Research Article

Cold executive function processes and their hot analogs in schizotypy

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Abstract

Objective: To examine cold (based on logical reasoning) versus hot (having emotional components) executive function processes in groups with high individual schizotypal traits. Method: Two-hundred and forty-seven participants were administered the Schizotypal Personality Questionnaire and were allocated into schizotypal (cognitive-perceptual, paranoid, negative, disorganized) or control groups according to pre-specified criteria. Participants were also administered a battery of tasks examining working memory, complex selective attention, response inhibition, decision-making and fluid intelligence and their affective counterparts. The outcome measures of each task were reduced to one composite variable thus formulating five cold and five hot cognitive domains. Between-group differences in the cognitive domains were examined with repeated measures analyses of covariance. Results: For working memory, the control and the cognitive-perceptual groups outperformed negative schizotypes, while for affective working memory controls outperformed the disorganized group. Controls also scored higher compared with the disorganized group in complex selective attention, while both the control and the cognitive-perceptual groups outperformed negative schizotypes in complex affective selective attention. Negative schizotypes also had striking difficulties in response inhibition, as they scored lower compared with all other groups. Despite the lack of differences in fluid intelligence, controls scored higher compared with all schizotypal groups (except from cognitive-perceptual schizotypes) in emotional intelligence; the latter group reported higher emotional intelligence compared with negative schizotypes. Conclusion: Results indicate that there is no categorical association between the different schizotypal dimensions with solely cold or hot executive function processes and support impoverished emotional intelligence as a core feature of schizotypy.

Keywords: Schizophrenia spectrum; working memory; selective attention; response inhibition; emotional intelligence; affective intelligence as a core feature of schizotypy.

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Introduction

As T.W. Robbins notes in his Editorial paper “In general, cognition refers to those, sometimes mysterious, covert processes that have to be inferred from behavior. Cognitive processes include seemingly miraculous products of modular processing to produce, for example, representational knowledge such as language, and mechanisms that intervene between stimulus and response . . .” (Robbins, 2011; p. 1). It can be, thus, easily understood that the integrated functioning of cognitive processes plays a crucial role for goal-directed behavior (e.g., Bouton, 2021; Chai et al., 2018; Rinaldi & Lefebvre, 2016). Cognitive processes can be further analyzed into “cold” or “hot,” with cold cognitive processing relying on logic while hot cognition involves processing of stimuli with emotional components/representations (David & Matu, 2020). Human behavior is the outcome of complex interactions between individual cognitive processes and this operationally useful categorization actually refers to complementary processes (Todd et al., 2020) – every cold cognitive process has its hot analog (Salehinejad et al., 2021) – that rely on interacting brain circuitries (M’Barek et al., 2022; Salehinejad et al., 2021).

Studies in clinical populations have revealed that both cold and hot cognition is impaired in patients with major psychiatric disorders such as schizophrenia (Duggirala et al., 2020; Gebreegziabhere et al., 2022), bipolar disorder (Keramatian et al., 2022; Vedel Kessing & Miskowiak, 2018) or major depressive disorder (Roiser & Sahakian, 2013), in accordance with the widespread (or non-specific) nature of these phenomena in disease states (Millan et al., 2012). Genetically high-risk populations for psychiatric disorders, such as the unaffected first-degree relatives of patients, present with milder cognitive impairments compared with probands (Bortolato et al., 2015; Luperdi et al., 2019). Although the available literature examining direct comparisons of cold and hot cognitive processes is still scarce, preliminary evidence indicates a pattern of associations in this group: relatives of bipolar disorder patients show (a) most prominent deficits in...
hot compared with cold cognitive computations (Miskowiak et al., 2017) and (b) more pronounced deficits in hot cognition, when compared with the relatives of schizophrenia patients (Besnier et al., 2009). MacKenzie et al. (2017) also studied cold and hot cognitive processes in very young individuals with a familial high-risk for severe mental disorders, a percentage of whom were also diagnosed with depression or anxiety disorders or attention-deficit/hyperactivity disorder, and found that only hot executive functioning was associated with psychotic symptoms.

In the psychosis continuum, unaffected relatives of patients are positioned one step before the patients in terms of severity of symptoms, cognitive deficits and daily functioning (Duggirala et al., 2020). Prior to the patients’ relatives, high schizotypal individuals are placed. This group is characterized by subthreshold psychotic-like experiences and is prone to the development of schizophrenia spectrum disorders (Debbané et al., 2015). With regard to schizotypy, it refers to personality traits, it is not a new construct and was first described by S. Rado (1953). Since Rado’s observations, a significant amount of research has described the cognitive (Giakoumaki, 2012; Ettinger et al., 2014; Ettinger et al., 2015; Mohr & Ettinger, 2014; Siddi et al., 2017; Steffens et al., 2018), affective (Giakoumaki, 2016; Zouraraki, Karamaouna, et al., 2023), psychophysiological (Giakoumaki, 2012; Wan et al., 2017), neuroanatomical (Ettinger et al., 2015; Kirschner et al., 2022; Tonini et al., 2021) and genetic (Ettinger et al., 2014; Mohr & Ettinger, 2014; Walter et al., 2016) correlates of schizotypy, which highly overlap with schizophrenia’s respective indices.

The three widely used self-assessment instruments for the assessment of schizotypal traits include the Wisconsin Schizotypy Scales (Chapman et al., 1982; Chapman et al., 1976, 1978; Eckblad & Chapman, 1983), the Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE; Mason & Claridge, 2006; Mason et al., 1995) and the Schizotypal Personality Questionnaire (SPQ; Raine, 1991). The main difference between the three scales is that they are based on different theoretical approaches, occasionally hampering the direct comparison and integrated interpretation of individual study findings (Oezgen & Grant, 2018; Tonini et al., 2021).

A prominent model of schizotypy, as assessed with the SPQ, classifies schizotypal traits into three factors, namely cognitive-perceptual (positive), interpersonal (negative) and disorganized, in accordance with the main symptom-clusters of schizophrenia spectrum disorders (Raine, 1991). A four-factor model has been tested in several countries and has been reported to have comparable psychometric properties with the three-factor model (Barron et al., 2015; Bedwell et al., 2014; Compton et al., 2009; Fonseca-Pedrero, Compton, et al., 2014, Fonseca-Pedrero, Fumero, et al., 2014, Fonseca-Pedrero et al., 2018; Mohamed et al., 2014; Rabella et al., 2018; Stefanis et al., 2004; Tsaoouidis et al., 2015; Xi et al., 2020). According to this four-factor approach, positive schizotypal traits are further organized into paranoid and cognitive-perceptual, with the latter latent construct referring to individuals experiencing unusual perceptual experiences and believing in supernatural forces/experiences; negative and disorganized schizotypy are retained as in the three-factor model. Studies employing the analytical four-factor model have revealed an intriguing pattern of neuropsychological (Giakoumaki et al., 2021; Giakoumaki et al., 2020; Karagiannopoulou et al., 2016; Karamaouna et al., 2021, Smyrnis et al., 2007) and sensorimotor gating (Giakoumaki et al., 2020); (b) differences in executive working memory between unaffected relatives of schizophrenia patients and controls are sensitive to the effects of both paranoid and negative schizotypy (Zouraraki et al., 2017); (c) only negative schizotypy has been associated with neurological soft signs (Theileritis et al., 2012); (d) negative and disorganized schizotypy are associated with higher levels of subjective cognitive failures (Giakoumaki et al., 2021) and visual perception indices (Zouraraki, Kyriklaki, et al., 2023) and (e) cognitive-perceptual schizotypes consistently perform equally with controls in cognitive, psychophysiological and neurological measures (Giakoumaki et al., 2021; Karagiannopoulou et al., 2016; Karamaouna et al., 2021; Smyrnis et al., 2007; Theileritis et al., 2012).

As there is currently a lack of research on the analogy of cold and hot cognitive processing in high schizotypal individuals, the aim of the present study was to attempt a direct comparison of cold executive function processes and their hot counterparts in groups with high individual schizotypal traits, as defined with the four-factor model of schizotypy. Based on the literature, we hypothesized that (a) the negative schizotypal group would show poorer performance in the tasks assessing cold executive functions and (b) the cognitive-perceptual group would perform similarly to controls in tasks examining cold executive functions. Due to the proximity of negative schizotypy with the negative symptoms of schizophrenia and the widespread deficiencies observed in negative schizotypes, we also hypothesized that this group would also present with diminished scores in tasks assessing hot executive function processes.

Method

Participants

Two-hundred and fifty-nine participants from the community were recruited via advertisements in local media. Exclusion criteria were (a) personal history of head trauma or medical conditions, (b) current use of prescribed/recreational drugs, (c) personal/family (up to second-degree) history of DSM-5 (Diagnostic and Statistical Manual of Mental Disorders—Fifth Edition; American Psychiatric Association, 2013) disorders and (d) inability, for any reason, to provide written informed consent. One participant was excluded due to the presence of psychiatric symptoms and another one withdrew consent, resulting in a sample of 257 participants (67 males/190 females, age mean ± SD = 35.97 ± 10.09 years, age range = 18–57 years). The study was approved by the Research Ethics Committee of the University of Crete (approval number: 4/2018/19-03-2018); the research was completed in accordance with Helsinki Declaration. Following presentation of the study’s aims and methods, all participants received written detailed information and gave written informed consent prior to participation.

Following the assessment of schizotypal traits, participants were allocated into groups according to criteria that were derived by a normative sample in Greece (Tsaoouidis et al., 2015). In detail, participants were included in a schizotypal group if their score in the respective schizotypal factor fell in the upper 10% and the scores in the remaining schizotypal factors did not fulfill this criterion. The upper 10% cutoff scores were ≥7 for cognitive-perceptual, ≥14 for paranoid, ≥18 for negative and ≥8 for...
disorganized schizotypy. For example, participants in the cognitive-perceptual schizotypal group had scores ≥7 for this factor and scores <14 for the paranoid, <18 for the negative and <8 for the disorganized factors, and so on. The control group included participants who did not meet the criteria for any schizotypal factor. Ten participants were excluded from the analyses as their scores fulfilled the criteria for inclusion in more than one group (two participants fulfilled the criteria for inclusion in the cognitive-perceptual and paranoid groups, two participants could be classified as both paranoid and disorganized schizotypals, one participant could be included in the cognitive-perceptual, paranoid or negative schizotypal groups, two participants reached the cutoff scores for inclusion in the paranoid, negative and disorganized groups, two participants fulfilled the criteria for inclusion in the cognitive-perceptual, paranoid and disorganized groups and one participant had scores falling in the upper 10% for all schizotypal factors). Thus, the final sample consisted of 247 participants (64 males/183 females, age mean ± SD = 36.08 ± 10.01 years, age range = 18–57 years) divided into cognitive-perceptual (n = 36, 8 males/28 females, age mean ± SD = 37.83 ± 10.36 years, age range = 18–56 years), paranoid (n = 24, 4 males/20 females, age mean ± SD = 30.42 ± 9.23 years, age range = 18–50 years), negative (n = 14, 4 males/10 females, age mean ± SD = 30.14 ± 8.56 years, age range = 21–47 years), disorganized (n = 41, 16 males/25 females, age mean ± SD = 34.80 ± 9.88 years, age range = 19–53 years) and control (n = 132, 32 males/100 females, age mean ± SD = 37.66 ± 9.66 years, age range = 18–57 years) groups.

Schizotypal personality questionnaire

Schizotypal traits were assessed with the Greek version (Tsaousis et al., 2015) of the Schizotypal Personality Questionnaire (SPQ; Raine, 1991). The SPQ is a 74-dichotomous-item questionnaire and items are grouped into nine subscales that are organized into four schizotypal factors (cognitive – perceptual, paranoid, negative and disorganized) according to the four-factor model of schizotypy. A detailed description is provided in Supplementary material.

Neuropsychological tasks

Working memory (WM) was assessed with a computerized version of an N-back sequential letter task (Giaourakaki et al., 2011) and Affective working memory (AWM) with a computerized N-back task that included images from the International Affective Picture System (IAPS; Lang & Bradley, 2005). Complex selective attention was examined with a pencil-paper version of the Stroop task (Golden, 1978) and Complex affective selective attention (CASA) with a modified computerized version of an affective Stroop task (Genov et al., 2002). Response Inhibition (RI) was evaluated with the Stop-Signal task and Affective response inhibition (ARI) with the Affective Go/No-go task of the Cambridge Automated Neuropsychological Test Automated Battery (CANTAB; Robbins et al., 1998). Decision-making (DM) was examined with the Stockings of Cambridge (SoC) task, which is also part of CANTAB, and Affective DM was examined with the Iowa Gambling task (IGT; Bechara et al., 2000; Bechara et al., 1994). Fluid intelligence (FI) was assessed with Raven’s Progressive Matrices (RPM; Raven et al., 2003) while trait Emotional intelligence (EI) was assessed with the Greek Emotional Intelligence Scale (GEIS; Tsaousis, 2008). Tasks were administered in the order they are reported here and the testing session lasted approximately 60 minutes. A detailed description of the tasks and outcome measures is provided in Supplementary material.

Visual Analogue Scales and Self-Assessment Manikin

Upon arrival at the lab, participants self-rated their mood and feelings on a battery of 16-item visual analog scales (VAS; Bond & Lader, 1974; Norris, 1971). The Self-Assessment Manikin (SAM; Bradley & Lang, 1994) was administered after completion of the AWM task for participants to rate their ‘pleasure’ and ‘arousal’ after viewing each image. A detailed description of both instruments is provided in Supplementary material.

Statistical analyses

Between-group differences in (a) demographic variables (age, years of education, smoking habits), VAS and SPQ scores were examined with either parametric or non-parametric analyses according to normality of the distribution and (b) sex were examined with chi-square analysis. Significant between-group differences were followed up with either Bonferroni post hoc or Mann-Whitney tests, respectively. The raw data of each variable for every neuropsychological task were transformed into z scores. For the tasks yielding more than one outcome measure, we calculated the average of the z scores, so that each task was represented by one composite variable (when the outcome measures included correct responses and errors, errors were negatively marked so that higher scores indicated superior performance, in accordance with correct responses). Thus, five cold cognitive domains and their hot counterparts were produced: working memory (N-back metrics) and affective working memory (affective N-back metrics), complex selective attention (Stroop task metrics) and complex affective selective attention (affective Stroop task metrics), response inhibition (Stop-signal task) and affective response inhibition (Affective Go/No-go task), DM (SoC metrics) and affective DM (IGT metrics), fluid intelligence (RPM metrics) and emotional intelligence (GEIS metrics). Between-group differences in the cognitive areas were examined with repeated measures analyses of covariance (ANCOVA) with (a) group (five levels, i.e., four schizotypal and one control group) as the between-subjects’ factor, (b) type of task (two levels, i.e., affective or non-affective) as the within-subjects’ factor and (c) age. VAS anxiety and discontentment as covariates (we included these variables in our models as covariates, as significant between-group differences were detected). Significant group main effects were followed up with Bonferroni post hoc tests and significant type of task × group interactions were followed up with separate univariate ANCOVAs with the same factorial design, as previously. To reduce the probability of type I error, Bonferroni correction was applied [0.05/10 cognitive areas = 0.005]; therefore, only p values <0.005 were considered significant and p values ≤0.01 were considered as trends for significance.

Results

Demographics, VAS and SPQ scores

There was a significant group main effect in (a) age [F(4,246) = 4.68, p < 0.001] with the paranoid group being younger compared with the control (p < 0.01) and the cognitive-perceptual (p < 0.05) groups; (b) VAS discontentment [F(4,246) = 5.88, p < 0.001] and VAS anxiety (Kruskal Wallis chi-square = 14.14, p < 0.01) with the control group scoring lower compared with both the paranoid (both p values < 0.005) and the negative (both p values < 0.05) groups. The remaining between-group differences were not significant (all p values > 0.06). A detailed description is provided in Supplementary Table 1. As
regards SPQ scores, the main findings were that (a) the control group scored lower compared with all schizotypal factors in all schizotypal factors (all p values < 0.001) and (b) every schizotypal group scored higher compared to all the other schizotypal groups in the respective factor scores. A detailed description is provided in Supplementary Table 2.

Self-Assessment Manikin (SAM)

With the procedure described in Statistical analyses, we calculated separate composite scores for pleasure and arousal and examined between-group differences with univariate ANCOVAs. These analyses did not reveal significant group main effect for pleasure (p > 0.19). However, a significant main effect of group was revealed for arousal [F(4,246) = 3.91, p = 0.004, partial eta-squared = 0.061] with the control group scoring lower compared with the cognitive-perceptual group (p = 0.009).

Neuropsychological task performance

A detailed description of all neuropsychological task raw scores (mean ± SD) is provided in Supplementary Table 3. A graphical presentation of the significant between-group differences is provided in Figure 1. For the purposes of the presentation, we set the mean for every cognitive domain of the control group to zero by subtracting the actual mean of the control group from each participant in the schizotypal groups.

Working Memory (WM) and Affective Working Memory (AWM)
The repeated measures ANCOVA revealed a significant main effect of group [F(4,239) = 5.83, p < 0.001, partial eta-squared = 0.089] and significant type of task × group interaction [F(4,239) = 4.07, p = 0.003, partial eta-squared = 0.064] while no other significant main effects or interactions were found (all p values > 0.08). Follow-up of the aforementioned interaction with univariate ANCOVAs revealed a different pattern of results. Thus, we found a significant group main effect [F(4,246) = 5.31, p < 0.001, partial eta-squared = 0.082] for WM with the control (p = 0.004, Cohen’s d = 0.78) and the cognitive-perceptual (p = 0.001, Cohen’s d = 0.93) groups outperforming the negative schizotypal group. We also found a significant main effect of group [F(4,246) = 5.03, p < 0.001, partial eta-squared = 0.078] for AWM, but this time the control group outperformed the disorganized group (p < 0.001, Cohen’s d = 0.49) and the cognitive-perceptual group tended to score higher (p = 0.008, Cohen’s d = 0.47) compared with the disorganized group.

As we found a significant between-group difference in SAM arousal, we repeated the analyses including this variable in the list of covariates. The group main effect in the repeated measures ANCOVA was retained [F (4,237) = 5.83, p < 0.001, partial eta-squared = 0.090] as was the type of task × group interaction [F(4,237) = 4.26, p = 0.002, partial eta-squared = 0.067]. Further following this up with a univariate ANCOVA for AWM, we found the exact same pattern as previously [group main effect: F (4,246) = 4.95, p < 0.001, partial eta-squared = 0.077] with the control group having superior performance (p < 0.001) and the cognitive-perceptual group tending to have superior performance (p = 0.015) compared with the disorganized group.

Complex Selective Attention (CSA) and Complex Affective Selective Attention (CASAP)
The repeated measures ANCOVA revealed both a significant main effect of group [F(4,239) = 4.93, p < 0.001, partial etta-squared = 0.076] and a significant type of task × group interaction [F(4,239) = 4.09, p = 0.003, partial eta-squared = 0.064] while no other significant main effects or interactions were found (all p values > 0.28). Follow-up of the significant interaction with univariate ANCOVAs revealed a different pattern of results, as previously. Thus, we found a significant group main effect [F(4,246) = 4.36, p = 0.002, partial eta-squared = 0.068] for CSA with the control group outperforming the disorganized group (p = 0.001; Cohen’s d = 0.24). We also found a significant main effect of group [F(4,246) = 4.98, p < 0.001, partial eta-squared = 0.077] for CASA, but this time the control and the cognitive-perceptual groups outperformed the negative schizotypal group (both p values < 0.001; Cohen’s d of controls vs negative = 0.60 and Cohen’s d of cognitive-perceptual vs negative = 0.67).

Response Inhibition (RI) and Affective Response Inhibition (ARI)
The repeated measures ANCOVA revealed a significant main effect of group [F(4,239) = 3.79, p = 0.005, partial eta-squared = 0.060] while the critical type of task × group interaction was also significant [F(4,239) = 4.00, p = 0.004, partial eta-squared = 0.063]; no other significant main effects or interactions were found (all p values > 0.05). Follow-up of the significant interaction with univariate ANCOVA for RI showed a significant group main effect [F(4,246) = 5.15, p < 0.001, partial eta-squared = 0.079] the negative group presenting with poorer performance compared with all other groups (negative vs. controls: p < 0.001, Cohen’s d = 1.29; negative vs. cognitive-perceptual: p = 0.001 Cohen’s d = 1.34; negative vs. paranoid: p = 0.005, Cohen’s d = 1.28; negative vs. disorganized: p = 0.002, Cohen’s d = 1.11). Identical analysis for ARI revealed only a trend for significant group-main effects [F(4,246) = 3.71, p = 0.006, partial eta-squared = 0.058] with the control group tending to outperform the disorganized group (p = 0.006, Cohen’s d = 0.60).

DM and Affective DM

Identical repeated measures ANCOVA as with the previous tasks did not reveal any significant group main effects of interactions involving group (all p values > 0.17).

Fluid Intelligence (Fl) and Emotional Intelligence (El)
The repeated measures ANCOVA revealed a significant main effect of group [F(4,239) = 8.60, p < 0.001, partial eta-squared = 0.126] and type of task × group interaction [F(4,239) = 6.07, p < 0.001, partial eta-squared = 0.092] while no other significant main effects or interactions were found (all p values > 0.01). Follow-up of the significant interaction with univariate ANCOVA for FI did not reveal any significant effects (all p values > 0.20). However, the identical analysis for EI did reveal a significant group main effect [F(4,246) = 15.14, p < 0.001, partial eta-squared = 0.202] with (a) the control group scoring higher compared with the paranoid (p = 0.005, Cohen’s d = 1.10), negative (p < 0.001, Cohen’s d = 1.95) and disorganized (p < 0.001, Cohen’s d = 0.96) groups and (b) the cognitive-perceptual group scoring higher (p < 0.001, Cohen’s d = 1.98) compared with the negative group; the disorganized group tended to score higher (p = 0.007, Cohen’s d = 1.25) compared with the negative group.

Discussion

In the present study, a detailed analysis of schizotypal traits was conducted using the four-factor model of schizotypy to examine...
the associations of each schizotypal dimension with cold (i.e., based on logical reasoning) and hot (i.e., involving emotional processes) executive functions. The results showed that these two types of cognitive processes are associated in different ways with the different facets of schizotypy.

Thus, negative schizotypes were found to have striking difficulties in response inhibition – they performed poorly compared to all other groups – in working memory and in complex affective selective attention, which was examined with an affective Stroop task. The finding of impoverished working memory and reduced response inhibition, two highly interconnected cognitive processes (Bissett et al., 2022), is in direct agreement with previous findings in the schizotypy literature (Ettinger et al., 2018; Karagiannopoulou et al., 2016; Karamaouna et al., 2021; Matheson & Langdon, 2008; Park & McTigue, 1997). It is also supported by evidence from (a) neuroimaging studies indicating commonalities in the neural substrate between the three constructs (Emich et al., 2019; Kühn et al., 2012; Pfarr & Nenadic, 2020; Sutcliffe et al., 2016; Kühn et al., 2012; Pfarr & Nenadic, 2020; Sutcliffe et al., 2016) and (b) studies linking the negative symptom cluster of schizophrenia symptoms with both cognitive processes (e.g., Bora & Murray, 2014; Gotra et al., 2020; Khalil et al., 2020; Shin et al., 2013) as well as schizotypal personality disorder symptoms with impairments in working memory (Mitropoulou et al., 2002, 2005; Rosell et al., 2014). The finding that negative schizotypes performed worse in the affective Stroop task compared to controls is interesting, given that there were no group differences in this group on the classical version of the task or in affective working memory, affective response inhibition or affective DM. A speculative but plausible explanation for this finding has to do with the nature of the task used in the present study, since all emotional words were adjectives describing mental/emotional states. Negative schizotypy – characterized by excessive social anxiety, lack of close friends, constricted affect and suspiciousness – has been associated with poor interactions/activities involving other people (Cohen et al., 2015). Although no causal relationships between the two can be easily detected, the net result of this association could be that negative schizotypes end up being more prone to a tendency for self-referencing and attribution of emotional states to themselves instead of perceiving them as conditions applying to all people (more self-focused rather than equally oriented into self and others) – in analogy to schizophrenia patients (van der Weiden et al., 2015). This tendency could leave them more vulnerable to the interfering effects of emotionally laden stimuli.

Disorganized schizotypes, on the other hand, were identified with poorer affective working memory and affective response inhibition along with poorer complex selective attention. Although there is currently a lack of literature addressing emotional cognitive processes, as assessed with typical neuropsychological tasks, in disorganized schizotypy, there is ample evidence associating this schizotypal dimension with irregular affective states (Kemp et al., 2018; Kemp et al., 2022; Kerns & Becker, 2008; Kerns, 2006; Kwapil et al., 2020) and deficient processing of emotional stimuli (Brown & Cohen, 2010; Zouraraki et al., 2023a). A frontal-temporal-parietal network has been reported to mediate disorganized schizotypy (Pfarr & Nenadic, 2020; Wang et al., 2020; Wiebels...
et al., 2016) as well as working memory for affective stimuli (García-Pacios et al., 2017) and affective response inhibition (Puu et al., 2020), which may account for our present findings. In contrast to previous studies that reported non-significant associations between performance on the Stroop task and disorganized traits (Ettinger et al., 2018; Szöke et al., 2009; Thomas et al., 2019), we found that disorganized schizotypes showed poorer performance in the task. However, the difference between the present finding and the findings of the aforementioned studies, is likely due to methodological issues [i.e., in the Thomas et al. (2019) study, schizotypy was assessed with the O-LIFE; Ettinger et al. (2018) and Szöke et al. (2009) administered the SPQ but they both analyzed other performance metrics of the task; Szöke et al. (2009) also included relatives of schizophrenia patients along with control individuals in their analyses]. Moreover, the finding is consistent with the schizophrenia literature linking disorganized symptoms with Stroop task performance (Brazo et al., 2002; Woodward et al., 2003) and supporting the linear decline of selective attention in the schizophrenia spectrum (Catalan et al., 2021; Hou et al., 2016).

Cognitive-perceptual schizotypy (comprising magical thinking and unusual perceptual experiences) is the least studied of all schizotypal dimensions, being "confated" with paranoid schizotypy under positive schizotypy in the three-factor model prevalent in the literature. So, thus far we know that cognitive-perceptual schizotypes perform comparably well to controls in both typical neuropsychological tasks (Karagiannopoulos et al., 2016) and in subjective measures of cognition (Giaoumaki et al., 2021); they also outperform other schizotypal groups in some cases [e.g., they have superior executive working memory abilities compared with negative schizotypes (Karagiannopoulos et al., 2016)]. Accordingly, cognitive-perceptual schizotypy does not mediate the differences in neurocognition observed between unaffected relatives of schizophrenia patients and control individuals (Zourarakis et al., 2017), it is not characterized by sensorimotor gating deficits (Giaoumaki et al., 2020), it is not subject to the effects of visual illusions (Zourarakis et al., 2023b), it is associated with superior psychological well-being (Giaoumaki et al., 2021) and remains stable over a 4-year period (Karamaouna et al., 2021). To further add to the profile of cognitive-perceptual schizotypy, in the present study we found that the cognitive-perceptual group did not differ from the control group in any measure and that they had better working memory and higher emotional intelligence compared with the negative schizotypes. All this accumulated evidence points to a close resemblance of cognitive-perceptual schizotypy with healthy schizotypy. The latter term was first introduced by McCreery and Claridge (2002) to describe individuals with increased aberrant perceptions and beliefs in the absence of negative and disorganized traits. A detailed review of the related literature is provided by Mohr & Claridge (2015). In brief, this group reports that they are not distressed by their high schizotypes may be prone to psychotic-like experiences, but not be adversely affected by them," possibly explaining the non-detrimental effects of cognitive-perceptual schizotypy. It remains to be seen whether this schizotypal dimension explains a percentage of the variance observed in the conversion rates of schizotypes into disease states.

Finally, while there were no group differences in fluid intelligence, a “broad” impoverishment in emotional intelligence was observed, as negative, paranoid and disorganized schizotypes scored lower compared to controls, in accordance with previous studies associating schizotypy scores with emotional (Aguirre et al., 2008; Albacete et al., 2016) but not fluid (Cochrane et al., 2012) intelligence. It seems, therefore, that the well-reported association of fluid reasoning abilities with emotional intelligence (Olderbak et al., 2019; Simonet et al., 2021) is dissociated in schizotypy irrespective of the prevailing schizotypal dimension; the only exception being cognitive-perceptual schizotypy. As emotional intelligence is a core component of social cognition (Salovey & Mayer, 1990), the finding also adds further evidence on the decline of this complex function observed in schizotypy (e.g., Bora, 2020; Kong et al., 2021; Plum & Gooding, 2018; Buck et al., 2017; Nahal et al., 2021; Wang et al., 2015; Wasterl & Lenzenweger, 2021; Morrison et al., 2013).

In conclusion, the present study (a) indicates that there is no categorical association between the different schizotypal dimensions with solely cold or hot executive functions – both negative and disorganized schizotypes were linked with poor performance in both types of cognition, (b) supports that impoverished emotional intelligence is a central feature of schizotypy and (c) further establishes cognitive-perceptual schizotypy as the latest analog of healthy schizotypy. The limitations of the study include (a) the examination of schizotypy with a self-report scale carrying weaknesses potentially limiting the validity of findings (e.g., people often do not disclose the truth in questions they find embarrassing/too personal/undesirable; responses can be biased by the respondent’s self-perception; forced-choice dichotomous responses do not categorically apply to all situations), (b) the lack of assessment of the effects of other personality (e.g., Hatzimanolis et al., 2018) or autistic (e.g., Nenadić et al., 2021) traits as well as genetic (e.g., Roussos et al., 2013; Tsang et al., 2015) and environmental (e.g., O’Hare et al., 2022; Vargas et al., 2019) factors known to interact with schizotypy and/or cognitive processing, (c) the cross-sectional design of the study which does not allow for conclusions on the stability of our findings over time, (d) the limited selection of neuropsychological tasks assessing specific executive functions and (e) although we examined a quite large sample, our grouping approach led to fairly small sample sizes with predominantly female participants for each schizotypal group; we employed strict statistical criteria in order to avoid false positive findings but one cannot exclude the possibility of the small sample sizes masking potential additional between-group differences and/or affecting the power of the findings.

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