Specific aspects of aberrant salience: comparison between patients with or without psychosis and healthy participants

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Summary

Aberrant salience is likely to be a key mechanism in the development of psychosis. This concept bridges the perceptual and the cognitive levels but little is known about their respective roles in the emergence of psychosis. It has also been suggested that not all aspects of aberrant salience are specific to psychosis. The aim of this study was to compare patients with psychosis, patients with other psychiatric diagnoses and healthy, non-clinical participants on several psychological dimensions related to aberrant salience.

A total of 432 French-speaking individuals participated in the study. Overall, 282 participants from the general population and 150 persons hospitalised in psychiatric institutions in Switzerland were assessed using the Perceptual Aberration Scale (PAS), the Internal and External Encoding Style Questionnaire (ESQ), the Highly Sensitive Person Scale (HSPS), the Aberrant Salience Inventory (ASI) and the Magical Ideation Scale (MIS).

Three scores (PAS, ESQ and ASI-Sharpening of Senses) were able to discriminate between psychiatric patients (both those with psychosis and those with other psychiatric diagnosis) and the general population whereas three other scores (HSPS, MIS and ASI-Heightened Cognition) discriminated patients with psychosis from both patients with other psychiatric diagnose and non-clinical participants.

The results suggest that low-level processes (perception) were not specific to psychosis, but rather to psychiatric disorders more generally. In contrast, aspects related to cognition, sensitivity, and ideation seems to be specific to psychosis. Future studies should examine whether aspects of cognition, sensitivity, and ideation play a more prominent role in the development of psychosis.

Introduction

Recent studies consider aberrant salience to be a key mechanism in the development of psychosis. In his 2003 article "Psychosis as a state of aberrant salience" Kapur [1] came up with this hypothesis, which provides an explanation of psychosis onset on both biological and cognitive levels. According to this hypothesis, the abnormal attribution of significance to innocuous stimuli comes from dysfunctional dopamine release. Irregularities induced by the dopaminergic system may contribute to aberrant salience via the creation of confusions between rewarding and aversive signalling, further provoking feelings of apprehension and the impression that the world is changing [2, 3]. According to Jaspers [4], this state characterises the prodromal phase preceding psychosis, referred to as a *delusional atmosphere*. Conrad (1958) also described an initial phase named "tréma" characterised by similar symptoms of anxiety and restlessness. In psychosis, the threshold of salience is lowered, leading to a search for stimuli in the environment that should attract attention [1]. Stimuli that were previously ignored thus receive excessive attention. Irrelevant stimuli are finally given a high degree of importance in an aberrant way. As a result, the person gives meaning to certain stimuli that he or she recognises as excessively important (delusions) or perceives internal sensations, memories or thoughts as external stimuli in a disturbed way (hallucinations). When the person attributes too much importance to many stimuli, the world appears confused and disorganised (disorganisation) [5]. During this period, the patients describe a feeling of an upcoming important event causing anxiety and depression symptoms. In this framework, delusions are seen as a cognitive effort by the patient to

make sense of these aberrantly salient experiences, and in this context, hallucinations reflect a direct experience of the aberrant salience of internal representations [1].

The aberrant salience hypothesis of psychosis is in accordance with cognitive models such as the vulnerability stress mode [6–8]. According to this model, stress triggers a psychotic decompensation if vulnerability is present, but it is the person's appraisal of stressful events that plays a key role in the formation of symptom, such as delusions. Aberrant salience is also strongly correlated with psychosis-proneness symptoms such as magical ideation [9] or perceptual aberration [10]. Salience is therefore a concept that links the perceptual level and cognitive level and yet little research, to our knowledge, allows us to differentiate their precise role in the emergence of psychosis. Recently, a study using the Aberrant Salience Inventory has suggested that not all aspects of aberrant salience are specific to psychosis: sharpening of senses (i.e., previously nonsalient stimuli become salient), although higher than in the general population, did not discriminate between psychiatric patients with psychosis or with other diagnoses [11].

Therefore, the aim of the present study was to determine to which extent several cognitive and perceptual dimensions related to aberrant salience are specific to patients with psychosis or to psychiatric patients in general in comparison with the general population. We hypothesised on the perceptual level that psychotic-like perceptual distortions, how encoding is affected by information coming directly from the senses and anomalies of perceptions and subjective feelings of greater acuteness of the senses would not be specific to psychosis [12–14]. We also hypothesised that cognitive dimensions such as those that accompany the attempt to find an explanation to the aberrant salience experience or strange belief in forms of causation would be more specific to psychosis [15].

Material and methods

Participants

This study was based on the data of the validation study of the French version of the Aberrant Salience Inventory [11]. A total of 432 French-speaking individuals participated in the study. The first sample was made up of 282 participants from the Belgian general population and was recruited online. The second sample consisted of 150 persons hospitalised in various psychiatric institutions in Switzerland.

The general population sample included 282 persons, 72% (n = 203) were students and 75% (n = 211) were female. Participants ranged from 18 to 58 years old, with a mean age of 23.85 years (standard deviation [SD] 7.64). Roughly

53% (n = 149) were single or divorced and 47% (n = 133) were in a relationship or married. None of the participants reported having a current mental disorder. Roughly 86% (n = 242) of participants had never had any mental problems in the past, whereas 16% (n = 40) had suffered from depression and/or anxiety disorders in the past. All participants provided informed consent and completed the online survey. To ensure data quality, 20 participants were excluded because of an extreme score (≥2.68 SD) on six quality check items. The quality check items consisted of two items aimed at detecting random completion or attention lapses (e.g., "please answer XX for this question"), two items to detect a lie (issued from the Eysenck Personality Questionnaire Revised; [16]) and two items were designed to detect the simulation of psychotic symptoms and were based on publicized clichés (issued from [17]). Eighteen additional participants were excluded because they reported a current psychiatric disorder, 1 because of current neuroleptic medication and 13 because they were consulting a mental health professional.

Participants from the clinical sample included 150 patients who were recruited during their hospitalisation in different psychiatric hospitals or in other residential facilities from three French-speaking Swiss cantons (Fribourg, Vaud and Neuchâtel). They were approached by research assistants (trained master's degree psychology students or sixth year medical students) in presence of their attending nurse or doctor. Participants were informed about the study and those interested in participating were assessed individually after having given written consent. Mean age was 40.6 years (SD12.81) years old and 63% (n = 94) were male. Almost 73% (n = 109) of the participants were born in Switzerland, 83% (n = 124) had Swiss nationality and all of them were native or proficient French speakers. Only 12.7% (n = 19) of the participants were married; the rest were single, divorced, separated or widowed. Primary diagnostic categories based on the International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10) were: 50% (n = 75) psychosis, 16.7% (n = 25) depression, 12% (n = 18) mania, 6.7% (n = 10) personality disorder, 4.0% (n = 6) anxiety and stress related disorder and 6% (n = 9) other diagnoses.

Measures

An overview of the instruments used and the dimensions tested with each instrument is provided in table 1.

Table 1: Overview of the instruments and the dimensions tested with each instrument.

Instrument	Dimension
Perceptual Aberration Scale (PAS)	Psychotic-like perceptual distortions
Internal and External Encoding Style Questionnaire (ESQ)	How encoding is affected by information coming directly from the senses (versus from preexisting schemata)
Sharpening of Senses (ASI)	Anomalies of perceptions and subjective feelings of greater acuteness of the senses
Highly Sensitive Person Scale (HSPS)	Sensory-processing sensitivity (high sensory sensitivity and associated arousability)
Enhanced Interpretation and Emotionality (ASI)	Emotions that accompany the attempt to find an explanation to the aberrant salience experience
Heightened Cognition (ASI)	Cognitive abilities that accompany the attempt of finding an explanation to the aberrant salience experience
Magical Ideation Scale (MIS)	Belief in forms of causation that by conventional standards are invalid

The Perceptual Aberration Scale (PAS)

The PAS is a 35-item true/false inventory measuring psychotic-like perceptual distortions [10]. Twenty-eight items describe perceptions of one's own body (e.g., "I sometimes have had the feeling that my body is abnormal") and seven items describe other perceptual distortions (e.g., "My hearing is sometimes so sensitive that ordinary sounds become uncomfortable"). Five types of deviant experiences are investigated: unclear boundaries of the body, feeling of unreality or estrangement of parts of one's body, feeling of deterioration of one's body, perceptions of change in the size, relative proportions, or spatial relationships of one's body parts and changes in the appearance of the body. High scores reflect high levels of perceptual aberration. These experiences of body-image aberration are more frequent in the prodromal phase of the illness and tend to diminish with the development of the illness. In our study, we used the French version of the PAS [18] and its internal consistency was good in the general sample (α = 0.87) and excellent in the clinical sample (α = 0.90).

The Internal and External Encoding Style Questionnaire (ESQ)

The ESQ is a 21-item questionnaire designed to measure individual differences in how encoding is affected by information coming directly from the senses versus from pre-existing schemata [19]. Encoding style is considered to be a low-level process shaping the interindividual differences [20]. Participants rate, on a six-point Likert scale, ranging from 1 (strongly disagree) to 6 (strongly agree), the frequency of having experiences of "split-second illusions", that indicate the hasty application of the preexisting interpretative categories. Typical items are: "Sometimes when I'm driving, I see a piece of paper or a leaf being moved by the wind and for a split second think it might be an animal (e.g., a squirrel or a cat)" or "I've sometimes noticed a particular object to my left or right, and only after I turned my head I realised it was something else". There are only six diagnostic items [5, 8, 11, 15, 18, 21]; the 15 other items are included in order to conceal the focus of the questionnaire. Lewicki (2005) assumed that the two encoding styles range on a continuum from "extremely internal" to "extremely external". A high score on the ESQ indicates an internal encoding style, whereas a low score reflects an external encoding style. In our study, we used the French version of the ESQ [21] and its internal consistency was satisfactory in the clinical sample (α = 0.79). As the scale consisted of only six diagnostic items, its internal consistency in the general sample can be considered as being adequate (α = 0.66).

The Highly Sensitive Person Scale (HSPS)

The HSPS is composed of 27 items and measures sensory-processing sensitivity, which involves high sensory sensitivity and associated arousability [22]. Sensitivity is linked with social introversion and emotionality, but the two terms are not equivalent [22]. Participants rated how they generally feel on a seven-point Likert scale ranging from 1 (not at all) to 7 (extremely). Typical items are: "Are you easily overwhelmed by strong sensory input?" or "Do other people's moods affect you?". High scores reflect a high level of sensitivity. In our study, we used the French-version of the HSPS. The internal consistency of the HSPS in the current samples was good (general sample: α = 0.84; clinical sample: α = 0.88).

The Aberrant Salience Inventory (ASI)

The ASI is a self-report questionnaire that measures aberrant salience and psychosis proneness [23]. The 29 items have a dichotomous response format on a true-false scale. The French version of the ASI showed good psychometric properties and reliability and convergent validity estimates were good with both psychiatric patients and the general population [11]. The French ASI distinguishes between one score related to the perceptual level (Sharpening of Senses; i.e., anomalies of perceptions and subjective feelings of greater acuteness of the senses; e.g., "Do your senses sometimes seem sharpened?") and two scores related to the cognitive level (Enhanced Interpretation and Emotionality, and Heightened Cognition; i.e., related to emotions and cognitive abilities that accompany the attempt of finding an explanation to the aberrant salience experience; e.g., "Do you ever have difficulty telling if you are thrilled, frightened, pained, or anxious?" or "Do you ever feel like you are rapidly approaching the height of your intellectual powers?").

The Magical Ideation Scale (MIS)

The MIS is a 30-item true/false questionnaire measuring "belief in forms of causation that by conventional standards are invalid" and is considered a general measure of schizophrenia proneness [9]. Typical items include superstitions, magical beliefs and the capacity to read one's thoughts (e.g., "Numbers like 13 and 7 have no special powers", or "I have sometimes felt that strangers were reading my mind"). There are seven reverse-scored items [4, 7, 15, 19, 22, 24, 25] and 23 standard items. The total score ranges from 0 to 30, with high scores reflecting high levels of magical thinking. In the present study, we used the French version of the MIS [18] and its internal consistency was good in both samples (general sample: α = 0.80; clinical sample: α = 0.86).

Ethics approval and consent to participate

Approval for this study was granted by the Human Research Ethics Committee of the Canton Vaud (protocol #2016-00768) (Switzerland) and by the Ethics Committee from the University of Liège (Belgium). Written informed consent was obtained from all participants and all methods were carried out in accordance with the recommendations of the Human Research Ethics Committee of the Canton Vaud and the Declaration of Helsinki.

Statistical analysis

In order to compare scores from participants with a diagnosis of psychosis, participants with another psychiatric diagnosis, and participants from the general population (without a psychiatric diagnosis) we used a Bayesian model comparison approach. It represents an elegant alternative to the classic problem of multiple comparisons [24]. Five possible Gaussian (μ, σ^2) models were estimated. The first model was the homogeneous model (scores from the three groups are issued from the same distribution). This model was referred as (1, 2, 3) and corresponded to the null hypothesis in the classical statistical testing framework. Another model was the heterogeneous model (1) (2) (3) that

states that the scores from the three groups differ from each other and are issued from three different distributions. The three models (1) (2, 3), (1, 2) (3) and (1, 3) (2) were also estimated and indicate than one of the three groups differ from the two other groups. The best model was determined by using the BIC (Bayesian information criterion) [26]. The BIC coefficients were used to calculate the Bayes factor and the posterior probability [27]. The Bayes factor provided a comparison of the best model with the homogenous model. A Bayes factor of 4 would indicate that the best model is four times more likely to be true than the homogenous model. Values over 3 are generally considered as sufficiently important to favour one model over another [28, 29]. An equal prior probability of 1/5 was assumed for all models so that no model was favoured. All statistical analyses were performed with the AtelieR package for R [30].

Results

Several scores related to the perceptual level (PAS, ESQ and ASI-Sharpening of Senses) were able to discriminate between psychiatric patients and the general population (table 2). For these scores, the best model did not distinguish patients with and without a diagnostic of psychosis. One score related to the perceptual level (HSPS) discriminated patients with psychosis from other participants (psychiatric patients without a diagnostic of psychosis and participants from the general population).

Two scores related to the cognitive level (ASI-Heightened Cognition and MIS) also distinguished patients with a diagnostic of psychosis. The ASI-Heightened Cognition did not distinguish psychiatric patients without a diagnostic of psychosis from participants from the general population while the MIS score did discriminate the three groups. Finally, the ASI-Enhanced Interpretation and Emotionality score did not discriminate any group.

Discussion

Several scores related to the perceptual level (PAS, ESQ and ASI-Sharpening of Senses) were able to discriminate patients from the general population but not patients with psychosis. This suggests that several perceptual dimensions, although related to aberrant salience, are not specific to patients with psychosis.

The Heightened Cognition (ASI) score and the Magical Ideation Score (MIS) were able to distinguish patients with psychosis from other patients. This suggests that these cognitive dimensions might be the most specific to psychosis. This is not surprising considering that many studies have highlighted specific cognitive biases and deficits related to psychosis [25, 31]. According to existing accounts, salience exerts its effects at an earlier stage of delusion formation, in facilitating the generation of implausible thought. Cognitive biases, on the contrary, generally play a role at later stages of delusion consolidation when this thought is uncritically accepted as true [32, 33].

Moreover, Magical ideation was the only dimension that was able to discriminate the three groups. Magical ideation has been shown to be an indicator of schizotypy and as being suggestive of predisposition to psychosis [9]. The same study showed that magical ideation, although partially related to perceptual aberrations, was more sensitive than the perceptual aberrations dimension in identifying patients prone to psychosis. The vast majority of the items refer to beliefs and some to perceptions. Invalid cognitions could be based on aberrant perceptions. We hypothesise that magical ideation adds an important cognitive element that is able to discriminate between different types of psychiatric patient. Magical ideation is related to aberrant salience in the sense that some stimuli will be more salient and significant for the person. Similarly, the relationship between psychotic symptoms (unusual thought content) and Heightened Cognition as measured by the ASI was also found in a recent paper [34].

The HSPS, which measures sensory-processing sensitivity, was also able to discriminate patients with psychosis from other patients. It could be hypothesised that the processing element of sensorial inputs also involves cognition, which makes this scale able to distinguish patients better than other scales more related to perception. This issue should be further investigated with a factor analytic approach in order to better understand how the HSPS items are organised with regards to the cognitive level and the perceptual level.

The ASI-Enhanced Interpretation and Emotionality did not discriminate any group from the others. In the validation

Table 2: Comparisons between the general population, patients with other diagnoses and patients with psychosis.

	(1) General population n = 282 Mean (SD)	Psychiatric patients		Best model*	Bayes factor against null hypothesis†	Probability of the model to be true‡
		(2) Clinical population n = 71 Mean (SD)	(3) Psychosis n = 79 Mean (SD)			
Perceptual Aberration Scale (PAS)	4.68 (4.96)	7.28 (6.15)	8.48 (7.39)	(1), (2, 3)	$7.18 * 10^8$	0.899
Internal and External Encoding Style Questionnaire (ESQ)	19.80 (5.17)	17.65 (6.91)	16.70 (6.91)	(1), (2, 3)	587.56	0.892
Sharpening of Senses (ASI)	1.85 (1.48)	2.79 (1.53)	2.94 (1.65)	(1), (2,3)	$5.38 * 10^7$	0.946
Highly Sensitive Person Scale (HSPS)	115.31 (19.74)	115.62 (27.51)	124.89 (24.18)	(1,2), (3)	13.98	0.854
Enhanced Interpretation and Emotionality (ASI)	9.03 (3.97)	9.75 (4.20)	10.24 (4.60)	(1,2,3)	1.00	0.438
Heightened Cognition (ASI)	1.80 (1.47)	2.11 (1.81)	2.95 (1.76)	(1,2), (3)	$1.14 * 10^5$	0.861
Magical Ideation Scale (MIS)	7.44 (4.82)	9.51 (5.36)	12.46 (6.92)	(1), (2), (3)	$9.46 * 10^{11}$	0.661

BIC = Bayesian information criterion; SD = standard deviation * On the basis of the BIC coefficient. † Bayes factor comparing the best model with the homogeneous model (1, 2, 3). ‡ Among all possible models ((1, 2, 3) / (1, 2) (3) / (1) (2, 3) / (1, 3) (2) / (1) (2) (3)).

study, this score was nevertheless significantly related to other scales in both the clinical and non-clinical group [11], suggesting that inter-individual differences were not random and that there may be meaningful inter-individual differences. However, since average scores were not significantly different between groups, this dimension cannot be used for diagnostic purpose.

Our study has several limitations that could be the focus of future studies. First, some demographic characteristics differed between our general population and our clinical population samples. Patients were older and more likely to be men and single. The Bayesian mean comparison method, as used here, does not allow for the inclusion of covariates. Second, our clinical sample size was moderate and our findings must be replicated in other samples.

Conclusions

It was possible to highlight which constructs specifically discriminated patients with a diagnosis of psychosis and which ones discriminated psychiatric patients more broadly. In general, differences in low-level processes (perception) were not specific to psychosis, but rather to psychiatric disorders more generally. In contrast, aspects related to cognition, sensitivity, and ideation seems to be specific to psychosis.

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