Psychiatry Research ∎ (∎∎∎∎) ∎∎∎–∎∎∎

Contents lists available at ScienceDirect

Psychiatry Research

journal homepage: www.elsevier.com/locate/psychres

Altered orienting of attention in anorexia nervosa

Mario Dalmaso [a,*], Luigi Castelli [a,b], Lorena Franchetti [a], Lorenza Carli [c], Patrizia Todisco [c], Daniela Palomba [b,d], Giovanni Galfano [a,b]

[a] Dipartimento di Psicologia dello Sviluppo e della Socializzazione, Università di Padova, Via Venezia 8, 35131 Padova, Italy
[b] Centro di Neuroscienze Cognitive, Università di Padova, Padova, Italy
[c] Centro per i Disturbi del Comportamento Alimentare, Casa di Cura Villa Margherita, Arcugnano, Vicenza, Italy
[d] Dipartimento di Psicologia Generale, Università di Padova, Padova, Italy

A R T I C L E I N F O

Article history:
Received 18 December 2014
Received in revised form
5 June 2015
Accepted 27 June 2015

Keywords:
Anorexia nervosa
Spatial attention
Social cognition

A B S T R A C T

The study of cognitive processes in anorexia nervosa (AN) is largely unexplored, although recent evidence suggests the presence of impairments in both social cognition and attention processing. Here we investigated AN patients' ability to orient attention in response to social and symbolic visual stimuli. AN patients and matched controls performed a task in which gaze and pointing gestures acted as social directional cues for spatial attention. Arrows were also included as symbolic cue. On each trial, a centrally-placed cue appeared oriented rightwards or leftwards. After either 200 or 700 ms, a lateralized neutral target (a letter) requiring a discrimination response appeared in a location either spatially congruent or incongruent with the directional cue. Controls showed a reliable orienting irrespective of both temporal interval and cue type. AN patients showed a reliable orienting at both temporal intervals only in response to pointing gestures. Both gaze and arrow cues failed to orient attention at the short temporal interval, that is when attention is under reflexive control, whereas a reliable orienting emerged at the long temporal interval. These results provide preliminary evidence of altered reflexive orienting of attention in AN patients that does not extend to body-related cues such as pointing gestures.

1. Introduction

Anorexia nervosa (AN) is a severe psychiatric disorder which is mainly characterized by a drastic food restriction and a difficulty to maintain a healthy body weight (e.g., Fairburn and Harrison, 2003; Hebebrand and Bulik, 2011). As a consequence, mortality rates among patients with AN is also dramatically high (e.g., Zipfel et al., 2000; Birmingham et al., 2005; Arcelus et al., 2011). Besides the understandable great interest about the clinical aspects of this disorder, such as causes, diagnosis and treatment (e.g., Schmidt and Treasure, 2006; Bulik et al., 2007; Treasure et al., 2010), less efforts have been made to investigate cognitive processes in patients with AN. This lack of empirical studies becomes particularly evident with regard to attentional processes. So far, a number of studies aimed to investigate attention in AN focused on selective attention for biological and social stimuli specifically related with AN, such as food or bodies, revealing the presence of an attentional bias towards these stimuli, at least under some circumstances (e.g., Brooks et al., 2011; Giel et al., 2011; Urgesi et al., 2012; Aspen et al., 2013; Urgesi et al., 2013; Kim et al., 2014). Interestingly, no studies have explored the impact of social stimuli onto orienting of attention in AN. This is somewhat surprising, as the ability to shift the attentional focus in response to spatial cues provided by others represents a key feature of human behaviour (e.g., Baron-Cohen, 1995) which has been shown to be impaired in AN patients, leading them to poor interactions with other individuals (Cipolli et al., 1989; Kucharska-Pietura et al., 2004; Cserjesi et al., 2011). This 'social attention' has been widely investigated in healthy participants by using a modified version of the spatial cueing paradigm (e.g., Posner, 1980), in which eye gaze is used as a directional cue for attention instead of the classic arrow. This is known as the gaze-cueing paradigm (Friesen and Kingstone, 1998; Driver et al., 1999). Typically, this consists of presenting participants with a task-irrelevant centrally-placed facial stimulus with gaze averted either rightwards or leftwards. After a certain temporal interval (Stimulus Onset Asynchrony, SOA), a target requiring a response appears in a spatial location which can be either congruent or incongruent with that indicated by gaze. Typically, lower reaction times (RTs) are observed on congruent rather than on incongruent trials, a result which is interpreted as evidence that gaze cues oriented attention effectively. Indeed, it is assumed that, on spatially congruent trials, participants shift their attention to the target location in advance being pushed by the task-irrelevant directional cue. The gaze-cueing paradigm has been successfully

* Corresponding author. Fax: +39 0498276611.
E-mail address: Mario.dalmaso@gmail.com (M. Dalmaso).

http://dx.doi.org/10.1016/j.psychres.2015.06.044
0165-1781/© 2015 Elsevier Ireland Ltd. All rights reserved.

employed both in healthy and in clinical populations, other than patients with eating disorders, to investigate many different aspects concerning social attention and social cognition and how their dysfunction influences pathogenesis or maintenance of psychopathology (e.g., Senju et al., 2004; Frischen et al., 2007; Kuhn et al., 2010; Galfano et al., 2011; Dalmaso et al., 2012; Liuzza et al., 2013; Marotta et al., 2013; Dalmaso et al., 2014).

Importantly, evidence is accumulating suggesting that AN patients show impairments in several mechanisms involved in social cognition (Caglar-Nazali et al., 2014), which led some authors to hypothesize a link between AN and autism spectrum disorders (e.g., Zucker et al., 2007; Oldershaw et al., 2011; but see also Adenzato et al., 2012). More specifically, it seems that AN patients would be less sensitive to social signals provided by other's face, such as emotional states (e.g., Kucharska-Pietura et al., 2004; Cserjesi et al., 2011). Furthermore, they would also tend to avoid eye contact with other individuals (Cipolli et al., 1989), exhibiting, instead, an exaggerated tendency to attend to the body of others (Watson et al., 2010). Interestingly, impairments in the processing of eye gaze stimuli have been reported in another psychiatric disorder associated with deficits in social cognition, namely schizophrenia (e.g., Tso et al., 2012). In the domain of attentional processes, schizophrenic patients fail to show a reliable cueing of attention in response to eye gaze as compared to symbolic cues (e.g., an arrow; Akiyama et al., 2008) or pointing gestures (Dalmaso et al., 2013), another social cue which is known to elicit reliable shifts of attention in healthy individuals (e.g., Cazzato et al., 2012; Porciello et al., 2014), despite it does not possess the same communicative richness as eye gaze.

The present study represents the first attempt to investigate spatial cueing of attention in response to social stimuli in AN patients as compared to a matched group of healthy controls. To this end, schematic eye gaze and pointing gestures were employed as social cues in a spatial-cueing task. In addition, arrow cues were also included in order to disentangle between social and symbolic cueing of attention (see also Kuhn and Kingstone, 2009; Galfano et al., 2012). Finally, we included two different SOAs (i.e., 200 ms vs. 700 ms), in order to explore the time course of attentional shifting elicited by these cues, as a short SOA is known to tap onto reflexive attentional control, whereas at longer SOAs more controlled processes are thought to intervene (Müller and Rabbitt, 1989). As for healthy controls, we expected to observe reliable orienting of attention (i.e., lower RTs on congruent than on incongruent trials) irrespective of both SOA and cue type (e.g., Dalmaso et al., 2013). Indeed, task-irrelevant centrally-displayed cues elicit significant spatial cueing effects even at SOAs longer than those used in the present study (e.g., Frischen and Tipper, 2004; Galfano et al., 2012). Based on the notions discussed above, in the case of AN patients, a different pattern of results was expected in relation to gaze cues. Indeed, we predicted a reduced orienting of attention to gaze signals (i.e., no or reduced difference between RTs on incongruent and congruent trials), confirming the alterations reported in AN patients in dealing with this stimulus (e.g., Cipolli et al., 1989). Pointing gestures and arrow cues enabled us to test two additional hypotheses, namely whether attentional deficits extend over other social cues (i.e., pointing gestures) and whether deficits involve higher-order cognitive domains and extend to the processing of symbolic signals (i.e., arrows).

2. Methods

2.1. Participants

Twenty-three AN patients (*Mean age* = 26.48 years, *SD* = 9.7, *Mean education* = 12 years, *SD* = 2.92, *Mean Body Mass Index* (*BMI*) = 16.2, *SD* = 2.65; two males; two left-handed) were recruited from a clinic, located in northern Italy. Fourteen individuals had diagnosis of restrictive subtype and nine were diagnosed with binge-purge subtype. Diagnoses of AN were made by a board-certified attending research team of senior psychiatrists through the Structured Clinical Interview (First et al., 2002) of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV, American Psychiatric Association, 2000). Exclusion criteria were board-certified diagnoses of cognitive or personality disorders, psychosis, mental retardation and major depression. Nineteen individuals were medicated with neuroleptics, antidepressants, neuroleptics combined with antidepressants, or benzodiazepines. Vitamins, diet supplements, gastrointestinal medications were also included in the treatment.

The control group consisted of 23 healthy participants (*Mean age* = 25.39, *SD* = 5.37, *Mean education* = 12.17, *SD* = 2.84, *Mean BMI* = 20.94, *SD* = 2.29; two males; two left-handed), carefully recruited from the local community to perfectly match the AN patients as concerns age, $t(44) = 0.470$, $p = 0.641$, $d = 0.139$, education, $t(44) = 0.205$, $p = 0.839$, $d = 0.06$, gender and handedness. An individual interview was administered to exclude both current and past history of neurological or psychiatric disorders, use of medications, substance abuse, or dependence. BMI of the two groups was different, $t(44) = 6.496$, $p < 0.001$, $d = 1.9$.

All participants had normal or corrected-to-normal vision, were naïve as to the purpose of the experiment and took part on a voluntary basis. The Ethics Committee for Psychological Research at the University of Padova approved the study, and an informed consent was obtained from all participants.

2.2. Clinical measures

AN patients had several clinical measures available which consisted of self-reported tests (see Table 1). The Beck Depression Inventory (BDI-II; Beck et al., 1996) was used to assess the severity

Table 1
Clinical information of AN patients.

Variable	Score	
	M	*SD*
Age of illness onset (years)	18.13	7.12
Duration of illness (years)	8.57	7.82
Beck Depression Inventory (BDI-II)		
Global score	26.96	16.17
Item 9 (suicide symptoms)	0.83	1.15
Bulimic Investigatory Test Edinburgh (BITE)		
Symptom scale	12.30	6.96
Severity scale	4.48	4.52
Clinical Impairment Assessment (CIA)	27.96	14.09
Eating Attitudes Test (EAT-40)	48	28.52
Eating Disorder Examination Questionnaire (EDE-Q)		
Global score	79.83	36.91
Restraint	18.96	8.60
Eating concern	14.57	7.76
Shape concern	34.04	11.81
Weight concern	18.83	8.79
The Symptom Checklist-90-Revised (SCL-90-R)	138.74	80.81

Note: *M* = mean; *SD* = standard deviation. Higher scores for clinical tests indicate higher levels of impairment.

Please cite this article as: Dalmaso, M., et al., Altered orienting of attention in anorexia nervosa. Psychiatry Research (2015), http://dx.doi.org/10.1016/j.psychres.2015.06.044

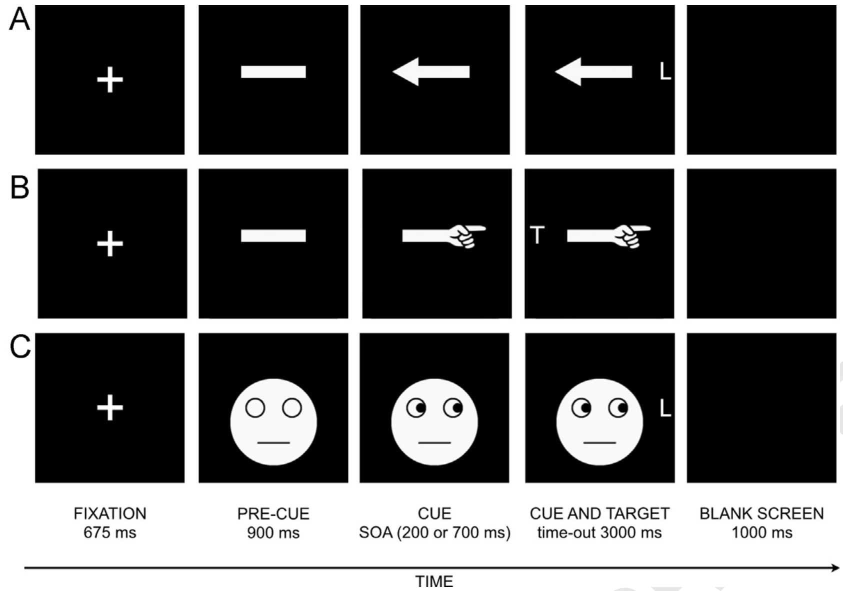

Fig. 1. Stimuli (not drawn to scale) and sequence of events for a spatially incongruent trial with arrow (A) and pointing gesture (B) cues, and for a spatially congruent trial with a gaze cue (C).

of depression; the Bulimic Investigatory Test Edinburgh (BITE; Henderson and Freeman, 1987) was used to assess bulimic behaviours; the Clinical Impairment Assessment (CIA; Bohn and Fairburn, 2008) was used to assess psychosocial impairments due to eating disorders; the Eating Attitudes Test (EAT-40; Garner and Garfinkel, 1979) and the Eating Disorder Examination Questionnaire (EDE-Q; Hilbert et al., 2007) were used to assess eating disorders; the Symptom Checklist-90-Revised (SCL-90-R; Derogatis, 1994) was used to assess a broad range of psychological problems and symptoms related to psychopathology.

2.3. Stimuli and apparatus

Three different stimuli were used as cues and presented in white against a black background in three distinct blocks of trials (see Fig. 1). Cue type was blocked to maximize the likelihood of obtaining significant cueing effects for each cue type. Indeed, previous evidence (Pavan et al., 2011; Zhao et al., 2014) suggests that gaze cueing might be sensitive to contextual factors, such as the presence of other cueing stimuli within the same block of trials. In the arrow-cue block, the cue was an arrow (3.8° width × 1.6° height) oriented either leftwards or rightwards; in the pointing gesture-cue block, the cue was a schematic pointing gesture (3.8° width × 1.6° height) oriented either leftwards or rightwards; in the gaze-cue block, the cue was a schematic face (6° of diameter) with gaze averted either leftwards or rightwards. The area covered by the eyes was 3.8° width × 1.6° height, which made the three cue stimuli comparable in size (for a similar logic see Dalmaso et al., 2013).

Participants sat approximately 57 cm from a 15-in. laptop monitor (1024 × 768 pixels, 60 Hz). Stimulus presentation and data recording was controlled using E-prime 2.0 (Psychology Software Tools, Pittsburgh, USA).

2.4. Procedure

Each trial began with a fixation cross (1°) visible for 675 ms at the centre of the screen, followed by a central pre-cue. In both the arrow-cue and the pointing gesture-cue blocks, the pre-cue was the arrow cue without the head and the pointing gesture cue without the hand, respectively. In the gaze-cue block, the pre-cue was the gaze cue without the pupils. After 900 ms, the pre-cue was replaced by the cue, namely the arrow, pointing gesture or gaze cue indicating either rightwards or leftwards. After either a 200-ms or 700-ms SOA, a target letter (L or T, 28-point Arial bold font) appeared 9° rightwards or leftwards with respect to the centre of the screen. Two different SOAs were used to investigate the time course of attention shifting elicited by the different cues. On each trial, both the cue and the target remained visible until the participant responded or 3000 ms were elapsed, whichever came first. The target was either spatially congruent or incongruent with respect to cue direction with the same probability. Participants were told that cue direction was uninformative with regard to target location and they were instructed to maintain fixation at the centre of the screen throughout each trial. They were asked to discriminate the target letter by pressing one of two possible response keys on the keyboard as fast as possible. The association between response keys and target letters was counterbalanced between participants. The red words “ERROR” and “NO RESPONSE” were presented for 500 ms when participants committed an error or did not respond within the time limit (i.e., missed response), respectively. Finally, a blank screen appeared for 1000 ms. Order of blocks was randomized separately for each participant, and cue type was constant within each block. Each experimental block was composed of 128 trials and was preceded by a practice block composed by 10 trials. In total, each participant went through 384 experimental trials (i.e., 32 observations per cell). The entire session required about 45 min.

3. Results

3.1. Data pre-processing

Trials in which participants committed errors (2.46% of total trials) were removed and analysed separately. Missed responses were rare (0.13% of total trials) and were not analysed further. Because raw RT data of correct trials were positively skewed, they were log-transformed ($\log_e$) in order to obtain a more normal distribution of values without the need to remove observations (see Howell, 2010). However, for ease of interpretation, descriptive statistics are reported as untransformed mean RT. Data were

Please cite this article as: Dalmaso, M., et al., Altered orienting of attention in anorexia nervosa. Psychiatry Research (2015), http://dx.doi.org/10.1016/j.psychres.2015.06.044

analysed by using the SPSS 22 software (IBM Corporation, Armonk, New York, USA). Alpha level was set at 0.05.

3.2. Data analysis

3.2.1. Reaction time analysis

Firstly, we checked whether performance was different in the two groups. To this purpose, RTs were analysed by means of an omnibus mixed-design repeated-measure ANOVA with cue-target spatial congruency (2: congruent vs. incongruent), cue type (3: arrow vs. pointing gesture vs. gaze) and SOA (2: 200 ms vs. 700 ms) as within-participant factors, and group (2: AN patients vs. healthy controls) as between-participant factor. The main effect of cue-target spatial congruency was significant, $F(1, 44)=59.695$, $p<0.001$, $\eta_p^2=0.576$, indicating lower RT on congruent ($M=659$ ms, $SD=181$) than on incongruent ($M=681$ ms, $SD=190$) trials. The main effect of SOA was also significant, $F(1, 44)=67.808$, $p<0.001$, $\eta_p^2=0.606$, indicating lower RT at the long ($M=655$ ms, $SD=185$) than at the short ($M=685$ ms, $SD=186$) SOA. Group also yielded a significant effect, $F(1, 44)=7.189$, $p=0.010$, $\eta_p^2=0.140$, due to lower RT for healthy controls ($M=601$ ms, $SD=103$) than for AN patients ($M=739$ ms, $SD=222$). The cue-target spatial congruency × SOA interaction was significant, $F(1, 44)=12.381$, $p=0.001$, $\eta_p^2=0.220$, as well as the cue type × SOA interaction, $F(2, 88)=3.340$, $p=0.040$, $\eta_p^2=0.071$, whereas the cue type × group interaction only approached statistical significance, $F(2, 88)=2.743$, $p=0.070$, $\eta_p^2=0.059$. Importantly, all these effects were further qualified by a significant cue-target spatial congruency × cue type × SOA × group interaction, $F(2, 88)=3.269$, $p=0.043$, $\eta_p^2=0.069$, suggesting that performance between the two groups was different and that they were differently affected by the directional cues as a function of temporal parameters. No other main effects or interactions were significant ($Fs<1.318$, $ps>0.273$). In order to clarify the meaning of the four-way interaction, two separate repeated-measure ANOVAs were conducted for the two groups with cue-target spatial congruency (2: congruent vs. incongruent), cue type (3: arrow vs. pointing gesture vs. gaze) and SOA (2: 200 ms vs. 700 ms) as within-participant factors.

As for the control group, we expected to observe a reliable orienting of attention irrespective of both SOA and cue type. The main effect of cue-target spatial congruency was significant, $F(1, 22)=40.675$, $p<0.001$, $\eta_p^2=0.649$, indicating lower RT for congruent ($M=590$ ms, $SD=99$) than for incongruent ($M=612$ ms, $SD=108$) trials. The main effect of SOA was significant, $F(1, 22)=27.654$, $p<0.001$, $\eta_p^2=0.557$, indicating lower RT at the long ($M=589$ ms, $SD=109$) than at the short ($M=613$ ms, $SD=99$) SOA. The main effect of cue type was also significant, $F(2, 44)=4.886$, $p=0.012$, $\eta_p^2=0.182$, reflecting lower RT in response to pointing gesture ($M=578$ ms, $SD=97$), followed by arrow ($M=609$ ms, $SD=111$) and by gaze ($M=616$ ms, $SD=120$). The cue-target spatial congruency × SOA interaction was not significant, $F(1, 22)=2.886$, $p=0.103$, $\eta_p^2=0.116$, although orienting was slightly stronger at the longer (26 ms) than at the shorter (18 ms) SOA, consistent with several previous reports (e.g., Driver et al., 1999; Dalmaso et al., 2014). The theoretically irrelevant cue type × SOA interaction was significant, $F(2, 44)=3.534$, $p=0.038$, $\eta_p^2=0.138$. Most importantly, neither the cue-target spatial congruency × cue type interaction ($F=1.606$, $p=0.212$) nor the cue-target spatial congruency × cue type × SOA interaction ($F<1$, $p=0.703$) were significant. Indeed, the simple effect analysis showed that, in line with our hypothesis, healthy controls oriented their attention in response to all cues irrespective of SOA ($Fs>4.164$, $ps\leq 0.05$; see Fig. 2).

As for AN patients, a different pattern of results was expected, namely that cue type modulated orienting of attention. In particular, we expected to observe a reduced orienting of attention (i.e., a decreased cueing effect) in response to eye gaze. The main effect of cue-target spatial congruency was significant, $F(1, 22)=22.005$, $p<0.001$, $\eta_p^2=0.500$, owing to lower RT on congruent ($M=728$ ms, $SD=218$) than on incongruent ($M=750$ ms, $SD=228$) trials. The main effect of SOA was also significant, $F(1, 22)=41.150$, $p<0.001$, $\eta_p^2=0.652$, indicating lower RT at the long ($M=722$ ms, $SD=221$) than at the short ($M=757$ ms, $SD=225$) SOA. The cue-target spatial congruency × SOA interaction was significant, $F(1, 22)=12.986$, $p=0.002$, $\eta_p^2=0.371$, and it was further qualified by the three-way cue-target spatial congruency × cue type × SOA interaction, $F(2, 44)=3.611$, $p=0.035$, $\eta_p^2=0.141$. Simple effect analysis at the short SOA indicated that AN patients oriented their attention in response to pointing gesture, $F(1, 22)=11.592$, $p<0.005$, but not in response to both gaze and arrow cues, $Fs<1$, whereas at the long SOA, AN patients oriented their attention in response to all types of cues, ($Fs>4.614$, $ps<0.05$). No other main effects nor interactions were significant ($Fs<1$, $ps>0.444$). In order to provide additional evidence for the lack of attentional cueing in response to gaze and arrow stimuli for the 200-ms SOA, we computed also the Bayesian Information Criterion (BIC; Masson, 2011). This approach is particularly useful for dealing with the null hypothesis (i.e., α level ≥ 0.05) appropriately, as it disentangles whether the null hypothesis (i.e., lack of attentional cueing in the present study) or the alternative hypothesis (i.e., the presence of attentional cueing)

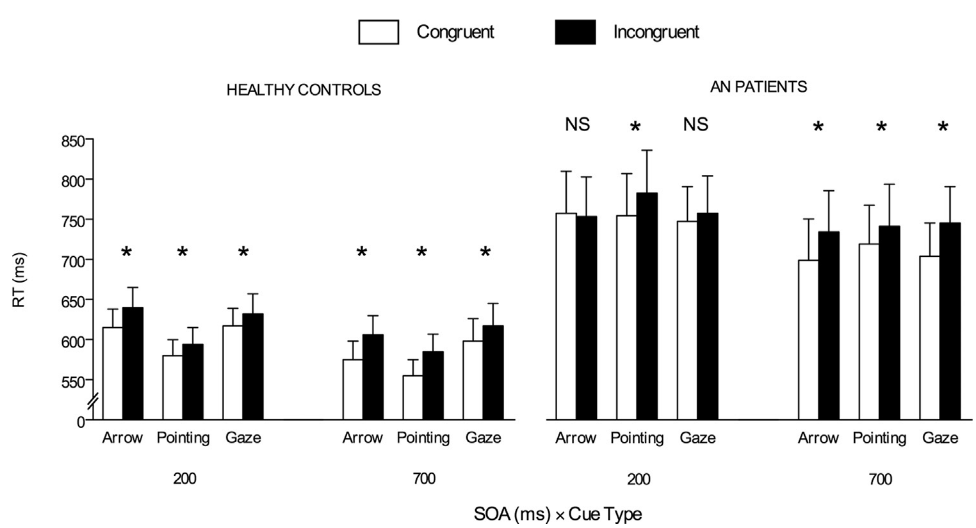

Fig. 2. Mean RT (ms) for all conditions presented in the study. Errors bars are SEM. Asterisk = $p<0.05$. NS = non-significant.

is more corroborated by the data. Here, BIC values higher than 0.50 indicate that there is more evidence for the lack of attention cueing rather than for its presence, whereas values lower than 0.50 indicate the opposite. The analysis showed that the posterior probability supporting the hypothesis that gaze cueing was absent in AN patients was $p_{BIC}(H_0|D)=0.775$. Similarly, the posterior probability supporting the hypothesis that arrow cueing was absent in AN patients was $p_{BIC}(H_0|D)=0.827$. The obtained posterior probabilities strengthen the conclusion that no orienting of spatial attention occurred in AN patients for both gaze and arrow cues at the short SOA. In sum, AN patients did not show orienting of attention in response to both gaze and arrow cues at the 200-ms SOA. In all the other conditions, a reliable orienting of attention emerged.

3.2.1.1. Correlations between spatial orienting and demographic/clinical measures. In order to investigate possible relationships between spatial orienting and demographic/clinical measures of AN patients, we calculated an index of the magnitude of spatial orienting (i.e., RT on incongruent trials-RT on congruent trials) divided by SOA and cue type. Because of the well-known comorbidity of AN and depression, we first examined the correlation between spatial orienting and BDI-II scores. No significant effects emerged ($ps > 0.157$). Similarly, spatial orienting was not correlated with BMI index, age of illness onset, duration of illness, and the other clinical test measures reported in Table 1 ($ps > 0.05$).

3.2.2. Errors analysis

The percentage of errors was analysed through an omnibus mixed-design repeated-measure ANOVA identical to that adopted for RT analysis. The main effect of cue type was significant, $F(2, 88)=4.001$, $p=0.022$, $\eta^2_p=0.083$, indicating more errors in response to gaze ($M=2.97\%$, $SD=5.23$), followed by pointing gesture ($M=2.48\%$, $SD=4.35$) and then by arrow ($M=1.92\%$, $SD=3.51$; see Table 2). No other main effects or interactions were significant ($Fs < 2.501$, $ps > 0.121$). Thus, speed-accuracy trade-off cannot account for the present findings.

4. Discussion

Despite AN is a psychiatric disorder associated to severe impairments in many aspects of social life (e.g., Zucker et al., 2007), so far no evidence has been collected to investigate spatial cueing of attention in response to centrally-placed task-irrelevant directional cues. This ability is fundamental in that it allows an efficient interaction with the world around us. The present study represents the first exploratory attempt to study this phenomenon in AN patients. Schematic eye gaze and pointing gestures were used in a spatial-cueing task. Arrow cues were also included in order to explore whether deficits in attentional orienting, if any, extended to symbolic cues.

In healthy controls we expected a reliable spatial cueing regardless of both cue type and SOA (see also Cazzato et al., 2012; Dalmaso et al., 2013). The overall results confirmed this hypothesis, as spatial orienting occurred for all cues at all SOAs.

In sharp contrast, in AN patients we expected to observe a reduced cueing effect to gaze signals. Furthermore, we were also interested to explore whether this altered response extended to other social cues (i.e., pointing gestures) and whether it involved even higher-order cognitive domains, embracing also symbolic signals (i.e., arrows). The results showed that spatial cueing of attention was modulated by both cue type and SOA. As concerns social cues, on the one hand pointing gestures elicited reliable orienting at both SOAs. On the other hand, eye gaze did not elicit

Table 2
Mean RT (ms) for correctly responded trials and percentage of errors (%E) for all the experimental conditions.

	200-ms SOA												700-ms SOA						
	Arrow				Pointing finger				Gaze				Arrow				Pointing finger		
	C		I		C		I		C		I		C		I		C		I
	RT	%E	RT	%E	RT	%E	RT	%E	RT	%E	RT	%E	RT	%E	RT	%E	RT	%E	RT
AN patients	755 (249)	2.04(3.72)	751(235)	3.40(6.98)	752(250)	3.26(6.76)	780(256)	2.99(6.95)	745(206)	3.67(8.72)	755(223)	3.67(7.98)	697(247)	3.26(6.14)	732(247)	2.04(4.06)	717(228)	2.31(4.73)	739(247)
Healthy controls	615 (111)	0.95 (1.75)	640 (119)	0.82 (1.69)	580 (94)	2.04 (3.48)	594 (101)	2.31 (3.68)	617 (104)	2.59 (4.95)	632 (118)	2.31 (3.79)	575 (110)	1.36 (2.07)	606 (114)	1.50 (2.96)	555 (96)	1.63 (2.81)	585 (107)

Note: Values in brackets are *SDs*. C=congruent trials; I=incongruent trials.

Please cite this article as: Dalmaso, M., et al., Altered orienting of attention in anorexia nervosa. Psychiatry Research (2015), http://dx.doi.org/10.1016/j.psychres.2015.06.044

attentional shifts at the shorter SOA whereas a reliable orienting emerged at the longer SOA. Interestingly, the same pattern observed in the case of eye gaze also emerged for arrow cues. The fact that spatial cueing of attention at the short SOA was reduced for both gaze and arrow cues can be interpreted as consistent with the view that the type of alteration characterizing orienting of attention in AN patients is rather general, involving both social and symbolic signals. No such alteration, however, was observed in the case of pointing gestures. One possibility to account for this latter finding is related to AN patients' biases in processing body parts and body-related stimuli (e.g., Shafran et al., 2007; Urgesi et al., 2012; Madsen et al., 2013). For instance, in a recent eye-tracking study, Watson et al. (2010) reported that AN patients tend to fixate body parts much longer than face and eyes, when exploring visual images. In line with this set of findings, the observation that AN patients exhibit a regular orienting of attention in response to pointing gestures may indicate that these stimuli represent a category (body parts) characterized by a special attentional priority. A critical test of this hypothesis can be obtained by using other types of spatial cues related to body parts such as body orientation, and verify whether AN patients display a reliable spatial cueing effect also with these body-related cue stimuli. Importantly, the fact that AN patients showed a reduced gaze- and arrow-mediated orienting emerged only at the 200-ms SOA, argues in favour of an impairment specific for reflexive processes, which are more likely to operate in isolation at particularly short SOAs (Müller and Rabbitt, 1989). This finding suggests that gaze and arrow stimuli take time to exert their effects in pushing attention in AN patients, unlike in the case of healthy controls, who display very rapid, pervasive, and automatic attentional shifts irrespective of cue type.

Although the present study does not provide any direct evidence about the involved neuroanatomical areas, results are consistent with the available knowledge concerning the brain structures that seem to be characterized by abnormal functioning in AN patients. The general alteration in attention shifting observed here may indeed be related to the reported abnormalities in functional connectivity concerned with networks which include the parietal lobe that are known to be heavily involved in visuospatial abilities (e.g., Favaro et al., 2012; Suchan et al., 2015, for a review). The fact that orienting mediated by pointing gestures was relatively spared in AN patients may on the other hand be associated with alterations that have been reported involving extra-striate areas that are known to respond selectively to body-related stimuli (e.g., Zhu et al., 2012).

In the context of other neurobehavioural disorders, studies addressing spatial attention have established that gaze cueing of attention is abolished in patients suffering from attention deficit hyperactivity disorder (Marotta et al., 2013). Because performance was comparable to that observed in matched controls for arrow-mediated orienting, the authors interpreted this finding as evidence for a deficit in responding to socially relevant information. This type of paradigm has also been administered to patients who are specifically known to show difficulties in dealing with social stimuli. On the one hand, evidence has been provided showing that individuals with autism spectrum disorder often exhibit a reduced response for gaze cues (e.g., Ristic et al., 2005; Goldberg et al., 2008; but see Kuhn et al., 2010). On the other hand, schizophrenic patients tend to display alterations for gaze cueing in the presence of a spared arrow-cueing effect (Akiyama et al., 2008). Critically, this pattern in gaze cueing has also recently been observed in combination with a spared performance for pointing gestures (Dalmaso et al., 2013). Considering the present set of data in light of the findings emerged with other psychiatric disorders, it seems reasonable to interpret the observed pattern in AN patients as suggesting a rather different type of alteration. It could then be argued that the present data speak in favour of the possibility that autism, schizophrenia and anorexia nervosa, although heavily involving a common cognitive domain related to social competence (e.g., Zucker et al., 2007; Oldershaw et al., 2011; Caglar-Nazali et al., 2014), exhibit a different cognitive profile associated with the ability to shift attention in response to spatial signals characterized by variable social relevance.

4.1. Limitations of the study and future directions

As in any experimental study, potential limitations can be identified which may serve as a guidance for future research. As for the procedural aspects, because we used a pre-cue which preceded the actual cue providing the spatial information, this might have led to an additional effect due to apparent movement. Although this choice was aimed to bolster ecological validity of the social stimuli, follow-up studies might directly address this issue by presenting the spatial cue in isolation. Other relevant issues concern the characteristics of our sample. Firstly, because most of AN patients who took part in the present study were medicated, we cannot rule out the possibility that medication played a role in the results. Further studies would benefit from including a control group allowed to have a psychotropic medication. However, it should also be noted that, if medication had an overall impact on orienting of attention in the present study, this should have emerged irrespective of cue type. In contrast, at least at the 200-ms SOA, cue type modulated attentional orienting and there was evidence for attention shifting only for pointing gestures. A further suggestion for future studies would be to include a control sample of individuals with a diagnosis of major depression in the absence of AN. Because of the well-known comorbidity of AN and depression, although participants in our clinical sample had no board-certified diagnosis of major depression, we nonetheless administered the BDI-II. Because the correlation between BDI scores and our measure of attentional orienting was not statistically significant, we can reasonably rule out the possibility that depression played a major role in the present findings. Future studies might also take individual levels of anxiety and social phobia into account, as these may be related to the way participants appraise and evaluate cueing stimuli. Another line of investigation might focus on the specific characteristics of the cueing stimuli. On the one hand, manipulating affective valence (e.g., positive and negative emotions) of the cueing and target stimuli may be important to unveil the interplay between basic attentional and emotional processes in AN patients. On the other hand, manipulating familiarity with the cueing stimulus may be critical to address whether in the current study the level of previous exposure to the different types of cues might have affected the obtained findings. Finally, as anticipated earlier, using other social and body-related cues known to elicit attentional shifts in healthy respondents (e.g., body orientation, biological motion), might also shed light on the cognitive underpinnings of attentional processes that are extremely important in everyday life but are still largely unexplored in the case of AN.

4.2. Conclusion

The present findings highlight two key elements: on the one hand, deficits among AN patients can be observed in relation to the more rapid and reflexive responses to eye and arrow cues; on the other hand, the adopted paradigm enabled to show that the processing of body parts such as pointing gestures is spared, likely indicating the intrinsic relevance of these cues for AN patients. The study of attentional impairments can thus provide important insights about the domains in which AN patients do process relevant information differently from healthy population and, more

Please cite this article as: Dalmaso, M., et al., Altered orienting of attention in anorexia nervosa. Psychiatry Research (2015), http://dx.doi.org/10.1016/j.psychres.2015.06.044

specifically, about what type of stimuli are primarily involved. On the same line, the analysis of the development of attentional processes in AN patients might provide additional hints about the domains in which clinical protocols can actually lead to a significant improvement (e.g., Shafran et al., 2008). For instance, Attentional Bias Modification Trainings have been put forward for treating anxiety (Hakamata et al., 2010) or phobias (e.g., Heeren et al., 2012) and similar intervention strategies might also prove effective in the case of AN. In summary, the present study opens a new window on the cognitive profile underlying AN patients that could be useful for rehabilitation and suggests that research on eating disorders should not be limited to using materials that are considered as relevant for the disorder such as food or body weight-related stimuli.

Contributors

Conceived the study: MD, LuC, GG; Collected the data: MD, LF, LoC, PT; Analyzed the data: MD, LuC, LF, LoC, PT, DP, GG; Wrote the paper: MD, LuC, LoC, PT, DP, GG. All authors approved the final version of the article for submission.

Conflict of interest

No conflict of interest declared.

Q5 Uncited reference

Cusi et al. (2012).

Acknowledgement

The present research was financially supported by the Italian Ministry of Education, University and Research (Futuro in Ricerca, 2012 Grant RBFR12F0BD).

References

Adenzato, M., Todisco, P., Ardito, R.B., 2012. Social cognition in anorexia nervosa: evidence of preserved theory of mind and impaired emotional functioning. PLoS One 7, e44414.

Akiyama, T., Kato, M., Muramatsu, T., Maeda, T., Hara, T., Kashima, H., 2008. Gaze-triggered orienting is reduced in chronic schizophrenia. Psychiatry Res. 158, 287–296.

American Psychiatric Association, 2000. Diagnostic and Statistical Manual of Mental Disorders, 4th ed. text rev. American Psychiatric Association, Washington.

Arcelus, J., Mitchell, A.J., Wales, J., Nielsen, S., 2011. Mortality rates in patients with anorexia nervosa and other eating disorders. A meta-analysis of 36 studies. Arch. Gen. Psychiatry 68, 724–731.

Aspen, V., Darcy, A.M., Lock, J., 2013. A review of attention biases in women with eating disorders. Cogn. Emot. 27, 820–838.

Baron-Cohen, S., 1995. The eye direction detector (EDD) and the shared attention mechanism (SAM): two cases for evolutionary psychology. In: Moore, C., Dunham, P.J. (Eds.), Joint Attention: Its Origins and Role in Development. Lawrence Erlbaum, Hillsdale, NJ, pp. 41–59.

Beck, A.T., Steer, R.A., Ball, R., Ranieri, W., 1996. Comparison of beck depression inventories-IA and -II in psychiatric outpatients. J. Person. Assess. 67, 588–597.

Birmingham, C.L., Su, J., Hlynsky, J.A., Goldner, E.M., Gao, M., 2005. The mortality rate from anorexia nervosa. Int. J. Eat. Disord. 38, 143–146.

Bohn, K., Fairburn, C.G., 2008. Clinical impairment assessment questionnaire (CIA 3.0). In: Fairburn, C.G. (Ed.), Cognitive Behavior Therapy and Eating Disorders. Guilford Press, New York, pp. 315–317.

Brooks, S., Prince, A., Stahl, D., Campbell, I.C., Treasure, J., 2011. A systematic review and meta-analysis of cognitive bias to food stimuli in people with disordered eating behaviour. Clin. Psychol. Rev. 31, 37–51.

Bulik, C.M., Berkman, N.D., Brownley, K.A., Sedway, J.A., Lohr, K.N., 2007. Anorexia nervosa treatment: a systematic review of randomized controlled trials. Int. J. Eat. Disord. 40, 310–320.

Caglar-Nazali, H.P., Corfield, F., Cardi, V., Ambwani, S., Leppanen, J., Olabintan, O., Deriziotis, S., Hadjimichalis, A., Scognamiglio, P., Eshkevari, E., Micali, N., Treasure, J., 2014. A systematic review and meta-analysis of 'Systems for Social Processes' in eating disorders. Neurosci. Biobehav. Rev. 42, 55–92.

Cazzato, V., Macaluso, E., Crostella, F., Aglioti, S.M., 2012. Mapping reflexive shifts of attention in eye-centered and hand-centered coordinate systems. Hum. Brain Mapp. 33, 165–178.

Cipolli, C., Sancini, M., Tuozzi, G., Bolzani, R., Mutinelli, P., Flamigni, C., Porcu, E., 1989. Gaze and eye-contact with anorexic adolescents. Br. J. Med. Psychol. 62, 365–369.

Cserjesi, R., Vermeulen, N., Lenard, L., Luminet, O., 2011. Reduced capacity in automatic processing of facial expression in restrictive anorexia nervosa and obesity. Psychiatry Res. 188, 253–257.

Cusi, A.M., Nazarov, A., Holshausen, K., Macqueen, G.M., McKinnon, M.C., 2012. Systematic review of the neural basis of social cognition in patients with mood disorders. J. Psychiatry Neurosci. 37, 154–169.

Dalmaso, M., Galfano, G., Coricelli, C., Castelli, L., 2014. Temporal dynamics underlying the modulation of social status on social attention. PLoS One 9, e93139.

Dalmaso, M., Galfano, G., Tarqui, L., Forti, B., Castelli, L., 2013. Is social attention impaired in schizophrenia? Gaze but not pointing gestures is associated with spatial attention deficits. Neuropsychology 27, 608–613.

Dalmaso, M., Pavan, G., Castelli, L., Galfano, G., 2012. Social status gates social attention in humans. Biol. Lett. 8, 450–452.

Derogatis, L.R., 1994. Symptom Checklist 90-R: Administration, Scoring, and Procedures Manual, 3rd ed. National Computer Systems, Minneapolis, MN.

Driver, J., Davis, G., Ricciardelli, P., Kidd, P., Maxwell, E., Baron-Cohen, S., 1999. Gaze perception triggers reflexive visuospatial orienting. Vis. Cogn. 6, 509–540.

Fairburn, C.G., Harrison, P.J., 2003. Eating disorders. Lancet 361, 407–416.

Favaro, A., Santonastaso, P., Manara, R., Bosello, R., Bommarito, G., Tenconi, E., Di Salle, F., 2012. Disruption of visuospatial and somatosensory functional connectivity in anorexia nervosa. Biol. Psychiatry 72, 864–870.

First, M., Spitzer, R., Gibbon, M., Williams, J., 2002. Structured Clinical Interview for DSM-IV-TR Axis I Disorders, Research Version, Patient Edition (SCID-I/P). Biometrics Research. New York State Psychiatric Institute, New York.

Friesen, C.K., Kingstone, A., 1998. The eyes have it! Reflexive orienting is triggered by nonpredictive gaze. Psychon. Bull. Rev. 5, 490–495.

Frischen, A., Bayliss, A.P., Tipper, S.P., 2007. Gaze cueing of attention: visual attention, social cognition, and individual differences. Psychol. Bull. 133, 694–724.

Frischen, A., Tipper, S.P., 2004. Orienting attention via observed gaze shifts evokes longer term inhibitory effects: implications for social interactions, attention, and memory. J. Exp. Psychol.: Gen. 133, 516–533.

Galfano, G., Dalmaso, M., Marzoli, D., Pavan, G., Coricelli, C., Castelli, L., 2012. Eye gaze cannot be ignored (but neither can arrows). Q. J. Exp. Psychol. 65, 1895–1910.

Galfano, G., Sarlo, M., Sassi, F., Munafò, M., Fuentes, L.J., Umiltà, C., 2011. Reorienting of spatial attention in gaze cuing is reflected in N2pc. Soc. Neurosci. 6, 257–269.

Garner, D.M., Garfinkel, P.E., 1979. The eating attitudes test: an index of the symptoms of anorexia nervosa. Psychol. Med. 9, 273–279.

Giel, K.E., Friederich, H.C., Teufel, M., Hautzinger, M., Enck, P., Zipfel, S., 2011. Attentional processing of food pictures in individuals with anorexia nervosa—an eye-tracking study. Biol. Psychiatry 69, 661–667.

Goldberg, M.C., Mostow, A.J., Vecera, S.P., Gidley Larson, J.C., Mostofsky, S.H., Mahone, E.M., Denckla, M.B., 2008. Evidence for impairments in using static line drawings of eye gaze cues to orient visual–spatial attention in children with high functioning autism. J. Autism Dev. Disord. 38, 1405–1413.

Hakamata, Y., Lissek, S., Bar-Haim, Y., Britton, J.C., Fox, N., Leibenluft, E., Ernst, M., Pine, D.S., 2010. Attention bias modification treatment: a meta-analysis toward the establishment of novel treatment for anxiety. Biol. Psychiatry 68, 982–990.

Hebebrand, J., Bulik, C.M., 2011. Critical appraisal of the provisional DSM-5 criteria for anorexia nervosa and an alternative proposal. Int. J. Eat. Disord. 44, 665–678.

Heeren, A., Reese, H.E., McNally, R.J., Philippot, P., 2012. Attention training toward and away from threat in social phobia: effects on subjective, behavioral, and physiological measures of anxiety. Behav. Res. Ther. 50, 30–39.

Henderson, M., Freeman, C.P.L., 1987. A self-rating scale for bulimia: the 'BITE'. Br. J. Psychiatry 150, 18–24.

Hilbert, A., Tuschen-Caffier, B., Karwautz, A., Niederhofer, H., Munsch, S., 2007. Eating disorder examination-questionnaire. Diagnostica 53, 144–154.

Howell, D., 2010. Statistical Methods for Psychology, 7th ed. Wadsworth, Belmont, CA.

Kim, Y.-R., Kim, C.-H., Cardi, V., Eom, J.-S., Seong, Y., Treasure, J., 2014. Intranasal oxytocin attenuates attentional bias for eating and fat shape stimuli in patients with anorexia nervosa. Psychoneuroendocrinology 44, 133–142.

Kucharska-Pietura, K., Nikolaou, V., Masiak, M., Treasure, J., 2004. The recognition of emotion in the faces and voice of anorexia nervosa. Int. J. Eat. Disord. 35, 42–47.

Kuhn, G., Benson, V., Fletcher-Watson, S., Kovshoff, H., McCormick, C.A., Kirkby, J., Leekam, S.R., 2010. Eye movements affirm: automatic overt gaze and arrow cueing for typical adults and adults with autism spectrum disorder. Exp. Brain Res. 201, 155–165.

Kuhn, G., Kingstone, A., 2009. Look away! Eyes and arrows engage oculomotor responses automatically. Atten. Percept. Psychophys. 71, 314–327.

Liuzza, M.T., Vecchione, M., Dentale, F., Crostella, F., Barbaranelli, C., Caprara, G.V., Aglioti, S.M., 2013. A look into the ballot box: gaze following conveys information about implicit attitudes toward politicians. Q. J. Exp. Psychol. 66,

209–216.
Madsen, S.K., Bohon, C., Feusner, J.D., 2013. Visual processing in anorexia nervosa and body dysmorphic disorder: similarities, differences, and future research directions. J. Psychiatr. Res. 47, 1483–1491.
Marotta, A., Casagrande, M., Rosa, C., Maccari, L., Berloco, B., Pasini, A., 2013. Impaired reflexive orienting to social cues in attention deficit hyperactivity disorder. Eur. Child Adolesc. Psychiatry 23, 649–657.
Müller, H.J., Rabbitt, P.M.A., 1989. Reflexive and voluntary orienting of visual attention: time course of activation and resistance to interruption. J. Exp. Psychol.: Hum. Percept. Perform. 15, 315–330.
Oldershaw, A., Treasure, J., Hambrook, D., Tchanturia, K., Schmidt, U., 2011. Is anorexia nervosa a version of autism disorder? Eur. Eat. Disord. Rev. 19, 462–474.
Pavan, G., Dalmaso, M., Galfano, G., Castelli, L., 2011. Racial group membership is associated to gaze-mediated orienting in Italy. PLoS One 6, e25608.
Porciello, G., Crostella, F., Liuzza, M.T., Valentini, E., Aglioti, S.M., 2014. rTMS-induced virtual lesion of the posterior parietal cortex (PPC) alters the control of reflexive shifts of social attention triggered by pointing hands. Neuropsychologia 59, 148–156.
Posner, M.I., 1980. Orienting of attention. Q. J. Exp. Psychol. 32, 3–25.
Ristic, J., Mottron, L., Friesen, C.K., Iarocci, G., Burack, J.A., Kingstone, A., 2005. Eyes are special but not for everyone: the case of autism. Cogn. Brain Res. 24, 715–718.
Schmidt, U., Treasure, J., 2006. Anorexia nervosa: valued and visible. A cognitive-interpersonal maintenance model and its implications for research and practice. Br. J. Clin. Psychol. 45, 343–366.
Senju, A., Tojo, Y., Dairoku, H., Hasegawa, T., 2004. Reflexive orienting in response to eye gaze and an arrow in children with and without autism. J. Child Psychol. Psychiatry 45, 445–458.
Shafran, R., Lee, M., Cooper, Z., Palmer, R.L., Fairburn, C.G., 2007. Attentional bias in eating disorders. Int. J. Eat. Disord. 40, 369–380.
Shafran, R., Lee, M., Cooper, Z., Palmer, R.L., Fairburn, C.G., 2008. Effect of psychological treatment on attentional bias in eating disorders. Int. J. Eat. Disord. 41, 348–354.
Suchan, B., Vocks, S., Waldorf, M., 2015. Alterations in activity, volume, and connectivity of body-processing brain areas in anorexia nervosa. Eur. Psychol. 20, 27–33.
Tso, I.F., Mui, M.L., Taylor, S.F., Deldin, P.J., 2012. Eye-contact perception in schizophrenia: relationship with symptoms and socioemotional functioning. J. Abnorm. Psychol. 121, 616–627.
Treasure, J., Claudino, A.M., Zucker, N., 2010. Eating disorders. Lancet 375, 583–593.
Urgesi, C., Fornasari, L., Perini, L., Canalaz, F., Cremaschi, S., Faleschini, L., Balestrieri, M., Fabbro, F., Aglioti, S.M., Brambilla, P., 2012. Visual body perception in anorexia nervosa. Int. J. Eat. Disord. 45, 501–511.
Urgesi, C., Fornasari, L., Canalaz, F., Perini, L., Cremaschi, S., Faleschini, L., Zappoli Thyrion, E., Zuliani, M., Balestrieri, M., Fabbro, F., Brambilla, P., 2013. Impaired configural body processing in anorexia nervosa: evidence from the body inversion effect. Br. J. Psychol. 105, 486–508.
Watson, K.K., Werling, D.M., Zucker, N.L., Platt, M.L., 2010. Altered social reward and attention in anorexia nervosa. Front. Psychol. 1, 36.
Zhao, S., Uono, S., Yoshimura, S., Toichi, M., 2014. Attention orienting by eye gaze and arrows reveals flexibility to environmental changes. Acta Psychol. 150, 100–105.
Zhu, Y., Hu, X., Wang, J., Chen, J., Guo, Q., Li, C., Enck, P., 2012. Processing of food, body, and emotional stimuli in anorexia nervosa: a systematic review and meta-analysis of functional magnetic resonance imaging studies. Eur. Eat. Disord. Rev. 20, 439–450.
Zipfel, S., Löwe, B., Rea,s, D.L., Deter, H.-C., Herzog, W., 2000. Long-term prognosis in anorexia nervosa: lessons from a 21-year follow-up study. Lancet 355, 721–722.
Zucker, N.L., Losh, M., Bulik, C.M., Labar, K.S., Piven, J., Pelphrey, K.A., 2007. Anorexia nervosa and autism spectrum disorders: Guided investigation of social cognitive endophenotypes. Psychol. Bull. 133, 976–1006.

Please cite this article as: Dalmaso, M., et al., Altered orienting of attention in anorexia nervosa. Psychiatry Research (2015), http://dx.doi.org/10.1016/j.psychres.2015.06.044