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Prosody abilities in a large sample of affective and non-affective first episode psychosis patients

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ABSTRACT

Objective: Prosody comprehension deficits have been reported in major psychoses. It is still not clear whether these deficits occur at early psychosis stages.
The aims of our study were to investigate a) linguistic and emotional prosody comprehension abilities in First Episode Psychosis (FEP) patients compared to healthy controls (HC); b) performance differences between non-affective (FEP-NA) and affective (FEP-A) patients, and c) association between symptoms severity and prosodic features.
Methods: A total of 208 FEP (156 FEP-NA and 52 FEP-A) patients and 77 HC were enrolled and assessed with the Italian version of the "Protocole Montréal d'Evaluation de la Communication" to evaluate linguistic and emotional prosody comprehension. Clinical variables were assessed with a comprehensive set of standardized measures.
Results: FEP patients displayed significant linguistic and emotional prosody deficits compared to HC, with FEP-NA showing greater impairment than FEP-A. Also, significant correlations between symptom severity and prosodic features in FEP patients were found.
Conclusions: Our results suggest that prosodic impairments occur at the onset of psychosis being more prominent in FEP-NA and in those with severe psychopathology. These findings further support the hypothesis that aprosodia is a core feature of psychosis.

1. Introduction

The diagnoses of major psychoses, including Schizophrenia (SZ) and Bipolar Disorder (BD) with psychotic features, have been progressively overcome by a transdiagnostic phenotype encompassing affective and non-affective psychosis [1,2]. Indeed, psychotic symptoms are present in psychotic disorders (e.g. SZ) but they may also

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characterize affective disorders (e.g. BD) during a specific mood episode [3]. Interestingly, the transdiagnostic nature of psychosis has also been confirmed by genetic studies showing that SZ and BD share some genetic etiology, which may determine a similar susceptibility of developing psychosis [4,5].

Notably, although it has been consistently suggested that non-affective psychotic patients showed verbal communication deficits [6] and a general worse cognitive functioning than the affective ones [7,8], language deficits have frequently been observed in both patient populations in syntactic comprehension [9] and even in the paralinguistic prosodic dimensions [10,11].

Prosody refers to the vocal system of non-verbal communication and consists of transient acoustic properties that accompany the utterance of a sentence [12], such as pitch (i.e. the tone of voice), intensity and time, which determine the speech's sequences and pauses. Prosody has grammatical, pragmatic and emotional functions [13]. The first function refers to the intonational contour that codifies question-mark features and affirmative or imperative utterances. Among the prosodic pragmatic indicators, pitch emphasizes new information in a message. Moreover, emotional prosody refers to the ability to convey a speaker's emotional state through modulations among various vocal parameters [14, 15]. Finally, expressive and receptive prosody refer respectively to the ability to convey and decode the prosodic information of a statement [16,17].

Although several studies suggested that aprosody (i.e., the inability to express or comprehend affective or non-affective tonal aspects of speech) is part of the symptomatology of both SZ [18–20] and BD [21, 22], it is still not clear whether it may be considered a trait marker of major psychoses in general, with particular regards to the early phases of the illness. An accurate comprehension of prosodic information is essential in maintaining successful social interactions and relational well-being [23]; therefore, investigating whether prosody is altered in both affective and non-affective psychosis is paramount.

Interestingly, receptive emotional prosody deficiency has been consistently observed in SZ, showing difficulties in identifying emotions based upon the tone of voice [24]. Furthermore, aprosody seems to precede the full expression of psychotic symptoms and to be present in first-episode psychosis (FEP) patients [10,25] in ultra-high risk population [26] and in children with early-onset of SZ [27], suggesting that there might be emotion recognition trait deficits in SZ.

Some studies reported impaired receptive syntactic domain [9] and emotional prosody processing also in affective disorders [28,29] albeit other investigations did not reveal abnormalities neither in pitch perception nor in semantic and linguistic comprehension [30–32]. Furthermore, Hoertnagl and colleagues [21] explored emotional prosody perception in symptomatically remitted SZ and BD patients and found similar anger identification impairments, although only patients with SZ confused sadness with other emotions. However, most of these studies suffer from some important methodological limitations, which may have limited the generalizability of their findings, such as the small sample size, the age or IQ differences between healthy controls (HC) and patients as well as the inclusion of patients at different illness severity.

1.1. Aims of the study

This study should be seen within the framework of the continuum model of psychosis, which highlights similarities across different psychotic diagnostic categories as well as differences between affective and non-affective psychoses [33,34]. In this context, the aim of this study was to bring a new contribution to the differentiation between psychotic disorders through the exploration of language abilities as well as through the investigation of the impact of symptoms severity on prosodic features in a very large sample of FEP patients, considering separately affective and non-affective subjects.

2. Materials and methods

2.1. The GET UP

Subjects were recruited from the GET UP (Genetics, Endophenotypes, Treatment: Understanding early Psychosis) (see Ruggeri and colleagues [35] for a more detailed description of subjects enrollment), a large multicentre randomised controlled trial involving 117 community mental health centres (CMHCs) located in the Italian regions of Veneto and Emilia-Romagna and in the urban areas of Florence, Milan and Bolzano [36].

The GET UP inclusion criteria [37] were: age 18–54 years, residence in the catchment regions of the CMHCs and first lifetime contact, presence of at least one of the following symptoms: hallucinations, delusions, qualitative speech disorder, qualitative psychomotor disorder, bizarre, or grossly inappropriate behavior, or two of the following: loss of interest, initiative, and drive; social withdrawal; episodic severe excitement; purposeless destructiveness; overwhelming fear; or marked self-neglect. Exclusion criteria were: (1) antipsychotic treatment (>3 months) prescribed for an identical or similar mental disorder; (2) mental disorders caused by a general medical condition; (3) moderate or severe mental disability evaluated by a clinical functional assessment; and (4) psychiatric diagnosis other than International Classification of Diseases (ICD)-10 for psychosis [39]. The specific ICD-10 codes for psychosis (F1x.4; F1x.5; F1x.7; F20–29; F30.2, F31.2, F31.5, F31.6, F32.3, F33.3) were assigned at 9 months. Diagnoses were made by using the Item Group Checklist (IGC) of the Schedule for Clinical Assessment in Neuropsychiatry (SCAN) [38] and were confirmed by the clinical consensus of two staff psychiatrists, according to the ICD-10 criteria.

Participants were Italian native speakers. Information about years of education and age of onset of illness were retrieved from specific interviews. Eligible participants signed an informed consent form prior to participating in the study.

The study was approved by the Ethics Committee of the Azienda Ospedaliera of Verona and by the local ethics committees of participating sites and was registered with ClinicalTrials.gov (NCT01436331).

2.2. Ethical standards

The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008.

2.3. Clinical assessment

The Global Assessment of Functioning (GAF) was used to assess global functioning (social, psychological and occupational functioning) [39]. Clinical symptoms were assessed using the Positive and Negative Syndrome Scale (PANSS) [40], composed by one total score (PANSS-Total) and three sub-tests: positive symptoms (PANSS-Positive), negative symptoms (PANSS-Negative), and general psychopathology (PANSS-Psychopathology). The Hamilton Depression Rating Scale (HDRS) [41] and the Bech–Rafaelsen Mania Rating Scale (BRMRS) [42] were administered to assess depressive and manic symptoms. The Brief Intelligence Test (TIB) was used to measure Intelligence Quotient (IQ). The absence of other DSM-IV axis I disorders in HC was assessed using the SCID-IV non-patient version (SCID-NP). HC had also no history of psychiatric disorders among relatives.

2.4. Prosody assessment and procedure

Two subtests of the Italian version of the *"Protocole Montréal d'Evaluation de la Comunication – MEC"* [43] were administered to the

three sample groups (FEP-NA, FEP-A and HC) to assess the linguistic and the emotional prosody comprehension: linguistic prosody comprehension subtest and the emotional prosody comprehension subtest. The linguistic prosody comprehension subtest evaluated the ability to identify the linguistic intonation patterns, in particular the affirmative, the interrogative, and the imperative ones. This subtest consists of four semantically neutral simple pre-recorded sentences (subject–verb–object) and each one is presented to the auditor through an audio device with three different intonations, for a total of 12 items. After listening to a sentence, subjects were asked to select the correct intonation among the three different options that were written and displayed as images on the stimulus book. The number of correct answers for each intonation is four; the three subtotal scores for each intonation are summed to obtain the total score (range 0–12) which is then compared with the normative values. Finally, the linguistic prosody comprehension subtest consists of four final scores: three subtotal scores (the affirmative, the interrogative and the imperative domains) and one linguistic total score. The emotional prosody comprehension subtest evaluates the ability to identify the emotional intonation patterns, in particular sadness, happiness, and anger. This subtest consists of four semantically neutral pre-recorded sentences (subject–verb–object) and each one is presented to the auditor through an audio device with three different intonations, for a total of 12 items. After listening to a sentence subjects were required to select the correct intonation among three options written and displayed as images on the stimulus book. The number of correct answers for each intonation is four; the three subtotal scores for each intonation are summed to obtain the total score (range 0–12) which is then compared with the normative values. Finally, the emotional prosody comprehension subtest consists of four final scores: three subtotal scores (sadness, happiness, and anger domains) and one emotional total score.

2.5. Statistical analyses

All the analyses were conducted using R [44]. A two-tailed significance level of $p = 0.05$ corrected for multiple comparisons was adopted. We performed a chi–square test ($\chi 2$) for qualitative variables (i.e. gender) and *t*-tests or Analysis of Variance (ANOVA) for quantitative variables for exploring group differences in socio-demographic and clinical measures. Then, a hierarchical approach was carried out for the inferential analysis. First, a general Multivariate Analyses of variance (MANOVA) with all linguistic and emotional variables as dependent variables as well as group, age and TIB as covariates were carried out in order to explore whether the variable "group" was significant. Second, two MANOVAs, with groups TIB and age as covariates, were performed, one to compare the linguistic variables between the whole group of patients and HC, and the other one to compare the emotional variables between the groups. Similarly, the same statistical analyses were performed in FEP-NA, FEP-A and HC to explore linguistic and emotional deficits among the three groups, with age and TIB as covariates. All the *p*-values were adjusted by using the inheritance procedure, a method of familywise error control for hypotheses, described by Goeman and Finos [45], i.e. a multiple testing correction method for structured hypotheses. Fourth, a gamma generalized linear model was performed separately only for the items resulted significant in the MANOVA. Then, for each significant model a post-hoc analysis for multiples comparisons was performed and we applied the Holm method. Finally, to further analyze patients' performance, partial correlations between clinical features and linguistic/emotional prosody comprehension subtest were performed by means of ANOVA based on a general linear model gamma with age and IQ as covariates. We used Bonferroni correction for multiple comparisons. Additionally, Cohen's f was employed for measuring the effect size of the regression. Cohen's f^2 values can be interpreted as small (0.02), medium (0.15) and large (0.35) [46].

3. Results

3.1. Sample

A total of 208 FEP patients (118 males and 90 females; mean age ± SD = 30.2 ± 10.3; IQ TIB total ± SD = 109.8 ± 6.0) and 77 HC (34 males and 43 females; mean age ± SD = 33.2 ± 10.2; IQ TIB total ± SD = 109.6 ± 4.0) were recruited. FEP patients were therefore assigned into two main diagnostic groups, non-affective FEP (FEP-NA) and affective FEP (FEP-A) patients. FEP-NA included 156 patients (91 males and 65 females; mean age ± SD = 30.2 ± 10.0; IQ TIB total ± SD = 109.4 ± 6.7) and FEP-A included 52 patients (27 males and 25 females; mean age ± SD = 30.7 ± 10.49; IQ TIB total ± SD = 110.8 ± 7.4).

3.2. Socio-demographic data and clinical variables

Age significantly differ between patients and HC ($t = 2.2$, $p = 0.02$) whereas no differences were observed in terms of gender ($X^2 = 3.8$, $p = 0.08$) (Table 1). No significant differences between patients and HC were detected in the TIB total score ($t = -0.3$, $p = 0.7$) (Table 1). Age ($F = 2.3$, $p = 0.1$), sex ($X^2 = 4.2$, $p = 0.1$) and TIB total score did not significantly differ between the three groups (FEP-NA, FEP-A and HC) ($F = 0.8$, $p = 0.4$) (Table 2). When comparing FEP-NA and FEP-A, we found no significant differences on age of onset ($t = -0.2$, $p = 0.7$), PANSS-Negative ($t = 1.4$, $p = 0.1$), BRMRS ($t = -0.2$, $p = 0.7$) and HDRS ($t = 0.6$, $p = 0.5$) scores (Table 2). In contrast, FEP-NA exhibited lower significant scores in PANSS-Positive ($t = 4.6$, $p < 0.001$), PANSS-Psychopathology ($t = 2.1$, $p = 0.04$), PANSS total ($t = 3.2$, $p = 0.001$) and GAF ($t = -2.9$, $p = 0.004$) scores when compared to FEP-A (Table 2).

Table 1
Demographic and clinical data of the whole sample.

	FEP patients ($n = 208$)	Healthy controls ($n = 77$)	Statistics	P-value
Age (years)	30.2 ± 10.3	33.2 ± 10.2	t = 2.2	p = 0.03
Gender (males/females)	118/90	34/43	$X^2 = 3.8$	p = 0.08
Race	Caucasian	Caucasian		
Age of onset	30.2 ± 10.0	–	–	–
TIB	109.8 ± 6.9	109.6 ± 4.0	t = −0.3	$p = 0.7$
PANSS positive	14.9 ± 5.5	–	–	–
PANSS negative	16.1 ± 6.7	–	–	–
PANSS psychopathology	35.4 ± 9.3	–	–	–
PANSS total	66.5 ± 17.4	–	–	–
HDRS	16.2 ± 9.3	–	–	–
BRMRS	2.4 ± 3.6	–	–	–
GAF	47.6 ± 13.9	–	–	–

FEP = first episode psychosis; TIB = Brief Intelligence Test; PANSS = Positive and Negative Syndrome Scale; HDRS = Hamilton Depression Rating Scale; BRMRS = Bech Rafaelsen Mania Rating Scale; GAF = Global Assessment of Functioning.

Table 2
Socio-demographic and clinical characteristics of the three groups of subjects.

	FEP-NA patients ($n = 156$)	FEP-A patients ($n = 52$)	Healthy controls (n = 77)	Statistics	P-value
Age (years)	30.3 ± 10.0	30.81 ± 10.5	33.3 ± 9.4	$F_{2,281} = 2.3$	p = 0.1
Gender (males/females)	91/65	27/25	34/43	$X^2 = 4.2$	p = 0.1
Race	Caucasian	Caucasian	Caucasian	–	–
Age of onset	30.134 ± 9.92	30.594 ± 10.518	–	t = −0.2	p = 0.7
TIB TOT	109.4 ± 6.7	110.8 ± 7.4	109.6 ± 4.0	$F_{2,281} = 0.8$	p = 0.4
PANSS positive	15.86 ± 5.5	12.2 ± 4.68	–	$t = 4.66$	p < 0.001
PANSS negative	16.5 ± 7.0	15.08 ± 5.5	–	t = 1.4	p = 0.1
PANSS psychopathology	36.2 ± 9.4	33.15 ± 8.85	–	t = 2.1	p = 0.04
PANSS total	68.6 ± 17.85	60.4 ± 14.96	–	t = 3.2	p = 0.001
BRMRS	2.43 ± 3.65	2.6 ± 3.63	–	t = −0.2	p = 0.7
HDRS	16.5 ± 9.3	15.5 ± 9.3	–	t = 0.6	p = 0.5
GAF	46 ± 13.24	52,8 ± 15.02	–	t = −2.9	p = 0.004

FEP-NA = non affective first episode psychosis; FEP-A = affective first episode psychosis; TIB = Brief Intelligence Test; PANSS = Positive and Negative Syndrome Scale; HDRS = Hamilton Depression Rating Scale; BRMRS = Bech Rafaelsen Mania Rating Scale; GAF = Global Assessment of Functioning.

3.3. Group differences

3.3.1. FEP patients vs HC

In the linguistic prosody comprehension subtest, FEP patients showed lower mean scores in the interrogative domain compared to HC ($t = 24.6$, $p < 0.001$). Only for this analysis, we performed a simple one sample *t*-test because there was no variation in scores in our group of HC, which always reported a score of 4 in this item (Fig. 1a, Table 3). No significant differences were found between the two groups in the affirmative and imperative domains and in the mean linguistic total score (all *p*-values > 0.05).

In the emotional prosody comprehension subtest, FEP patients showed lower mean scores in all three domains, including anger ($z = 2.7$, $p = 0.006$), sadness ($z = 2.8$, $p = 0.004$) and happiness ($z = 2.1$, $p = 0.03$) compared to HC (Fig. 2a). Finally, FEP patients also showed significant lower total mean linguistic ($t = -2.3$, $p = 0.02$) and emotional ($t = -3.5$, $p = 0.004$) scores compared to HC (Fig. 3a, Table 3).

3.3.2. Non-affective FEP patients vs affective FEP patients vs HC

In the linguistic prosody comprehension subtest, post-hoc analyses showed lower mean scores in the interrogative domain among FEP-NA ($z = 3.1$; $p = 0.01$) and FEP-A ($z = 3.5$; $p = 0.003$) compared to HC (Fig. 1b). No significant differences were observed in any other domains of the linguistic prosody (all *p*-values > 0.05).

In the emotional prosody comprehension subtest the results showed lower mean scores in the sadness ($z = 2.8$, $p = 0.04$) and anger ($z = 3.0$, $p = 0.02$) domains among FEP-NA compared to HC (Fig. 2b). Finally, FEP-NA patients also showed significant lower total mean emotional scores compared to HC ($z = 3.8$, $p = 0.001$) (Fig. 3b, Table 4). No significant differences were observed in any other domains of the emotional prosody (all *p*-values > 0.05).

3.4. Correlations with clinical features

3.4.1. Linguistic prosody comprehension subtest and clinical variables

In FEP patients, no significant correlations were found between the linguistic prosody comprehension subtest scores and social, occupational, psychological functioning assessed by GAF or any of the clinical variables assessed with PANSS, HDRS and BRMRS (all $p > 0.05$).

3.4.2. Emotional prosody comprehension subtest and clinical variables

In FEP patients, we found no significant correlations between the GAF, BRMRS or HDRS scales and any emotional prosody scores (all $p > 0.05$). Also, we found negative correlation between PANSS-Psychopathology scale and happiness (Effect size = −0.07, $p = 0.001$), anger (Effect size = −0.04, $p = 0.01$) and the emotional total (Effect size = −0.07, $p \leq 0.001$) scores, and other significant negative correlations were found between the PANSS total scores and anger (Effect size = −0.06, $p = 0.004$), happiness (Effect size = −0.06, $p = 0.005$) and emotional total (Effect size = −0.09, $p < 0.001$) scores. Similarly, significant negative correlations were detected between the PANSS-Negative scale and anger (Effect size = −0.06, $p = 0.008$), and emotional total (Effect size = −0.07, $p = 0.001$) scores.

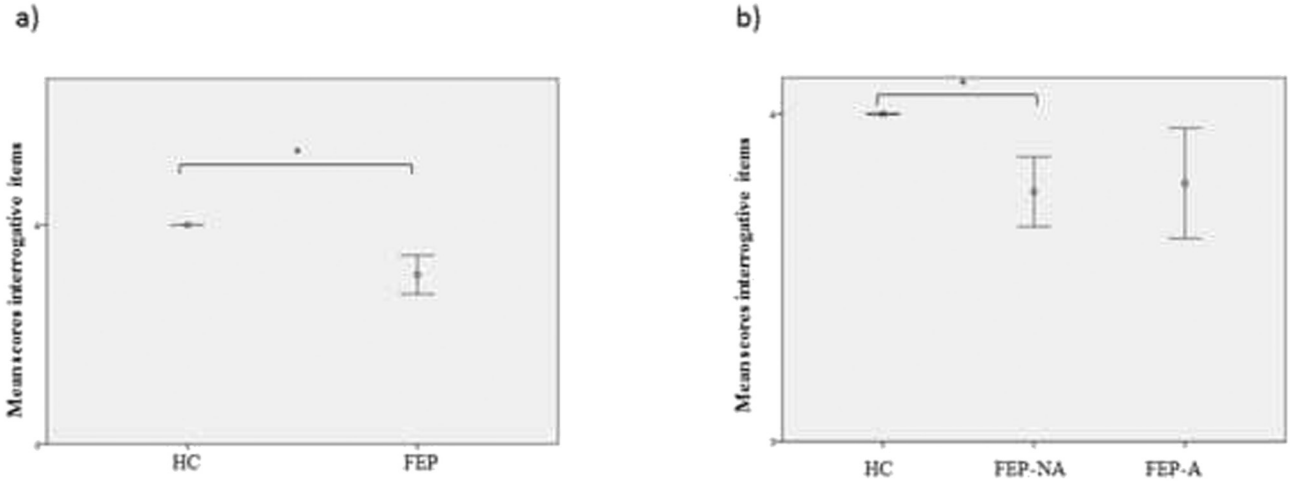

Fig. 1. Linguistic prosody: significant mean differences in interrogative items in (a) First-Episode Psychosis (FEP) patients vs healthy controls (HC) and (b) between non-affective First-Episode Psychosis (FEP-NA), affective First-Episode Psychosis (FEP-A) and HC. *Statistically significant (all $p < 0.003$, Bonferroni corrected).

Table 3
Linguistic and emotional prosody in first episode psychosis (FEP) patients and healthy controls (HC).

	FEP patients ($n = 211$)	Healthy controls (n = 77)	Statistics	P-value (after correction for multiple comparisons)
Linguistic prosody domain				
Interrogative sentences	3.7 ± 0.6	4 ± 0	t = 24.6	$p < 0.001$
Affirmative sentences	3.8 ± 0.6	3.9 ± 0.5	$t = 1.366$	$p = 0.172$
Imperative sentences	3.8 ± 0.6	3.9 ± 0.4	$t = 1.09$	$p = 0.276$
Total linguistic	11.4 ± 1.6	11.8 ± 0.6	t = −2.3	$p = 0.02$
Emotional prosody domain				
Sadness	3.7 ± 0.6	3.9 ± 0.2	z = 2.8	$p = 0.004$
Happiness	3.5 ± 0.8	3.7 ± 0.5	z = 2.1	$p = 0.03$
Anger	3.3 ± 1.1	3.6 ± 0.6	z = 2.7	$p = 0.006$
Total emotional	10.5 ± 1.9	11.3 ± 0.9	t = −3.5	$p = 0.004$

FEP = first episode psychosis.

4. Discussion

Linguistic and emotional prosody are two necessary abilities for effective social relationships [47]. Specifically, while linguistic prosody help us to identify linguistics mechanisms that underlie the assignment of prosodic information at the lexical and phrasal levels, the emotional prosody allows us to study the methods of assigning the extra linguistic pragmatic values, such as the expression of mood [48]. Therefore, the investigation of linguistic and communication dysfunctions in psychosis is of paramount importance especially because emotional recognition impairments may underlie social and interpersonal problems which are often present in psychotic patients. Notably, this study, carried out in one of the largest cohort of FEP patients, reported that linguistic and emotional prosody deficits are already present at the onset of psychosis, which may actually be present even before the full expression of schizophrenia [49,50], as reported by a previous study [51]. Specifically, FEP patients showed significant impairments in (a) decoding mental states from the emotional intonation of speech and (b) in linguistic comprehension for interrogative sentences. Moreover, our results showed that FEP-NA patients had more prominent emotion recognition deficits in respect to FEP-A, which in turn show no difference when compared to HC. Finally, we observed that the degree of emotional prosody impairment positively correlated with symptoms severity. Considering the specific emotional intonation pattern, our results on FEP-NA patients indicate that greater psychotic symptoms severity relates to poorer performance in prosody, especially for negative-valenced stimuli. Finally, aprosody was also associated with FEP patients' global functioning, in particular when considering the non-affective group.

4.1. Emotional and linguistic prosody impairments in first-episode psychosis patients

In the present study, we found that FEP patients manifested lower ability to label emotions and less accurate linguistic comprehension for interrogative sentences, thus showing impairments in both emotional and grammatical prosody, compared to HC. Our results are consistent with previous studies reporting the presence of impaired linguistic comprehension [9] and reduced prosody performance in both SZ [10,24,52,53] and BD [28,29], but not all [54].

Specifically, our FEP patients showed greater difficulty in recognizing positive (e.g., happiness), and negative (e.g., anger and sadness) emotions, similarly to previous findings obtained in patients with SZ [52,55] and in first episode SZ [10] respectively. Our study partially supports the negative valence hypothesis previously mentioned in Huang and colleagues [55], according to which non-affective psychotic patients exhibit greater impairment in recognizing stimuli with emotional negative valence. Surprisingly, we also found an impairment in recognizing positive emotions in FEP patients, suggesting that they have a disruption in the emotion recognition system which relates not only to negative-valenced emotions. Importantly, our result points towards

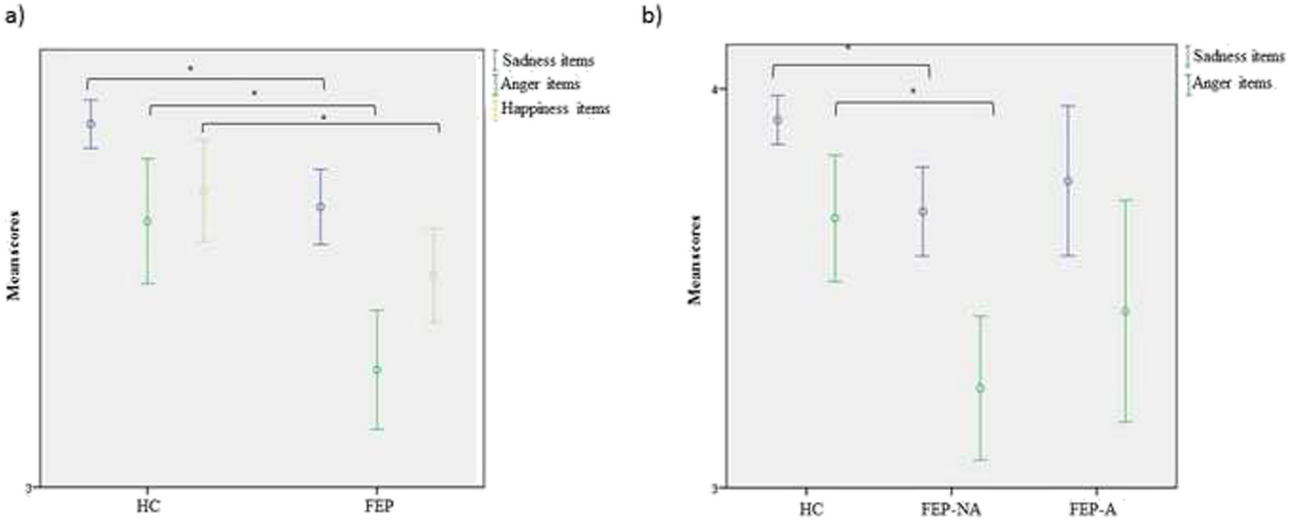

Fig. 2. Emotional prosody: significant mean differences in mean (a) sadness, anger and happiness scores in First-Episode Psychosis (FEP) patients vs healthy controls (HC) and (b) sadness and anger scores between non-affective First-Episode Psychosis (FEP-NA), affective First-Episode Psychosis (FEP-A) and HC. *Statistically significant (all $p < 0.008$, Bonferroni corrected).

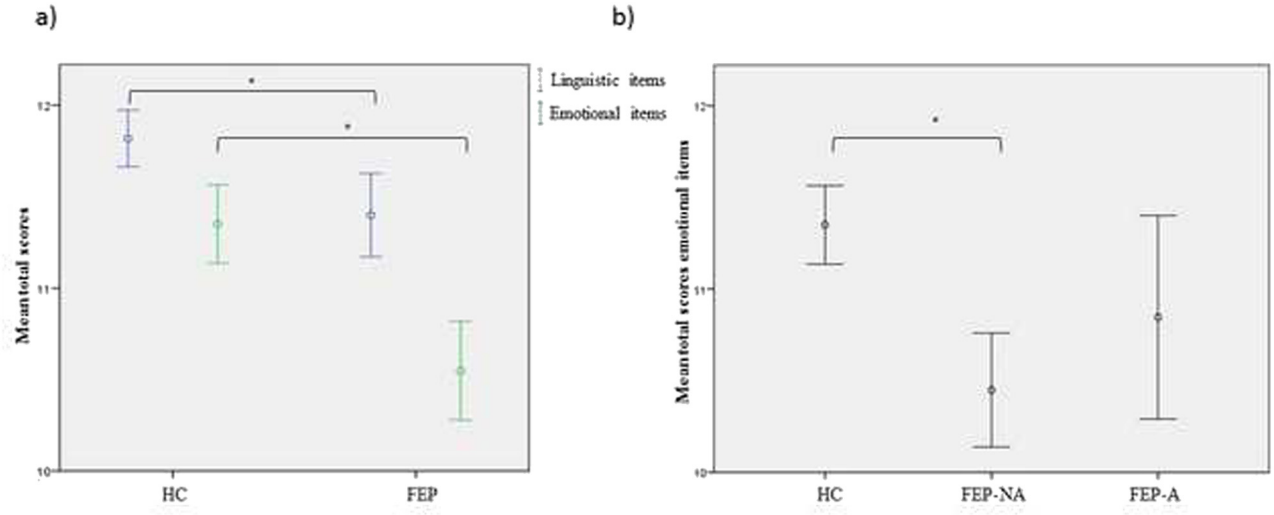

Fig. 3. Emotional prosody: significant mean and differences in (a) total emotional and linguistic scores in First-Episode Psychosis (FEP) patients vs healthy controls (HC) and (b) total emotional scores between non-affective First-Episode Psychosis (FEP-NA), affective First-Episode Psychosis (FEP-A) and HC. *Statistically significant (all $p < 0.008$, Bonferroni corrected).

the hypothesis that deficit in recognizing positive emotions may also negatively influence the way the external world is perceived, ultimately participating in the onset of psychotic symptoms, such as thought disorders and/or delusions, in accordance with previous evidence reporting that prosodic deficits in SZ are independent from illness duration [10] or medication [56].

Furthermore, FEP-NA patients revealed a general lower ability to label emotions compared to FEP-A patients, who in turn did not significantly differ in respect to HC. This is in line with previous results reporting greater difficulty in recognizing sadness in FEP-NA [55,57] and more pronounced prosody deficits in SZ compared to BD [32]. However, receptive prosody has been in general poorly investigated in affective FEP patients and to date results are mixed, with some demonstrating impairments [28,29] and others showing intact emotional prosody processing [30,31]. In contrast, the two groups of patients showed similar deficits in grammatical prosody, especially when considering interrogative comprehension sentences. Deficits in interrogative prosody have already been described in FEP-NA [58] but, to the best of our knowledge, this is the first study observing these impairments also in FEP-A patients.

4.2. Correlations between emotional prosody measures and clinical variables

Our results showed that selective emotional prosody deficits were associated with symptoms severity, in line with previous evidence reporting a broader emotion dysfunction in psychosis [51,59,60]. Specifically, we found a negative correlation between the emotional total score and all the PANSS subscales. These results are partially in accordance with Tseng et al. [61], who found an inverse correlation between PANSS total scores and emotional processing, although not in all the emotional measures analyzed. Furthermore, evaluating the specific emotional intonation patterns, we found an inverse correlation between the ability to recognize negative valence emotions and the PANSS negative subscale. Interestingly, this finding further support the negative valence hypothesis according to which non-affective psychotic patients exhibit greater impairment in recognizing stimuli with emotional negative valence, specifically "anger" and "sadness" [28, 62]. Finally, a similar negative correlation was also found between the happiness scores and the PANSS-psychopathology subscale. This is partially in line with previous evidence showing a negative correlation

Table 4
Linguistic and emotional prosody differences in non-affective (FEP-NA) and affective first episode psychosis (FEP-A) patients and healthy controls (HC).

	FEP-NA patients (n = 156)	FEP-A patients (n = 52)	Healthy controls (n = 77)	Statistics	P-value	Post-hoc (after correction for multiple comparisons)
Linguistic prosody domain						
Interrogative sentences	3.8 ± 0.5	3.7 ± 0.6	4 ± 0	HC-FEP-NA: z = 3.1 HC-FEP-A: z = 3.5	HC-FEP-NA: p = 0.01 HC-FEP-A: p = 0.003	FEP-NA = FEP-A < HC
Affirmative sentences	3.8 ± 0.6	3.8 ± 0.5	3.9 ± 0.5	HC-FEP-NA: z = 1.4 HC-FEP-A: z = 0.7	HC-FEP-NA: $p = 0.9$ HC-FEP-A: $p = 1$	
Imperative sentences	3.8 ± 0.6	3.8 ± 0.5	3.9 ± 0.4	HC-FEP-NA: z = 1.1 HC-FEP-A: z = 0.6	HC-FEP-NA: p = 1 HC-FEP-A: $p = 1$	
Total linguistic	11.3 ± 1.7	11.4 ± 1.4	11.8 ± 0.6	HC-FEP-NA: z = 2.1 HC-FEP-A: z = 1.7	HC-FEP-NA: p = 0.2 HC-FEP-A: p = 0.5	
Emotional prosody domain						
Sadness	3.6 ± 0.7	3.7 ± 0.6	3.9 ± 0.2	HC-FEP-NA: z = 2.8 HC-FEP-A: z = 1.9	HC-FEP-NA: p = 0.04 HC-FEP-A: $p = 0.3$	FEP-NA < HC
Happiness	3.5 ± 0.8	3.6 ± 0.8	3.7 ± 0.5	HC-FEP-NA: z = 2.3 HC-FEP-A: z = 0.8	HC-FEP-NA: $p = 0.13$ HC-FEP-A: p = 1	
Anger	3.3 ± 1.1	3.4 ± 0.9	3.6 ± 0.6	HC-FEP-NA: z = 3.0 HC-FEP-A: z = 1.2	HC-FEP-NA: p = 0.02 HC-FEP-A: p = 1	FEP-NA < HC
Total emotional	10.5 ± 1.9	10.8 ± 1.9	11.3 ± 0.9	HC-FEP-NA: z = 3.8 HC-FEP-A: z = 1.7	HC-FEP-NA: p = 0.001 HC-FEP-A: p = 0.5	FEP-NA < HC

FEP-NA = non-affective first episode psychosis; FEP-A = affective first episode psychosis; HC = healthy controls.

between the recognition of positive facial emotions and psychotic symptoms in schizophrenia, including delusions, hallucinations and disorganized thought dimensions [61,63,64].

Interestingly, our results are in accordance with a previous study showing that negative symptom severity in first episode patients with SZ was associated with poorer emotion recognition, especially of sad faces [65]. Furthermore, although there is lack of studies exploring the relationships between language abilities and illness severity in major psychoses, our results are in line with evidence reporting that symptomatology associated with cognitive deficits in both SZ and BD [66]. Therefore, overall our results further confirm the importance of considering clinical severity as a key index influencing language performance in psychosis.

To the best of our knowledge, this is that largest study investigating language abilities in FEP patients, which identified the presence of prosody deficits before the full expression of psychotic illness. Interestingly, our results also indicates that prosody impairments are more prominent in FEP-NA patients and they are significantly correlated with severe psychopathology, ultimately confirming the presence of a less pronounced emotional and linguistic deficits in FEP-A patients.

Finally, our results should be considered in light of few important limitations. First, it is important to point out that cognitive abilities were not considered at this stage of the study. In particular, executive functions and social cognition should be taken into consideration in future reports to better understand their role in prosody recognition, as suggested by previous investigations [67–70]. This is because emotion recognition disturbances could be a manifestation of a general cognitive deficit, not concerning only specific emotions.

Second, our group of HC was at ceiling performance on the linguistic prosody tasks, ultimately suggesting that this scale was not sensitive enough for HC. However this performance, consistent with the normative data described in the Italian manual of MEC, was expected because the test was designed with very elementary items and specifically to identify communication deficits in patients with neurological or psychiatric disorders [43]. Finally, although the *Protocole Montréal d'Evaluation de la Comunication* – MEC focuses on the evaluation of the prosodic abilities based on the tone of voice through the recorded phrases available on Springer Extra Materials (http://extras.springer.com, ISBN 978-88-470-5455-4) as indicated in the Index of the Italian MEC protocol [43], little is known about the acoustic properties of this test.

5. Conclusions

Aprosody can represent an early trait marker of illness already present at the onset of psychosis being independent of illness duration or medication and more prominent in non-affective patients with severe symptoms. Furthermore, the identification of both linguistic and emotional prosody deficits may be of relevance to the prevention of psychoses, being of potential help in characterizing subjects at risk to develop psychosis.

Future studies should explore the presence of aprosody not only in FEP patients but also in high risk subjects coupling these investigations with neuropsychological and neurobiological measures in order to better delineate the neural network sustaining alterations of prosody abilities.

Contributors

Paolo Brambilla and Alessandro Tavano designed this study.

Elisabetta Caletti, Giuseppe Delvecchio and Paolo Brambilla prepared the first version of the manuscript.

Giuseppe Delvecchio, Livio Finos and Angela Andreella carried out the data analysis.

Marcella Bellani, Cinzia Perlini, Antonio Lasalvia, and Mirella Ruggeri supervised patient recruitment.

Marcella Bellani, Chiara Bonetto, Cristofalo Doriana, Mirella Ruggeri, and Paolo Brambilla coordinated data management.

Cinzia Perlini, Dario Lamonaca, Enrico Ceccato, Francesca Pileggi, Fausto Mazzi and Paolo Santonastaso were involved in patient recruitment.

Mirella Ruggeri, Antonio Lasalvia, and Paolo Brambilla designed the GETUP project.

All authors revised and approved the final versions of the manuscript.

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Conflict of interest

None.

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