Encoding style and its relationships with schizotypal traits and impulsivity during adolescence

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Abstract

This study intends to explore how individual differences in encoding style (i.e. how encoding is implicitly affected by pre-existing schemata, so called an internal style, versus by cues from the outside world, so called an external style) are associated with schizotypal traits and impulsivity expression during adolescence. Moreover, we aim to provide first evidence reliability for the encoding style questionnaire with an adolescent sample. 101 French-speaking community adolescents (M_{age}¼ 16.06, S.D.$_{age}$¼ 2.01; 57 girls; primarily Caucasian) participated in a cross-sectional study. The whole sample filled out a battery of self-report questionnaires. Our data supports a positive association between a predominant internal encoding style, the level of positive and disorganized schizotypal traits, and a higher degree of urgency and sensation seeking impulsivity components. On the one hand, these results have clinical implications in the sense that a low level in implicit processing, namely encoding style, is involved in positive and disorganized schizotypal traits as well as in impulsivity. Schizotypal traits and impulsivity are two sets of traits that put youth at risk for the development of severe psychopathological states in adulthood. On the other hand, this research enables an increased understanding of encoding style by providing the first reliable assessment tool for French-speaking adolescents.

Introduction

Adolescence represents an important developmental stage marked by notable cerebral, cognitive and social changes (Steinberg, 2005). In approximately 10% of adolescents (van Os et al., 2009) perplexing and distressing mental phenomena, such as delusion and hallucination-like symptom expression (so-called positive schizotypal traits) arise during teenage years (Cougnard et al., 2007). Epidemiological studies suggest that positive schizo-typy holds significant predictive power for the unfolding of psychotic disorders in adulthood (Poulton et al., 2000; Gooding et al., 2005). To date however, few studies examine the potential cognitive processes that may promote the expression of positive schizotypal traits during adolescent development.

Recent evidence suggests that low-level aspects of encoding, namely encoding style, may constitute one important cognitive process involved in the expression of positive schizotypal traits.

Encoding style belongs to processes involved in nonconscious knowledge acquisition and underlies important individuals differences. Differences are especially observed in the schemas, which are defined (following a specific usage of the term; see Lewicki, 2005) as early implicit filters that influence the way individuals encode external information. These schemas are imposed onto our external world in the very first phase of ambiguous information processing. Indeed schemas may behave as early filters that restrain what a person can notice (encode) and, thereby, influence the subsequent dynamic and implicitly acquired knowledge. Studies in cognitive psychology have shown that encoding pro-cesses impose on stimuli pre-existing categories (interpretive schema), regardless of the fact that the stimuli do not perfectly fit those categories. Nevertheless, even if the match is not totally accurate, the schema is always prompted by a minimum of supportive external evidence. The degree of information necessary to instantiate an interpretative schema (so called schema instantation threshold, SIT) varies among individuals and repre-sents a trade-off between speed and accuracy, such that a lower threshold leads to faster encoding and decreased accuracy in the final encoded product. The SIT relates to how individuals may be characterized as internal (i.e hasty) versus external (i.e. conservative) encoders. Internal encoders show a greater probability to interpret environmental cues in terms of pre-existing encoding categories (Lewicki et al., 1992; Lewicki, 2005). Importantly, this higher probability to rashly interpret external stimuli in terms of internal schema is reinforced through the process of self- perpetuation (Lewicki et al., 1992; Lewicki, 2005), which explains how individuals tend to draw relations between variables that are not interrelated in the real world. For instance, one might think that people with dark eyes (A) are harmful (B) level of danger, which leads one to believe that each time one meets (A) without explicit data on (B) (level of danger), he will tend to encode B's level of anger in a way that is consistent with his initial biased A–B relation. Then, the strength of the schema supporting the relation between A and B can increase over time, even in the absence of any supportive evidence. While self-perpetuation is common propensity for everyone, its strength can vary across individuals.

It is thought to underlie interpretative biases involved in serious mental disorders, such as paranoia (Combs et al., 2003; Lewicki, 2005), obsessive-compulsive symptoms (Belayachi and Van der Linden, 2010) or anxiety and depression (Hill et al., 1991).

In other words, an internal encoding style may facilitate, through self-perpetuation, various psychopathological states. Recently, it has been argued that a predominant internal style may account for positive schizotypal traits in adulthood (Valérie et al., 2011) and contribute to the total level of schizotypal traits in adolescents (Badoud et al., submitted for publication). Indeed, an extreme internal style may present a risk of losing touch with reality and lead to a higher propensity of psychotic-like symptoms (Gill, unpublished results).

With regards to adolescence specifically, it is noteworthy to mention that adult internal encoders have been found to exhibit higher levels in specific facets of impulsivity (Billieux et al., 2009) As conceptualized by the model of Whiteside and Lynam (2001), impulsivity encompasses four separate components associated with impulsive behaviour, namely urgency, (lack of) premeditation, (lack of) perseverance and sensation seeking. This is of particular interest as impulsivity represents a core feature for the risk of externalizing psychopathology in adolescents (e.g., Luengo et al., 1994). Indeed adolescence is often characterized as a period marked by the emergence of impulsive and sometimes problematic behaviours, including violent delinquency, substance abuse and risk-taking behaviour (Steinberg, 2007).

While impulsivity might also be developmentally normative in adolescence (e.g. Steinberg et al., 2008, who show that the developmental course of sensation seeking follows an u-inverted curve, which increases between preadolescence and mid-adolescence and then declines), evidence suggests that higher levels of impulsivity are at the heart of many problematic behaviour that arise in late adolescence and in adulthood (e.g. antisocial behaviour or excessive gambling, Luengo et al., 1994; Vitaro et al., 1999; Moeller et al., 2001). To the best of our knowledge, the examination of internal encoding style in relation to adolescent impulsivity has yet to be performed. Similarly, the links between internal encoding style, impulsivity and positive schizotypy during adolescence have yet to be investigated.

In line with a developmental psychopathology approach (Cicchetti and Rogosch, 2002), investigating the cognitive mechanisms that potentially sustain impulsivity and schizotypal traits expression in adolescence is crucial given their potential implication in the emergence of adult psychopathology. In particular, the close examination of adolescent encoding style may prove to be clinically and scientifically useful, especially for early identification of psychosis and disorders involving lack of impulse control. Indeed, in the line of the theoretical conceptualization of encoding style and previous associations with clinical conditions in adult samples, encoding style might be considered as a promising candidate for an early cognitive marker indicating susceptibility to psychopathology, mainly psychosis, in adolescence. This could strengthen early identification of at-risk youths before they present full-blown psychopathology. However, the main obstacle in our current understanding of adolescent encoding style lies in the lack

of a reliable validated tool for this age range. Such an instrument would allow an efficient evaluation of individual encoding style.

In its first scientific elaboration, the assessment of encoding style relied upon in heavy experimental settings, using tachistoscopic devices and partial display experiments (e.g. Gill, unpublished results). While such settings provided evidence for lower SIT in internal encoders (Gill, unpublished results), their impracticality prevented wider investigations of encoding style. To overcome this issue, Lewicki (2005) developed a self-report scale entitled "encoding style questionnaire" (ESQ) designed to ask simple questions about the frequency of split-second illusions in daily life as an index of encoding style. The rationale implies that the individual level of SIT (i.e the amount of supportive evidence a person needs to collect before implicitly imposing an interpretative schema when facing equivocal stimuli) will condition the frequency of having split-second illusions (Lewicki, 2005). The validation of the ESQ has been performed with adult samples, in English (Lewicki, 2005) and French (Billieux et al., 2009).

The present research sets out to explore the relationships between encoding style and both impulsivity and schizotypal trait expression during adolescence. As neither the psychometric properties of the ESQ nor its factorial structure have ever been tested in adolescent populations, we began by validating the French version of the ESQ (Billieux et al., 2009) in a community adolescent sample, using confirmatory factorial analysis. This subsequently allowed us to perform correlation analyses between encoding style, facets of impulsivity and schizotypy measures. Thus, this study is directed by two main objectives. First, we aim to provide a validation of the ESQ for an adolescent population. Following Billieux et al. (2009), we postulate that a single factor structure will best fit our data. Second, we intend to explore how encoding style is associated with, on the one hand, the level of schizotypal traits and, on the other hand, impulsivity facets. Regarding schizotypal traits, we expect that adolescents with a predominantly internal encoding style will show higher levels of positive schizotypal traits. The rationale relies on recent cognitive models of positive psychotic symptoms (Morrison et al., 1995; Garety et al., 2001) and empirical results highlighting that internally generated information in the form of internal schemata can readily interfere with the reality testing. Indeed, previous work suggests that adolescent schizotypal expression is affected by beliefs about oneself (Debbané et al., 2012), and that in memory tasks the attribution of an internal content (e.g. a thought) to an external source is associated with increased positive schizotypal expression, in non-clinical adolescents (Debbané et al., 2009), and adults (Larøi et al., 2005), as well as in adults with schizophrenia (Brébion et al., 2000; Keefe et al., 2002). Together, these studies suggest that an internal style may consistently sustain faulty attributions in everyday life, thereby representing an early developmental potentiator of positive schizotypal expression in adolescence.

Concerning impulsivity, and in keeping with initial evidence provided by Billieux et al. (2009), we posit a link between an internal encoding style and high levels of urgency and

lack of perseverance. Urgency is defined as the tendency to experience strong reactions under the condition of negative affect (Whiteside and Lynam, 2001) while low perseverance refers to difficulties in remaining focused on a task that may be boring and/or difficult. Given that an extreme internal encoding style entails a strong proneness to impose interpretative schema on external stimuli that do not perfectly match the categories, we expect a correlation with the level of urgency (Billieux et al., 2009). Moreover, we expect that internal encoders are more influenced by internal schemata and therefore less attentive to external environment, which will lead to difficulties to engage in tasks requiring a prolonged effort to focus on external stimuli (Billieux et al., 2009). Thus, in line with the principle of multifinality – which postulates that the same risk factor may lead to different life outcome (Cicchetti and Rogosch, 1996) – an internal style may facilitate different trait expressions (i.e. positive schizotypy and impulsivity), resulting in widely varied functioning (i.e., normal functioning, high levels of impulsivity or increased positive schizotypal traits) in adolescents with an internal encoding style.

Methods

PARTICIPANTS

Participants in this research were French-speaking community adolescents attending schools in the city of Geneva, Switzerland. To be eligible to participate in the study, youths needed to be aged between 12 and 19, French-native speakers and receive parental consent. After a telephone contact during which research objectives were explained to parents and potential adolescent participants ($N =$ 121), families decided whether they wished to volunteer for the study; nine parents declined, eight adolescents declined and four failed to show up at their scheduled appointments. The final sample encompassed 101 adolescents ($M_{age} = 16.06$, S.D.$_{age}$ = 2.01; 57 girls), including 94.1% white Caucasian, 3.0% African, 2.0% mixed-ethnicity and 0.9% Asian. Participants were primarily from middle socioeconomic status ($N = 87$). Each adolescent received financial compensation for completing this study. Written informed consent was received from participants and their parents under protocols approved by the Institutional Review Board of the Department of Psychiatry of the University of Geneva Medical School.

MEASURES

The French validated version of the *Encoding Style Questionnaire* (ESQ; Billieux et al., 2009), adapted from the original English version (ESQ; Lewicki, 2005), was used for

the adolescent validation. As in the original English version, the French ESQ contains 21 items rated on a six-point Likert-scale (ranging from 1 ="strongly agree" to 6="strongly disagree"): six diagnostic items referring to simple questions about the frequency of experiencing split-second illusions in daily life (e.g., for a split-second from a distance, I sometimes mistake strangers for people I know) mixed with 15 additional items to conceal critical items. The total score computed from the six diagnostic items produces a continuum of encoding style. High and low total scores on ESQ respectively indicate an internal and an external encoding style. Indeed, in contrary to what the terms "external" and "internal" style may insinuate, encoding style is better conceptualized along a continuum ranging from extremely internal to extremely external and approximately follows a Gaussian curve (Billieux et al., 2009).

The French validation study showed that the translation of the ESQ replicated the original single factor- structure and had a good internal consistency (α= 0.77; Billieux et al., 2009).

The *Schizotypal Personality Questionnaire* (SPQ; Raine, 1991) was employed to assess the expression of schizotypal traits in our sample. The SPQ is a 74 dichotomous item instrument, yielding the three main following dimension scores: "Cognitive-Perceptual" (made up of unusual perceptual experiences, magical thinking, paranoid ideation, and ideas of reference, e.g., "I often hear a voice speaking my thoughts aloud"), "Interpersonal" (including social anxiety, constricted affects and no close friends, e.g., "I tend to avoid eye contact when conversing with others") and "Disorganization" (namely odd speech and behavior, e.g. "I sometimes jump quickly from one topic to another when speaking"). This scale was validated in French-speaking adolescents (Badoud et al, 2011).

The French UPPS impulsive behavior scale (UPPS; Van der Linden et al.,2006) consists of 45 four-point scale items that evaluate four impulsivity facets labelled: "urgency" (the tendency to experience strong reactions, frequently under the condition of negative effect, e.g. "Sometimes I do things on impulse that I later regret"); "lack of premeditation" (the tendency not to think on the consequences of an act before engaging in that act,e.g. "I don't like to start a project until I know exactly how to proceed"); "lack of perseverance" (an individual's inability to remain focused on a task that may be boring or difficult, e.g. "I am not one of those people who blurt out things without thinking"); and "sensation seeking" (i.e. the tendency to enjoy and pursue activities that are exciting and an openness to trying new experiences that may or may not be dangerous, e.g. "I generally seek new and exciting experiences and sensations"). The UPPS scale has been found to have good psychometrical properties in French-speaking adolescents, with an internal relia-bility of each subscale ranging from good to very good (α= 0.79–0.84; d'Acremont and Van der Linden, 2005).

PROCEDURE

Participants were individually administered a battery of self-report question-naires assessing the encoding style together with external constructs, namely the expression of schizotypal personality traits, the level of impulsivity and vocabulary as well as social desirability bias. To ensure that all subjects understood the items, trained clinical psychologists (M.D. and D.B.) supervised the process.

Results

DESCRIPTIVE

Table 1 reports descriptive statistics (mean, standard deviation and range) for the measures included in this study.

PSYCHOMETRIC PROPERTIES OF THE FRENCH ESQ IN AN ADOLESCENT SAMPLE

To determine the factor structure of the French ESQ in an adolescent sample, we undertook Confirmatory Factor Analysis (CFA) with robust standard errors and a mean-adjusted chi-square statistic test (MLM, Muthén and Muthén, 2006). This initial examination of the item's distribution revealed that some of them departed from normality. We used CFA instead of exploratory factor analysis because the former allows one to test specific a priori hypotheses regarding the factorial structure of the scale, which is particularly suited for translated scales having received prior validations. Only one model was computed, as it was not possible to test relevant alternative models (the ESQ comprises only six critical items which have consistently been relied to the same construct, see Lewicki, 2005; Billieux et al., 2009). Goodness of fit was tested with χ^2 (a non-significant value corresponds to an acceptable fit). In addition to χ^2, two other indexes depending on a conventional cut-off were also computed: the root mean square error of approximation (RMSEA) and the standardized root mean square residual (SRMR) (Hu and Bentler, 1999). The combination of these two indexes is valuable because the RMSEA is sensitive to the misspecification of the factor "loadings" and the SRMR is sensitive to the misspecification of the factor "covariances". An RMSEA between 0 and 0.05 indicates a good fit, and between 0.05 and 0.08 an acceptable fit. An SRMR between 0 and 0.05 indicates a good fit, and between 0.05 and 0.10 an acceptable fit (Hu and Bentler, 1999). We also reported the Comparative Fit Index (CFI). A CFI 40.90 is generally interpreted as indicating an acceptable fit. The χ^2 of the model is non-significant, χ^2 (9)= 5.44, p= 0.79. For the fit

indices we obtained RMSEA = 0.00 and SRMR = 0.04.

Table 1

Descriptive results.

	Mean (S.D.)	Range
Age	16.08 (2.01)	12.01–19.98
ESQ Total Score	18.93 (5.76)	6–33
SPQ Positive	9.31 (6.52)	0–25
SPQ Negative	6.55 (4.50)	0–19
SPQ Disorganized	6.31 (4.05)	0–15
UPPS Urgency	2.42 (0.55)	1–3.5
UPPS Lack premeditation	2.26 (0.54)	1–4
UPPS Lack perseverance	2.20 (0.58)	1–4
UPPS Sensation seeking	2.86 (0.58)	1–4

The CFI is equal to 1.00. Their combination indicated an excellent fit. The internal consistency of the scale is satisfying, according to the Cronbach's alpha coefficient (α = 0.67). As Cronbach's alpha is partially dependent upon the number of items in the scale, we also performed the mean interitem correlation and obtained 0.253, ranging from 0.103 to 0.408.

Table 2

Pearson's correlations (95% confidence interval) between ESQ, SPQ and UPPS scale scores.

	SPQ Positive	SPQ Negative	SPQ Disorganized	UPPS Urgency	UPPS Lack Premeditation	UPPS Lack Perseverance	US Sensation aking
ESQ total score	0.320** (0.144–0.486)	0.174 (0.004–0.380)	0.339** (0.199–0.544)	0.227* (0.025–0.427)	−0.041 (−0.253–0.173)	0.018 (−0.220–0.253)	0.222* (0.045–0.403)

Note. ESQ stands for Encoding Style Questionnaire, SPQ for Schizotypal Personality Questionnaire. *p<05. **p<01.

PEARSON CORRELATIONS BETWEEN THE ESQ AND OTHER MEASURES

Out of the 101 participants, five had missing values on the UPPS scale and were therefore removed from these correlations. As outlined by Cohen (1988), a correlation between 0.10 and 0.30 corresponds to a small effect, a correlation between 0.30 and 0.50 to a medium effect, and above 0.50 to a large effect. Confirming or rejecting hypotheses based on *p*-value might be problematic as *p*-value relies on both effect sizes and sample size. Thus, as suggested by several authors (Schmidt, 1996), effect sizes were reported within a 95% confident interval (CI), which was used in the interpretation of the results. Table 2 presents the correlations between the ESQ total score, the four facets of impulsivity and the different dimensions of schizotypal traits. Significant relationships were shown between encoding style and the urgency and sensation seeking facets of impulsivity, as well as with the positive and disorganized dimensions of schizotypal trais. Conversely, no significant correlation was observed between the ESQ and lack of perseverance and premeditation or negative schizotypal traits.

Discussion

The aim of the present study was to validate the French version of the ESQ in an adolescent sample in order to address the relationships between encoding style, schizotypal traits and impulsivity in this developmental period. Consistent with the French validation study in an adult sample (Billieux et al., 2009), our analyses contribute further support to the single factor model and provides an adequate fit to the data. In addition to this, we observed significant relationships between the ESQ total score and positive/disorganized schizotypy as well with the urgency/sensation seeking impulsivity dimensions. These associations replicate results found in independent studies in adult samples (Billieux et al., 2009; Valérie et al., 2011), thereby extending the external validity of the ESQ to an adolescent sample.

More precisely, the pattern of correlations first supports the fact that people with a predominantly internal encoding style, namely a greater tendency to impose pre-existing categories when processing ambiguous stimuli, might also be prone to express positive and disorganized schizotypal traits. In other words, the current findings suggest that an internal encoding style during adolescence is a psychological process underlying schizotypal traits expression, at least for the positive and disorganized dimensions when examined in a cross-sectional design.

These results are in line with recent models of schizotypal manifestations suggesting that several information-processing biases may contribute to the formation and/or maintenance of these manifestations (Bentall and Taylor, 2006; Freeman, 2007). In particular, studies have consistently shown that individuals prone to delusional ideation need access to less information to reach a decision (so-called jumping to conclusions bias), which contributes, under certain conditions, to erroneous inference (Van Deal et al., 2006). In addition, others

studies have observed that schizophrenic and schizotypic people adapt their hypothesis according to every new piece of data they receive, which often ends up by causing muddled conclusions. Some studies have reported that some individuals tend to change their appraisals following disconfirmatory evidence (overadjustment bias) while other studies have shown a strong confirmatory reasoning style, which goes against the overadjustement bias (Buchy et al., 2007). Interestingly, encoding style shares some characteristics with these processes, as they are all data-gathering biases xpressed in ambiguous conditions that imply making early and hasty decisions on the basis of little evidence. Thereby, these decisions may lead to inaccurate, or even false conclusions and thus foster the expression of positive schizotypal traits. Nevertheless, encoding style differs from other biases in, at least, two main ways. On the one hand, while encoding style is an implicit low-level mechanism, other biases occur downstream in information processing, where underlying cognitive processes such as decision- making work on the basis of a sum of information that surpasses the plain perceptual level. Thus, we can postulate that an internal encoding style is one of the building blocks for jumping to conclusion proneness. Put another way, it may represent one basic mechanism that sustains more elaborate biases in decision-making. On the other hand, encoding styles operate in different time windows. Indeed, interpretive schema related to an internal encoding style operates as a filter, which is implicitly prompted as soon as the information is perceived. Therefore, it may have an effect in the earliest links of the emotion processing chain and therefore chronologically precede other cognitive biases. Indeed, the latter refer to disrupted forms of decision-making that are considered to occur later in the information processing chain. Of particular interest would be to further jointly investigate encoding style, jumping to conclusions and schizotypal expression to test likely mediation relationships. Here, we would hypothesize that an internal encoding style promotes less elaborate data collection, on the basis of which jumping to conclusions occur, which in turn would facilitate the expression of positive schizotypal traits expression such as delusional beliefs.

Because schizotypal features are conceptualized as signalling a liability to develop psychotic disorders (Lenzenweger, 2010), these results prompt the question of whether an internal encoding style may actually play a role in the unfolding of frank psychotic states. Studies involving adolescents with at-risk mental states or meeting prodromal criteria for psychosis are needed to examine this issue.

Moreover, the association we observed between encoding style and urgency suggests that internal encoders and adolescents reporting a high degree on the urgency dimension of impulsivity may exhibit decreased capacity to inhibit their personal interpretative schemata, especially in intense emotional contexts. This result is consistent with theoretical considerations regarding the personality of internal versus external encoders and previous work on adult impulsivity (Billieux et al., 2009). More precisely, it suggests that internal encoders may present difficulties in inhibiting the prepotent response, as already highlighted in relation to urgency (Gay et al., 2005). On the other hand, contrary to results in adults, in our adolescent sample we found a significant link between sensation seeking and encoding style,

while no association was observed with lack of perseverance. These inconsistencies may be interpreted in the light of recent research in develop- mental differences in cerebral maturation. A number of authors suggest that during adolescence, the immediate reward provided by sensation seeking is consistent with the maturation of temporal limbic structures, that precede prefrontal cortical (PFC) areas, leading to a temporary imbalance between mature reward seeking processes and immature executive inhibition processes (Steinberg, 2005; Casey et al., 2008). Indeed, an increased activation of the limbic subcortical regions (Ernst et al., 2005) as well as a delayed functional connectivity between these regions (Hwang et al., 2010) are consistent with this view, and signal the decreased control of the PFC on the limbic structure as observed behaviourally during adolescence (Casey et al., 2008). Developmentally towards adult- hood, and as sensation seeking is increasingly constrained by executive functions, any residual impairments in such prefrontal functions will take over as the principal factor promoting extreme internal encoding style. Thus, developmental differences in the consolidation of self-control skills, underpinned by critical pat- terns of cerebral maturation in the limbic structures and the PFC, may contribute to understand why the association between sensation seeking and encoding style observed during adolescence shifts to an association with lack of perseverance during adult- hood. These hypotheses require integrative longitudinal studies to more specifically characterize the associations between cerebral development and patterns of encoding style associations.

In conclusion, the consideration of these results must bear four main limitations. First, we note the absence of an alternative model that would be relevant to test the CFA. Indeed, the computation of others competing factorial structures is impeded by the fact that the original version of ESQ includes only six items, which have always been linked to a single factor. In addition to this our study encompassed a homogeneous sample of subclinical participants, predominantly Caucasian and from middle socio- economic status, that may restrict the generalization of our conclusions. Therefore, these results need to be replicated in a multicultural sample from diverse socio-economic backgrounds, as well as clinical adolescents. Third, we acknowledge that our data is driven from self-report based measures, which represent a limitation in our study. Future encoding style investigations, especially those including clinical participants who may suffer from a lack of introspection, should combine the ESQ with laboratory cognitive methods that rely, for instance, on patterns of reaction times (Lewicki, 2005).

Nevertheless, the present research provides the first valid tool for evaluating encoding style in adolescence. This self-report questionnaire presents a promising perspective in both research and clinical practice. First, encoding style may be central in the understanding not only of the adaptive but also the disordered thought processes. Bearing that in mind, an interesting question is whether we may hypothesize the existence of a threshold related to the level of internal style beyond which the risk to lose touch with reality increases. A better appreciation of the factors enabling to disentangle circumstances in which encoding style favours adaptive issue from those who lead to a psychopathological outcome will help clinicians to have objective criteria to identify at-risk adolescents. Second, neuroimaging studies and cognitive

tasks should be integrated to enhance our understanding of the processes that sustain an internal encoding style and its associations in adolescence. For instance, developmental changes that occur during adolescence in the prefrontal cortex are crucial to the development of cognitive control and may therefore be involved in the relationships between urgency and encoding style.

In general terms, this validation offers promising opportunities to investigate how an internal encoding style plays a role in adolescent developmental issues.

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