two different types of error are recorded, corresponding to the source to which the words are attributed: internal attribution errors (when a word generated by the subject is attributed to the computer, that is, a self-generated word is considered hetero-generated), and external attribution errors (when a word initially generated by the computer is identified as being produced by the subject).

   b) *Visual Test of Working Memory* (Prueba Visual de Memoria Operativa, PVMO), developed by this research team. This task was designed for assessing so-called working or functional memory, through the use of visual stimuli. For it to be carried out it is necessary to initiate attentional processes and to use memory, basically short-term memory processes.

   A series of computer screens are presented with green or blue circles distributed in different ways. The subject must count the number of green circles that appear in each screen presentation. At a given moment, s/he is asked to recall the number of green circles in each of the screens. The diffi-

culty level of the task increases progressively as the number of screens the person has to remember rises. An error is registered when the total number of target circles stated by the subject does not correspond to what really appeared in each screen.

5. Executive function tasks, which imply, in turn, processes of both attention and working memory:
   a) *Trail Making Test*, parts A and B (TMT-A and TMT-B) (Reitan, 1958; Reitan and Davison, 1974). In version B of this test the subjects must draw a series of lines that connect 26 letters and numbers in random order (for example, 1-A-2-B-3-C…). Performance of this test combines motor rapidity and the individual's ability to maintain in the memory the correct order of the sequences of letters and numbers, as well as his/her latest responses, with the aim of completing the sequence correctly and efficiently. Time for completing the series is recorded.

      Part A of this test (TMT-A) is simpler, since in this case the subject only has to link with lines a series of 25 numbers in correlative order, so that the cognitive demands are the same, except that in this case alternation of criteria is omitted. Again, time taken is recorded.
   b) *Verbal Fluency Task(FV).* This test requires the subject to produce, in 90 seconds, as many words as possible beginning with a given letter. Target letters used were T, P, C and S. Task conditions are that any word is acceptable, except for those with the same root, those made simply by changing the gender, and proper nouns. This test is scored according to number of words generated, which reflects, among other things, the person's capacity for retaining in the memory the conditions stipulated in the task.
6. Tests that complete general cognitive functioning. Those selected were from the *Wechsler Intelligence Scale for Children* (WISC): the verbal subtests of Similarities and Vocabulary, and the manipulative Digit Symbol and Block Design. These subtests were applied in accordance with the norms specified in the manual of the Spanish version (Wechsler, 1974).

PROCEDURE

Potential participants in the study were given basic information about the objective of the research, and were asked to collaborate as volunteers. The members of each group were cited to take the tests individually in a laboratory of the Psychology Faculty of the University of Oviedo. These tests were administered in the following order: Stroop Tests, CPT, WCST and the first part of the TRP. With the purpose of leaving a reasonable interval (around 30 min.) before administering the second part of this final test, subjects were given the four subtests selected from the WISC (Similarities, Vocabulary, Digit Symbol and Block Design), the Verbal Fluency Task and the TMT (parts A and B). Subsequently, the second part of the TRP was applied, and finally the PVMO.

The administration of the schizotypy test (MSTQ) was different for each sample. For the normal control group it was applied collectively in the school itself; for the risk group it was applied individually in the same session as the rest of the tests.

The size of the sample and the time employed with each subject made it necessary for several researchers to participate. With the aim of guaranteeing inter-rater reliability, possible differences in the form of administration of the tests were reduced to a minimum, after prior agreement on the way the experimental sessions should be carried out. It is also important to point out that possible interaction with the researcher was kept to a minimum, given that the majority of the tasks were presented in computerised versions, and each test included the necessary instructions.

RESULTS

The first objective of the study was to compare the performance obtained in the neuropsychological tests by the subjects with high and low schizotypy, defined by means of the MSTQ scales. In order to do so, and with the aim of maximising possible differences in the cortical functions of high- and low-schizotypy subjects, we selected from the total sample only those cases whose scores, in each one of the MSTQ factors, were equal or superior to percentile 70 (high schizotypy) and those whose scores were equal to or below percentile 30 (low schizotypy).

From the results of the analysis, shown in Table 1, it can be seen that negative schizotypy is the factor in which the most notable differences in the cognitive functions of the two groups are accumulated. In the majority of the neuropsychological measures, we find poorer performances by the high negative schizotypy group, with significant differences in tasks that involve attentional processes (Stroop Tests, CPT and TMT-B),

working memory (PVMO) and verbal fluency. On the other hand, no significant differences are found between the two groups in the concept formation test (WCST). The other measures, of recognition memory (TRP) and of intellectual processes (WISC), also show differences between high- and low-schizotypy subjects, but they do not present a consistent and exclusive relationship to the negative factor (perhaps with the exception of the Similarities subtest of WISC, for which the difference between the subgroups is bordering on statistical significance). The Similarities test presents a relationship, however, to abstract verbal reasoning and concepts formation.

Bearing in mind that, of the cognitive functions explored, deficit in sustained attention has been considered by previous research as one of the principal cognitive markers of schizotypy, we compared in more detail the performance of high- and low-schizotypy subjects in each of the four blocks of stimuli into which the CPT was divided and in global means. The results, shown in Table 2, again corroborate the hypothesis that negative schizotypy is the factor that best discriminates in the attentional processes of the two groups, compared to the other two factors.

On the basis of the above data, it would appear reasonable to state that negative schizotypy is the most relevant factor of this clinical condition, and in which the greatest neuropsychological differences are manifested. It has been demonstrated, moreover, that the negative factor expresses characteristics differentiated from the other two factors, since its correlations with the positive factor and that of impulsive nonconformity are quite low (r=0.21 and r=0.06, respectively).

In the second part of the study we compared total scores obtained in schizotypy and in the neuropsychological measures by the subgroups normal (n=55) and risk (n=27). Results indicate that the two groups are different in the positive and negative factors of schizotypy, and also in various neuropsychological functions (Table 3). The highest levels of positive and negative schizotypy correspond to the risk group –which could be interpreted as reflecting both genetic and environmental influences. At the same time, the risk group is seen to present a greater number of cognitive deficits, given the significant differences appreciated in the majority of the neuropsychological measures.

Bearing in mind, however, that the main objective of this study was to determine the relationship between cognitive anomalies and the factors of schizotypy, several Analyses of Variance were carried out in order to compare the extreme subgroups of subjects within each of the two groups. To this end, we once again selected those subjects whose scores in each of the three schizotypy factors were situated in percentile 70 or higher

Table 1
Comparison of means of performances in neuropsychological tests by subjects with low and high schizotypy (percentile ≤30 and percentile ≥70, in each of the three factors). Mann-Whitney "U" values and statistical significance

Positive factor (n=24-21)	Negative factor (n=22-25)	Impulsive nonconformity factor (n=6-12)
TRP: External attributional errors (U=173; p=.071) WISC: Block Design (U=73; p=.076) Digit Symbol (U=155.5; p=.046)	STROOP: Correct responses (U=66; p=.007) Reaction time for congruent stimuli (U=81; p=.030) Reaction time for incongruent stimuli (U=87; p=.049) CPT: Correct responses (U=161.5; p=.015) Errors of commission (false alarms) (U=189; p=.066) Sensitivity (a-prime) (U=176; p=.034) TRP: External attributional errors (U=184; p=.051) PVMO: Errors (U=116; p=.001) Verbal Fluency: Number of words (U=86; p=.045) TMT-B: Execution time (U=158; p=.013) WISC: Similarities (U=191; p=.071) Vocabulary (U=160.5; p=.013) Digit Symbol (U=162.5; p=.016)	WISC: Vocabulary (U=16; p=.057)

(high schizotypy), or in percentile 30 or lower (low schizotypy).

Another, more extreme cut-off criterion was also set (percentile 80 or above and percentile 20 or below), in order to compare more markedly opposing subpopulations in the schizotypy measures.

The results of comparing performances, for the significant variables, in the neuropsychological tests of the four subsamples are shown in Tables 4, 5 and 6.

Once again, it can be seen that the negative factor of schizotypy is the most relevant with regard to the neuropsychological deficits of the two groups of subjects, the risk group being that which presents the poorer performances or a greater number of alterations. The neuropsychological differences between the groups become more evident when the terms of comparison are made narrower, that is, when performance of the most markedly schizotypal subjects (those above percentile 80) is compared with that of the least schizotypal subjects (those below percentile 20). Tests in which specific deficits associated with negative schizotypy are observed, and therefore those with most discriminative capacity, are the WCST, number of correct responses in the CPT, errors of internal attribution in the TRP, errors in the PVMO, the TMT-B, and the Digit Symbol subtest of the WISC. The remainder of the tests used produced results that were quite unstable, and therefore not specific to negative schizotypy (Table 5).

With regard to positive schizotypy and impulsive nonconformity, the differences between the extreme subgroups (percentile 20 vs. percentile 80), in the cognitive variables, are restricted to the Similarities and Vocabulary subtests of the WISC, a fact that indicates the poor discrimination of the rest of the tests in these factors (Tables 4 and 6).

DISCUSSION

The aim of this study was to determine the essential components of schizotypy, identifying which of its factors are most closely related to possible neurocognitive anomalies. Taking previous research as a reference, tests were chosen that explore frontal neuropsychological functions, and others designed for assessing certain memory functions. Alterations in the cortical and orbital structures of the frontal lobe give rise to difficulties in the suppression of irrelevant stimuli and hinder the discrimination of and appropriate response to important stimuli, producing attentional deficits, impulsiveness and deterioration of the abilities to organise goal-oriented responses and to attend to and adequately process affective signals.

In accordance with the hypothesis formulated, the results obtained confirm the existence of a significant relationship between psychometric schizotypy and cognitive deficits. Moreover, they are conclusive with regard to establishing that the negative factor of schizotypy is the only one consistently related to a large number of deficits in executive frontal and verbal functions that are detectable in schoolchildren; scarcely any differences were

Table 2
Comparison of means of performances in CPT by subjects with low and high schizotypy (percentile ≤30 and percentile ≥70, in each of the three factors). Mann-Whitney "U" values and statistical significance

Positive factor (n=24-21)	Negative factor (n=22-25)	Impulsive nonconformity factor (n=6-12)
Block 1: Correct responses (U=166.5; p=.022) Sensitivity (a-prime) (U=157; p=.024)	Block 1: Correct responses (U=203; p=.089) Sensitivity (a-prime) (U=182; p=.043) Reaction time (U=196; p=.092) Block 2: Correct responses (U=198.5; p=.087) Errors of commission (U=146.5; p=.005) Response criterion (beta) (U=181.5; p=.045) Sensitivity (a-prime) (U=165.5; p=.015) Block 3: Correct responses (U=170; p=.016) Errors of commission (U=175; p=.028) Sensitivity (a-prime) (U=165.5; p=.015) Block 4: Correct responses (U=196; p=.082) Sensitivity (a-prime) (U=183.5; p=.047 Mean Correct responses (U=161.5; p=.014) Mean Errors of commission (U=189; p=.066) Mean Sensitivity (a-prime) (U=176; p=.034)	Block 1: Reaction time (U=17; p=.0752)

found in the positive or impulsive nonconformity factors. Subjects with high negative schizotypy obtain, in general, poorer results in attentional tasks and those related to concept formation, planning and mental flexibility, working memory and executive functions.

The significant and specific relationship observed between the negative schizotypy factor and frontal neurocognitive alterations, in contrast to the case of the other two factors, partly explains the finding of inconsistent correlations in other studies that compare global measures or total scores from schizotypy questionnaires with neuropsychological performance (Paíno Piñeiro, López Rodrigo, Inda Caro, Martínez Suárez and Lemos Giráldez, 1997). Total scores may in some way mask or strongly attenuate the specific and probably exclusive effect of negative features.

Table 3
Comparison of normal and risk groups in MSTQ scores and in performances in neuropsychological measures. Means, Mann-Whitney "U" values and statistical significance

Variables	Normal group	Risk group	U	p
MSTQ:				
Positive	9.70	12.93	468.5	.009
Negative	3.54	3.67	476.0	.010
Impulsive nonconformity	2.20	1.93	675.5	n.s.
STROOP:				
Correct responses	68.81	65.17	332.0	n.s.
Time outs	15.64	20.19	326.0	n.s.
Reaction time for congruent stimuli	708.25	665.40	396.0	n.s.
Reaction time for incongruent st imuli	794.19	683.06	356.0	n.s.
WCST:				
Correct responses	56.48	51.85	483.0	.038
Errors	47.27	58.44	452.0	.030
Categories completed	5.48	4.93	488.5	.044
CPT:				
Correct responses	13.96	13.06	359.5	.001
Errors of commission (false alarms)	4.86	7.69	552.5	n.s.
Response criteria (beta)	0.95	0.92	438.0	.020
Sensitivity (a-prime)	0.77	0.41	613.5	n.s.
Reaction time	345.22	362.04	564.0	n.s.
TRP:				
Internal attributional errors	6.04	10.52	389.5	.004
External attributional errors	6.27	7.85	514.0	n.s.
PVMO:				
Errors	16.46	20.93	459.0	.037
TMT-A:				
Time in secs.	48.48	58.59	498.5	n.s.
TMT-B:				
Time in secs.	96.90	130.30	374.5	.002
Verbal Fluency:				
Number of words	17.10	11.48	304.5	.075
WISC:				
Similarities	12.46	9.00	259.0	.000
Vocabulary	10.44	5.17	188.0	.000
Block Design	10.16	8.83	267.5	n.s.
Digit Symbol	12.21	8.79	273.5	.000

n.s. = non-significant

We should not ignore, however, the significant relationship observed between neuropsychological deficits and the poor performance of subjects with high schizotypy in some tasks designed to test intellectual abilities. This association has also been found in other studies (Obiols, 1996), and both aspects may be considered a consequence of cortical deterioration.

The results of the study indicate, moreover, that when, in addition to the features of negative schizotypy, other risk factors are present, such as possible genetic vulnerability or psychosocial stress, neuropsychological alterations are much more evident and severe.

The importance of this finding lies in the fact that these neuropsychological anomalies may be detected in healthy populations, without appreciable psychiatric alterations and at early ages. Furthermore, the results reinforce the construct validity of psychometric schizotypy and its possible predictive validity in the identification of risk subjects.

These results clearly do not predict that the set of cognitive deficits observed in high negative schizotypy subjects (with or without family psychiatric morbidity or environmental stress) constitute a definite and specific risk for the development of schizotypal processes in the future. It is possible that they reflect vulnerability to a wide range of disorders in the future, but this is a question that can only be answered by means of longitudinal studies of the subsamples. Nevertheless, in theory, we can expect subjects with high negative schizotypy and high stress levels or genetic predisposition to be the most vulnerable to disorders from the schizophrenic spectrum.

The present study, in addition to corroborating the fact that the negative factor of schizotypy is its most important or essential factor when the condition is defined on the basis of psychometric criteria, demonstrates that it probably continues to be the most relevant factor when schizotypy is analysed with criteria of a somewhat more genetic and/or environmental nature. This is the conclusion that would seem to emerge from the fact that the significant association between negative schizotypy and neuropsychological deficit increases in risk-group subjects, that is, in those presenting greater family psychiatric morbidity and more psychosocial problems.

The findings of this study are coincident with theoreti-

cal models that refer to the existence of differences in the prefrontal neurobiological bases of schizotypy, as compared to schizophrenia, in which there would supposedly exist a dopaminergic over-arousal of the striate. Whilst schizotypy is related to functional alterations in a circuit of the prefrontal cortex, which are responsible for social isolation and flat affect (i.e., for the negative symptoms characteristic of it) (Barrantes, Serrano and Obiols, 1996), schizophrenia is supposedly related to a dysfunction of a limbic circuit, which constitutes the neurological substrate of perceptive anomalies and positive symptoms (Bogerts, 1997).

Various authors have confirmed the relationship between a circuit that links the prefrontal cortex with subcortical structures and the presence of negative symptoms (the fronto-striate-palido-thalamic circuit) (Waddington, 1993), manifested in the significant reduction of the metabolic activity of these structures (Tamminga et al., 1992; Walker and Gale, 1995; Weinberger, 1987). Negative symptoms, on the other hand, appear to have a character that is relatively more persistent than the positive ones, as longitudinal studies have shown (Peralta, Cuesta and de León, 1991; Walker and Lewine, 1988). Functional alterations in the prefrontal cortex, observed in schizotypes with negative symptoms, have been demonstrated in a variety of tasks, such as the CPT, the WCST or the Trail Making Test (part B), but not in tests that explore more generalised cortical functions, such as the Vocabulary and Block Design subtests of the Wechsler scales. These neuropsychological findings are associated, moreover, with a reduction in the concentration of homovanilic acid in

Table 4
"F" values and statistical significance of means of neuropsychological variables obtained by subjects with low and high positive schizotypy (cut-off points at percentile ≤30 and percentile ≥70, and percentile ≤20 and percentile ≥80), from normal and risk groups

Cut-off points:	Normal group		Risk group			
Percentile ≤30/Percentile ≥70	Low schizotypy (n=17)	High schizotypy (n=14)	Low schizotypy (n=10)	High schizotypy (n=10)	F	p
TRP:						
Internal attributional errors	6.59	5.14	9.80	10.60	3.07	.030
External attributional errors	8.35	5.43	11.00	4.90	3.41	.030
TMT-B:						
Time in secs.	109.65	80.57	109.90	135.70	2.71	.050
WISC:						
Similarities	12.59	13.36	9.33	5.11	5.14	.004
Vocabulary	10.47	10.43	6.33	5.11	5.76	.002
Digit Symbol	12.47	11.72	9.45	8.45	3.30	.030
Cut-off points:	**Normal group**		**Risk group**			
Percentile ≤20/Percentile ≥80	**Low schizotypy (n=11)**	**High schizotypy (n=10)**	**Low schizotypy (n=7)**	**High schizotypy (n=6)**	**F**	**p**
WISC:						
Similarities	13.73	13.20	10.43	8.67	4.33	.012

Table 5
"F" values and statistical significance of means of neuropsychological variables obtained by subjects with low and high negative schizotypy (cut-off points at percentile ≤30 and percentile ≥70, and percentile ≤20 and percentile ≥80), from normal and risk groups

Cut-off points:	Normal group		Risk group			
Percentile ≤30/Percentile ≥70	Low schizotypy (n=20)	High schizotypy (n=20)	Low schizotypy (n=17)	High schizotypy (n=10)	F	p
STROOP:						
Reaction time for congruent stimuli	813.28	596.38	666.59	663.38	2.47	.070
WCST:						
Correct responses	57.70	56.55	53.65	48.80	3.38	.020
Errors	45.25	45.25	55.29	63.80	2.86	.040
Categories completed	5.65	5.50	5.12	4.60	2.96	.040
TRP:						
Internal attributional errors	6.50	6.75	10.82	10.00	2.65	.050
TMT-B:						
Time in secs.	89.4	111.5	129.59	131.50	3.04	.030
WISC:						
Similarities	13.40	11.85	9.36	8.50	5.88	.001
Vocabulary	10.65	10.10	6.07	3.90	11.55	.000
Digit Symbol	12.70	10.95	9.29	8.10	5.52	.002
Cut-off points:	**Normal group**		**Risk group**			
Percentile ≤30/Percentile ≥70	**Low schizotypy (n=20)**	**High schizotypy (n=11)**	**Low schizotypy (n=16)**	**High schizotypy (n=7)**	**F**	**p**
WCST:						
Correct responses	57.70	56.00	53.94	46.57	3.89	.014
Errors	45.25	47.64	54.31	69.71	3.06	.037
Categories completed	5.65	5.36	5.19	4.29	3.50	.022
CPT:						
Correct responses	13.79	13.70	13.77	11.36	3.07	.036
TRP:						
Internal attributional errors	6.50	6.45	11.18	11.43	3.09	.035
PVMO:						
Errors	13.05	26.27	18.25	25.14	3.56	.021
TMT-B:						
Time in secs.	89.40	121.36	127.25	127.86	2.46	.075
WISC:						
Similarities	13.40	11.63	9.36	7.43	7.25	.000
Vocabulary	10.65	8.91	6.07	2.71	13.58	.000
Digit Symbol	12.70	10.27	9.29	7.57	5.65	.002

Table 6
"F" values and statistical significance of means of neuropsychological variables obtained by subjects with low and high schizotypy and impulsive nonconformity factor (cut-off points at percentile ≤30 and percentile ≥70, and percentile ≤20 and percentile ≥80), from normal and risk groups

Cut-off points:	Normal group		Risk group			
Percentile ≤30/Percentile ≥70	Low schizotypy (n=21)	High schizotypy (n=20)	Low schizotypy (n=13)	High schizotypy (n=10)	F	p
TRP: Internal attribution errors	6.19	6.55	10.62	11.30	3.31	.020
TRP: External attribution errors	6.05	5.65	6.77	9.90	2.54	.060
TMT-B: Time in secs.	95.76	97.70	134.23	136.80	3.46	.020
WISC: Similarities	11.38	13.00	10.00	8.22	4.34	.008
WISC: Vocabulary	10.29	10.60	5.75	4.56	8.25	.000
WISC: Digit Symbol	12.87	11.05	9.25	9.00	4.08	.010
Cut-off points:	**Normal group**		**Risk group**			
Percentile ≤20/Percentile ≥80	**Low schizotypy (n=10)**	**High schizotypy (n=11)**	**Low schizotypy (n=11)**	**High schizotypy (n=10)**	**F**	**p**
WISC: Similarities	12.70	11.73	10.00	8.22	2.79	.054
WISC: Vocabulary	10.80	9.19	5.75	4.56	5.25	.004

plasma (Cornblatt, Lenzenweger, Dworkin and Erlenmeyer-Kimling, 1992; Mirsky, 1988; Siever, 1995). Other tasks, not used in this study, whose poor execution is related to the negative characteristics of schizotypy are those of backwards masking (Siever, Bernstein and Silverman, 1991), sensory gating (Cullum et al., 1993; Freedman et al., 1994), ocular pursuit (Clementz et al., 1992; Clementz, Sweeney, Hirt and Haas, 1991; Simons and Katkin, 1985) and evoked potentials (Kutcher; Blackwood, Gaskell, Muir and St. Clair, 1989).

Positive symptoms, in their most intense expression, however, are determined by functional and structural limbic deficits (of a functional system involving the medial temporal lobe, the hippocampus and the amygdala, responsible for the interpretation of external reality and contextual stimuli) which, when they are intense, give rise to schizophrenia (Bogerts, 1997). This limbic dysfunction is attributed to certain changes in the maturation of the CNS, or to psychosocial stressors, capable of causing an increase in dopaminergic arousal. A less intense limbic alteration would explain why cognitive-perceptual anomalies are more subtle in schizotypy (Siever, 1995).

In a complementary way, it has been observed that the positive and negative characteristics of schizotypy, in addition to having divergent psychophysiological correlates, are inherited independently (Siever, 1995). The different heritability of the two dimensions suggests the possible existence of different antecedents which, nevertheless, may converge in the case of chronic schizophrenia.

Thus, in sum, schizotypy and schizophrenia present similar alterations of certain frontal and motor circuits; nevertheless, they present significant differences in the structure of limbic circuits. Negative symptoms are caused by deficient information processing (or faults in controlled vs. automatic processing) due to frontal dysfunction (Siever, Kalus and Keefe, 1993), whilst positive symptoms appear to be related to a hyper-dopaminergic function in certain subcortical areas linked to states of hypervigilance (Siever, 1995), difficulties in contextual analysis (Millner, 1992), the interpretation of reality and the origin of memories (Frith, 1992; Johnson and Raye, 1981; Ruiz-Vargas, Cuevas and López-Frutos, 1998), and the comparison of present stimuli with past experience (Gray, 1982). Moreover, positive symptoms are not exclusive to schizotypy or schizophrenia.

By way of conclusion, it can be said that the negative symptoms of schizotypy, which involve the absence of emotional responses to the environment, lack of close friends and social isolation, are the characteristics most significantly associated with serious deterioration of frontal neuropsychological functions. All of this constitutes a pattern of risk for the development of disorders from the schizophrenic spectrum.

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