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Detail and Gestalt Focus in Individuals with Optimal Outcomes from Autism Spectrum Disorders

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Abstract Individuals with high-functioning autism (HFA) have a cognitive style that privileges local over global or gestalt details. While not a core symptom of autism, individuals with HFA seem to reliably show this bias. Our lab has been studying a sample of children who have overcome their early ASD diagnoses, showing "optimal outcomes" (OO). This study characterizes performance by OO, HFA, and typically developing (TD) adolescents as they describe paintings under cognitive load. Analyses of detail focus in painting descriptions indicated that the HFA group displayed significantly more local focus than both OO and TD groups, while the OO and TD groups did not differ. We discuss implications for the centrality of detail focus to the autism diagnosis.

Keywords Pragmatic language · Global/local bias · Weak central coherence · Optimal outcomes · Executive function

Introduction

In his initial description of the autism spectrum, Leo Kanner (1943) noted that affected individuals displayed specific interests in parts of objects rather than the whole—seeing the "trees" rather than the "forest." Since then, many studies have reported this cognitive pattern—often called weak central coherence (WCC)—among individuals with autism spectrum disorders (Frith and Happé 1994; Happé and Frith 2006). This cognitive style, which involves either enhanced attention to local features or difficulty integrating elements of a complex stimulus set, has been associated with heightened performance on visuospatial tasks, such as embedded figures and block design (Happé and Frith 2006); with verbal tasks, such as reduced use of sentence context for disambiguation of homographs (Frith and Snowling 1983; Happé 1997; Lopez and Leekam 2003); with difficulty integrating semantic information in linguistic stimuli (Joliffe and Baron-Cohen 1999, 2000). The current study asks whether a detail focus can be observed in brief spontaneous narratives by high-functioning children with ASD, and further, whether this cognitive style is present in a sample of children who have lost their ASD diagnosis (that is, individuals with "optimal outcomes;" Fein et al. 2013).

Optimal Outcomes (OO) in ASD

As defined by Fein et al. (2013), individuals with "optimal outcomes" (OO) received clearly documented diagnoses of ASD at a young age, but no longer meet diagnostic criteria when followed-up during later childhood or adolescence. Recent research has aimed to identify differences between this group of individuals and the larger group whose diagnoses endure (Helt et al. 2008; Fein et al. 2013) and to establish whether residual, non-symptomatic, ASD characteristics persist despite the loss of diagnosis. No studies to date have examined broad phenotypic (non-core) characteristics of ASD in OO individuals. However, studies by Kelley et al. (2006, 2010) revealed subtle residual deficits in pragmatic language abilities in narrative tasks. When producing a story narrative using the *Frog, Where Are You?* book (FWAY; Mayer 1969), an OO group of 6–9-year-olds provided fewer character motivations, were more

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likely to misunderstand story events, and also provided fewer causal pathways for story events than their TD peers (Kelley et al. 2006). A follow-up study, with an overlapping sample, found the OO group performed similarly to a TD group and significantly better than an HFA group on measures of pragmatic language, but did not study narrative (Kelley et al. 2010). In addition to identifying WCC in non-narrative verbal tasks, to help us to better understand WCC as it relates to pragmatic language skills, studies of WCC in individuals with optimal outcomes from ASD could help to inform models of the phenotypic characteristics of ASD.

Weak Central Coherence

A bias toward local details in ASD appears to reflect a cognitive *style* (an enhanced perceptual function) rather than a *deficit* in processing global aspects of stimuli (Koldewyn et al. 2013; Mottron et al. 2003); Mottron and colleagues review this evidence in detail (Mottron et al. 2006; Wang et al. 2007). In general, the empirical data suggests that WCC, or local detail bias, may be an important component of the ASD phenotype. One significant question, thus, is whether individuals with optimal outcomes show persistence of this perceptual style, or whether it "remits" along with their clinical symptoms.

The presence of a detail-focused or detail-enhanced perceptual functioning style in ASD regardless of intellectual level has been replicated many times (for reviews, see Happé and Frith 2006 and Happé and Booth 2008). A now-classic finding is the bias toward local-level details in Navon Hierarchical Figures (alphabetic letters drawn using smaller alphabetic characters) in individuals with ASD (i.e. Koldewyn et al. 2013; Rinehart et al. 2000; Wang et al. 2007). In general, individuals with ASD appear to preferentially focus on local-level details (the smaller alphabetic letters) in these Navon figures if not explicitly directed to attend to the global figure. In contrast, typically developing individuals preferentially attend toward the global character. Further studies have implicated WCC in performance on block design and embedded figures tasks (i.e. Jolliffe and Baron-Cohen 1997; Ropar and Mitchell 2001).

WCC in Language

Recent research has examined the role of detail focus in story narrations, both created and recreated. The ability to narrate a story is a complex function requiring working memory, planning and pragmatic language skills, as well as basic linguistic ability (Diehl et al. 2006; Losh and Capps 2003). When retelling a story, comprehension and retention of the central elements and details is also required. When retelling the story to a listener, memory for the "gist" of a story is likely more effective for preserving the intent of the story than is verbatim recall of a story text (Brainerd and Reyna 1998). In order for a listener to understand, the story must be coherent; it must flow in an organized manner and should include all central plot points (Diehl et al. 2006). Individuals who focus on local details rather than global information, or on story text rather than story gist, both in producing or reproducing a story, may tell stories with fewer structural elements and more unorganized details.

Several studies indicate a tendency among individuals with high-functioning autism (HFA) to provide local, noncentral story details. A study by Losh and Capps (2003) explored narratives in 28 individuals with HFA or Asperger's Syndrome (AS) (age 8–14) and 22 TD age-matched controls. Participants looked through the FWAY picture book. They told the structured FWAY story to the experimenter, and also generated a personal narrative. Both structured FWAY and personal narratives were coded for length, grammatical complexity, evaluation (causality, emotion and cognition, negatives, hedges, character speech/sound effects, intensifiers, and subjective remarks), structure, theory of mind, and emotional understanding. The individuals with ASD were less likely to produce causal explanations in either narrative condition; performance was unrelated to verbal IQ or theory of mind measures (Losh and Capps 2003).

Diehl et al. (2006) conducted a similar study focusing more closely on narrative coherence. In their study, children with ASD (ages 6–14 years) paged through *FWAY* while listening to a recorded narration, which they subsequently retold to the experimenter. Results suggested that the ASD group produced significantly fewer "causal connections" (e.g., event B occurred as a result of event A) than age and language-matched TD controls, despite producing the same number of story elements overall (Diehl et al. 2006). This was described as reduced coherence. Additionally, findings indicated that the ASD group was able to recall the gist of the story, but was less able to then use it in their retelling (Diehl et al. 2006).

This "reduced gist" effect has also been reported in adults with ASD (Barnes and Baron-Cohen 2012). Adult participants (TD and ASD) watched four clips from a television show, and then wrote down a description of the clips. Descriptions were scored for four story elements: setting, character, conflict, and resolution. Descriptions received a score of zero if the element was not mentioned, a score of one if a local detail was mentioned, and a score of two if a global detail was mentioned, for a total of eight possible points. The ASD group was significantly more likely to produce local details than the TD group on all elements except conflict; this latter effect likely reflects a methodological manipulation, in that each clip provided

detailed information regarding a conflict (Barnes and Baron-Cohen 2012).

Overall, studies suggest that individuals with HFA produce narratives that lack a well-structured plot, and include local details rather than global or gist information; such narratives are less informative. However, these differences seem uncorrelated with theory of mind (Barnes and Baron-Cohen 2012), as performance is uncorrelated with TOM measures or use of mental state words. One way to interpret these findings is that a focus on global themes rather than local details is associated with organizational skills, and with a capacity to discern a central theme, rather than reflecting a response to the needs of a listener.

In addition to WCC or detail focus, narrative deficits could also reflect deficits in executive functions. The executive functions are those processes associated with the frontal lobe, typically including planning, inhibition, and working memory (Hughes et al. 1994). While the pattern of results for studies of executive functions in ASD is complex (see Eigsti 2011 for a review), many studies report executive impairments that may be relevant for narrations. Individuals with ASD may rely more on verbatim as opposed to gist memory, potentially reflecting planning and short-term memory differences (Bennetto et al. 1997; Diehl et al. 2006).

Prior studies of WCC in the verbal mode, thus, have primarily utilized narrative prompts or the judgment of ambiguous verbal materials. The current study elicits verbal descriptions from participants, similar to narratives. However, in addition to individuals with HFA and typical development, the current study aims to evaluate WCC style in a group of individuals with OO. As such, the methodology was designed to be potentially sensitive to even very subtle, minimal differences in cognitive style. There is evidence that the presence of a dual task or additional cognitive load is found to disrupt global coherence of narratives (Rogalski et al. 2010), likely due to decreased access to working memory resources (e.g., see Dodwell and Bavin 2008). Dual-task studies of language and discourse typically utilize motor tasks, such as walking, digital rotary pursuit tasks, or, commonly, tapping one's fingers while talking (Kemper et al. 2003, 2006, 2009). In dual task studies of discourse function, global coherence refers to high-level conceptual maintenance of topic across the discourse as a whole, while local coherence is the maintenance of topic within an utterance (Rogalski et al. 2010). Analyses typically contrast changes in performance of the motor task (slowing, errors, etc.) when those tasks are performed alone versus in a dual task, and also examine speech rate, grammaticality, off-topic comments, and utterance complexity in the discourse. The dual task context is thought to result in competition for cognitive resources, and to strain resources needed for topic maintenance and goal representation over time.

The current study evaluated WCC in the context of brief verbal descriptions produced under cognitive load. In addition to testing whether WCC is present in non-narrative verbal descriptions in HFA, the methodology of producing descriptions during a cognitive load task may be a particularly sensitive test of detail versus gist focused style in individuals with OO, who do not display the same linguistic or social difficulties as their high-functioning peers with current ASD symptoms (Fein et al. 2013), but may show some persistent mild executive functioning difficulties (Troyb et al. 2014). It remains unknown whether subtle phenotypical characteristics of ASD, such as the WCC cognitive style, persist even in OO individuals. The current study examines WCC characteristics of brief spontaneous descriptions produced under cognitive load by adolescents with optimal outcomes from ASD, those with current HFA, and those with a history of typical development (TD), probing in particular for the presence of global and local details.

Methods

Participants

Fifty-nine adolescents included those with high-functioning ASD (HFA; $n = 20$), a history of typical development (TD; $n = 17$), or with optimal outcomes from ASD (OO; $n = 22$); details are shown in Table 1. Groups were matched on chronological age with no significant differences in full-scale IQ. All participants had to have verbal and nonverbal IQ scores above 77 (1.5 SD below the mean). Demographic data are shown in Table 1. All procedures were approved by the University of Connecticut Institutional Review Board.

OO Inclusion Criteria

All participants were part of a larger study of Optimal Outcomes in ASD, in which children from the US and Canada were recruited in order to better understand the phenomenology of possible resolution of ASD symptoms following early intervention (see Orinstein et al. 2014 for intervention data on this group). Participants had to have received a diagnosis early in life (prior to age five years) from a specialist in the field of autism, focusing directly on the ASD diagnosis, and verified in a written report covering the period prior to age five. Participants in the OO group could not exhibit *current* ASD symptomatology on the basis of the ADOS or by clinical judgment. Additionally, OO participants were required to demonstrate the presence of age-appropriate social and communicative skills (validated using relevant measures:

Table 1 Characteristics of optimal outcome (OO), high-functioning autism (HFA), and typically developing (TD) groups

	OO ($n = 22$)	HFA ($n = 20$)	TD ($n = 17$)	F	p	Tukey's HSD
Age (years)	13.43 (3.75)	12.92 (2.09)	13.37 (1.43)	.22	.81	
FSIQ[a]	114 (14)	109 (12)	116 (11)	1.57	.22	
ADOS Soc + Comm[b]	1.18 (1.62)	10.25 (3.16)	.82 (1.13)	118.8	<.001	HFA > OO, TD
SCQ[c]	17.32 (6.18)	22.11 (6.45)	1.19 (1.28)	70.5	<.001	HFA > OO > TD
CELF FS[d]	11.8 (2.0)	9.8 (3.3)	13.4 (1.5)	10.33	<.001	HFA > OO > TD
Planning[e]	9.29 (2.28)	10.10 (2.81)	11.56 (2.19)	3.9	.03	OO < TD; HFA < TD[‡]
Inhibition[f]	9.77 (3.9)	9.80 (3.89)	11.71 (2.14)	.16	.86	

Data are presented as M (SD)

[a] Wechsler Abbreviated Scale of Intelligence (WASI', Wechsler 1999), full scale IQ

[b] Autism Diagnostic Observation Schedule (ADOS, Lord et al. 2002). *Summed score for communication and social domains.* Cutoff is 7 for ASD, 10 for autistic disorder

[c] Social Communication Questionnaire (Rutter et al. 2003a), *Lifetime* version; cutoff is 15 for ASD

[d] CELF Formulated Sentence score, $M = 10$, $SD = 3$ (Semel et al. 2003)

[e] Tower subtest scaled score, DKEFS (Delis et al. 2001)

[f] Color-word (Stroop-like) subtest scaled score, DKEFS (Delis et al. 2001)

[‡] $p < .10$

Clinical Evaluation of Language Fundamentals, Test of Language Competence, Vineland Adaptive Behavior Scales), and participation in a regular education class with no one-on-one assistance.

HFA Inclusion Criteria

Participants in the HFA group met criteria for ASD based on expert clinical judgment using DSM-IV criteria (APA 2000), which was confirmed using gold-standard clinical tools: the Autism Diagnostic Observation Schedule (Lord et al. 2002), the Autism Diagnostic Interview-Revised (Rutter et al. 2003b), the Social Communication Questionnaire, Lifetime version (Rutter et al. 2003a), as reviewed below.

TD Inclusion Criteria

Participants in the TD group did not meet criteria for ASD based on clinical judgment and parent report. Additionally, participants were excluded from the TD group if they had a first-degree relative with ASD.

The full methodology, including verification of early diagnoses in the OO group, is described in detail in Fein et al. (2013). Participants in the OO group exhibited *no current ASD symptomatology* according to gold-standard diagnostic evaluation. Participants were excluded from all groups if they had possible seizures, Fragile X, psychosis, significant sensory or motor disability, or history of head injury with loss of consciousness.

Measures

Participants completed comprehensive assessments of IQ, executive function, language ability, and ASD symptoms as part of the larger study. Measures relevant to the current report included.

Autism Diagnostic Observation Schedule (ADOS)

The ADOS (Lord et al. 2002), is a semi-structured play-based assessment used as a diagnostic tool for ASD. Participants in this sample completed either Module 3 or Module 4. Assessments were video recorded for further review by trained clinicians.

Social Communication Questionnaire, Lifetime Version (SCQ)

The SCQ (Berument et al. 1999) is a short (40-item) parent questionnaire intended to screen for ASD symptoms across the lifespan.

Clinical Evaluation of Language Fundamentals-4 (CELF-IV)

The CELF-IV (Semel et al. 2003) is a standardized measure of language. The Formulating Sentences subtest provides a measure of the ability to formulate grammatical utterances, but with a minimal influence of attention and working memory, processes that are less relevant for the current paradigm.

Delis–Kaplan Executive Function System (D-KEFS)

The D-KEFS (Delis et al. 2001), is a standardized executive functioning battery which assesses ability to form concepts, solve problems, plan, inhibit, and think flexibly (among others). Participants completed planning ("Tower") and inhibition ("Color-Word Interference" or Stroop-like) subtests.

Experimental Task

Participants completed a dual-task paradigm, in which they were asked to tap their left or right index finger on a computer key for 10 s and simultaneously describe a painting (presented via a laptop computer). Before and after the verbal description trials, participants completed three 10-s baseline tapping-only trials, in which they were told to tap as fast as they could, for a total of 18 trials. It is the dual-task verbal description trials that are the focus of the current study. Paintings were oil paintings by famous artists and included two portraits of individuals, two landscape scenes including humans, and two distant scenes without any individual people. In order to control for possible interactions between hand dominance and dual-task interference, the tapping hand was randomized and counterbalanced such that each participant tapped an equal number of trials with the index finger of each hand. Trials were videotaped for transcription and further analysis.

Transcription

Verbal descriptions of six paintings were transcribed by trained research assistants who were naïve to diagnosis. Words, partial words, and pauses were all transcribed. The descriptions were then coded for WCC focus into five categories based in part on the dual-task discourse literature (Glosser and Deser 1991; Van Leer and Turkstra 1999) and the WCC literature (Barnes and Baron-Cohen 2012):

Global focus categories

1. Person statements: described the main character(s) of the painting, including adjectives and actions.
2. Gist statements: a summary or gist description of the painting as a whole or its major features.
3. Evaluative statements: judging the painting's quality.

Detail focus categories

4. Non-central statements: described background elements in the painting, not integral to the painting's theme.
5. Related statements: described something related to, but not present in, an element of the painting (e.g., referring to animal hibernation while describing a winter scene). Such statements focus on local details, but are less relevant to the global description.

All descriptive narratives were divided into utterances and coded by the first author who was naïve to diagnosis at the time of coding. A trained research assistant also coded 20 of the 65 (31 %) descriptions; inter-rater reliability was calculated at $\kappa = .823$, $p < .001$. The five categories included only utterances that were directly "on task;" statements that were off-task or otherwise failed to meet the above criteria (i.e. unintelligible, asked for instructions from experimenter, descriptions of something unrelated to paintings, etc.) were excluded from analysis (15 % of total utterances; no significant differences between diagnostic groups, $p = .35$). Responses within each category were tallied and calculated relative to the overall number of utterances to provide a proportion of utterances within each category.

Results

Dependent variables were examined for deviations from the assumptions of normality and sphericity. Of the individual category variables, there were many zero scores, and several variables were not normally distributed; as such, the group by category analyses utilized a non-parametric statistic (Kruskal–Wallis test), with diagnostic group designated as the independent variable (group differences were of particular interest). When the Kruskal–Wallis indicated significant group differences, we followed up with Mann–Whitney U post hoc tests.

We calculated a *Global Focus* composite score (the sum of Person, Gist, and Evaluative statements), and a *Local Focus* composite score (the sum of Non-central and Related statements). A Global:Local score was calculated as: (Person + Gist Statements) − (Non-central + Related statements)/(Person + Gist Statements) + (Non-central + Related statements), such that a higher score indicated a larger proportion of global relative to local utterances. These composite and ratio scores all met the assumptions of normality and sphericity. A 2 (global versus local) × 3 (OO, HFA, TD) repeated measures ANCOVA was used to evaluate group differences in global versus local focus, followed by post hoc comparisons for any significant variables. Because of the variability in language abilities, the CELF Formulated Sentences score was included as a covariate to reduce the likelihood that group differences simply reflect overall expressive ability. Regression analyses examined the relative contributions of language ability, IQ, symptom severity, and executive processes to the Global:Local ratio score. Effect sizes were calculated with partial eta squared (η_p^2), which refers to the

proportion of variance attributable to a given effect after partialling out non-error sources of variance (Cohen 1988).

Non-parametric group comparisons for each of the category variables indicated significant group differences for the Person and Related categories. Data are shown in Table 2. The HFA group produced significantly more Related statements than the OO and TD groups, and the OO group produced significantly more than the TD group. For person statements, only the TD/HFA contrast was significant, with the HFA group producing significantly fewer such statements.

A repeated-measures ANCOVA examined Global versus Local composite scores as a function of group, with Formulated Sentences score as a covariate. There was a significant main effect of detail focus, $F(1, 53) = 9.78$, $p = .003$, $\eta_p^2 = .16$, such that all participants produced more global than local details. There was no main effect of group, $F(2, 53) = 1.03$, $p = .36$, $\eta_p^2 = .04$. The main effects were qualified by a significant interaction between detail focus and group, $F(2, 53) = 4.50$, $p = .02$, $\eta_p^2 = .15$, such that the HFA group, $M(SD) = .32$ (.12), produced significantly more local details than OO, $M(SD) = .21$(.14), $p = .003$, and TD, $M(SD) = .21$ (.08), $p = .005$, groups, which did not differ, $p = .64$. The group contrasts for global-focus details did not reach significance, $F(2, 51) = 2.16$, $p = .13$, $\eta_p^2 = .08$. The Global/Local composite score data are presented in Fig. 1. An ANCOVA examining the Global:Local ratio score, with CELF as a covariate, indicated significant group differences, $F(2, 53) = 4.23$, $p = .02$, $\eta_p^2 = .14$, with the HFA group score being significantly lower than both OO and TD groups, both p's $< .03$, which did not differ, $p = .29$.

Linear regression analysis was used to identify predictors of the Global:Local composite score in the OO and HFA groups (analyzed separately, to identify all relevant predictors of global/local focus). No regression was run for the TD group, due to floor effects with all diagnostic measures. Data are shown in Table 3. For the OO group, the predictors accounted for a significant 72 % of the variance in the Global:Local composite score, $R^2 = .723$, $F(7, 13) = 4.85$, $p = .007$. Of the variables entered, significant predictors included: full-scale IQ, $\beta = .49$, $p = .04$; *history* of autism communication symptom severity (measured on the ADI-Lifetime form), $\beta = -.75$, $p = .01$, and current executive functioning abilities (D-KEFS planning, $\beta = .72$, $p = .002$, and inhibition, $\beta = -.52$, $p = .02$). To further explore these associations in the OO group, simple correlational analyses were run, with results indicating that WCC style was significantly correlated with *planning*, $r(22) = .61$, $p = .003$, but not *inhibition*, $r(22) = -.13$, $p = .56$. The model was not significant for the HFA group, $R^2 = .421$, $F(7, 9) = .94$, $p = .53$. The simple correlations, for all groups, are reported in Table 4.

The results of a similar regression including current symptoms, assessed via ADOS, rather than ADI lifetime symptoms, yielded a model that was not significant.

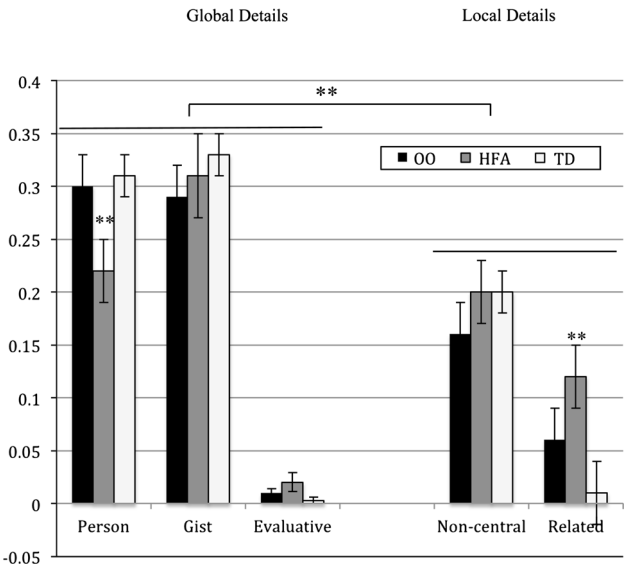

Fig. 1 Proportion of global and local details, as a function of group. All participants produced more global than local details. The HFA group produced significantly more local details than TD or OO, which was driven by an increased proportion of Related statements

Table 2 Utterance category proportion means as a function of diagnostic group

	OO	HFA	TD	Mann–Whitney	*Z*	*p*	
Person	.30 (.15)	.22 (.12)	.31 (.08)	86.00	−2.56	.01	HFA < TD
	.00–.75	.00–.43	.17–.44				
Gist	.29 (.14)	.31 (.19)	.33 (.10)	143.00	−.823	.41	
	.09–.60	.08–.83	.17–.50				
Evaluative	.01 (.02)	.02 (.04)	.003 (.01)	137.50	−1.543	.33	
	.00–.09	.00–.17	.00–.05				
Non-central	.16 (.13)	.20 (.11)	.20 (.02)	169.50	−.015	.98	
	.00–.38	.00–.43	.10–.37				
Related	.06 (.05)	.12 (.11)	.01 (.02)	58.00	−3.629	<.001	HFA > OO > TD

Data are presented as *M* (*SD*), range

Table 3 Hierarchical regression analysis for global versus local detail focus (*relative proportion of global versus local utterances*) as a function of planning and inhibitory control, language level, and autism symptom severity (*lifetime* score), for clinical groups only

	B	*SE B*	β	Model R^2
OO group				
FSIQ	**.010**	**.004**	**.466***	
CELF Form Sen[a]	−.026	.027	−.160	
ADI-Ever-Social[b]	**.031**	**.014**	**.586***	
ADI-Ever-Comm[c]	**−.065**	**.020**	**−.812****	
ADI-Ever-Repet[d]	−.019	.029	−.140	
Planning[e]	**.108**	**.027**	**.775****	
Inhibition[f]	**−.048**	**.015**	**−.573****	
				.724**
HFA group				
FSIQ	.012	.012	.508	
CELF Form Sen	−.016	.011	−.673	
ADI-Ever-Social	.002	.002	.032	
ADI-Ever-Comm	.037	.029	.662	
ADI-Ever-Repet	−.172	.080	−.870	
Planning	.038	.040	.312	
Inhibition	.010	.026	.125	
				.421

Significant predictors are highlighted in bold

* $p < .05$; ** $p < .01$

[a] CELF lang = Clinical Evaluation of Language Fundamentals, Core Language score

[b] ADI-Ever-Social = Autism Diagnostic Interview Lifetime ("ever"), Social domain score

[c] ADI-Ever-Comm = Autism Diagnostic Interview Lifetime ("ever"), Communication domain score

[d] ADI-Ever-Repet = Autism Diagnostic Interview Lifetime ("ever"), Repetitive behaviors domain score

[e] Planning = D-KEFS Tower Subtest Score

[f] Inhibition = D-KEFS Color-Word Inhibition Subtest score

Taken together, the group comparisons indicate that, consistent with multiple prior studies, individuals with HFA focused relatively more on local details than individuals with a typical developmental history, prioritizing the "trees" over the "forest." A novel finding is that OO individuals, who had a history of ASD, were indistinguishable from their typically developing peers. This suggests that this local focus accompanies the diagnosis, rather than the diagnostic history. Furthermore, a regression analysis indicated that a lifetime history of individual differences in ASD symptomatology, along with executive function differences (specifically, planning and inhibition) were associated with an information processing style often linked to ASD: a preferential focus on local detail, sometimes at the expense of global or gestalt perception.

Discussion

The purpose of this study was to examine WCC in HFA in a short, descriptive speech sample under conditions of cognitive load, as well as to examine WCC as a possible residual deficit in OO. With regard to the first question, there was a robust group difference in production of global relative to detail-focused descriptions; the HFA group displayed significantly more local detail focus than either of the other two groups. These results are consistent with prior reports from Mottron et al. (2003), and provide support for the claim that local bias in ASD is a cognitive preference as opposed to a global deficit.

This result was driven by two particular group differences: Person focus and Related detail focus. Participants with HFA were significantly less likely than individuals with either OO or TD to produce Person details, and significantly more likely to describe details that did not reflect the primary subject matter of the painting. The latter finding could reflect increased focus on local detail, but could also reflect difficulty with the task itself (i.e. poor sustained attention, reduced comprehension of instructions, decreased task motivation). This possibility is potentially consistent with the HFA group's decreased performance on measures of executive function. However, we are disinclined to interpret our findings through this lens. The HFA group produced as many details in total, suggesting a similar level of task engagement; and qualitatively, our observations indicate a high degree of motivation (that is, it was not necessary for the experimenter to provide significantly more encouragement or reinforcement to the participants in this group), as is often the case for high-functioning individuals on the spectrum. Furthermore, the HFA group did not produce fewer *global* details; rather, the group difference was in the greater number of local focus statements, particularly the Related statements category, which reflected a tendency to produce statements that were related to a painting element, but not physically present in the painting. There was also a tendency for the HFA group to produce fewer mentions of the central human figure(s) in the paintings where appropriate.

The pattern of findings suggests that the HFA group did indeed understand the task, and were successful at providing informative, global descriptions of the paintings. However, they were more likely to hone in on specific local details when describing complex visual scenes under cognitive load; this is consistent with other studies reporting a WCC style in ASD.

The findings of group differences were straightforward. A more detailed exploration of individual-level predictors of global/local detail focus yielded somewhat more complicated results. First, the severity of lifetime history of ASD symptoms in the OO group was a predictor of global/

Table 4 Correlations of global/local score with other measures, for OO, HFA, and TD groups

Global/local score	FSIQ[a]	ADOS Soc + Comm[b]	ADI-Ever-Social[c]	ADI-Ever-Comm[d]	ADI-Ever-Repet[e]	Planning[f]	Inhibition[g]
OO	.16	.18	−.11	−.21	.34	**.61****	−.13
HFA	.17	.05	.35	.20	−.29	.09	.09
TD	.06	n/a	n/a	n/a	n/a	−.16	−.08

** $p < .01$ (two-tailed)

[a] FSIQ: Wechsler Abbreviated Scale of Intelligence (WASI', Wechsler 1999), full scale IQ

[b] Autism Diagnostic Observation Schedule (ADOS, Lord et al. 2002). *Summed score for communication and social domains.* Cutoff is 7 for ASD, 10 for autistic disorder

[c] ADI-Ever-Social = Autism Diagnostic Interview Lifetime ("ever"), Social domain score

[d] ADI-Ever-Comm = Autism Diagnostic Interview Lifetime ("ever"), Communication domain score

[e] ADI-Ever-Repet = Autism Diagnostic Interview Lifetime ("ever"), Repetitive behaviors domain score

[f] Planning = D-KEFS Tower Subtest Score

[g] Inhibition = D-KEFS Color-Word Inhibition Subtest score

local processing style, such that individuals with a *history* of more severe communication and social symptoms were more likely to display a greater focus on details relative to gist. Interestingly, current symptom severity was not a predictor of global/local focus in the HFA group. These data suggest that the relative severity of ASD symptoms over the lifespan, but not current symptoms, is a predictor of global/local focus; clearly, more data are needed to clarify these relationships.

Results were consistent with the hypothesis that global/local style in verbal description reflects, at least in part, executive impairments in planning, in the OO group. Specifically, regression analysis indicated that significant variance in global/local focus was predicted by individual differences in standardized measures of planning (the D-KEFS tower subtest) and inhibition (the D-KEFS color-word interference subtest) in the OO group. Interestingly, the relationships were reversed, such that better planning was associated with reduced detail focus, whereas better inhibition was associated with greater detail focus. Global/local focus was significantly correlated with planning but not inhibition in the OO group, in simple correlational tests; this may indicate that planning is associated in a relatively straightforward way with global/local focus, but that the relationship between inhibition and global/local focus is moderated by other factors. It should also be noted that global/local focus was not associated with executive planning or inhibitory control in the TD group, which may reflect ceiling effects (as the OO group had relatively greater variability in scores on these EF tasks than did the TD group). Global/local focus style was not associated with planning or inhibition in the HFA group, potentially reflecting the fact that multiple predictors (IQ, language, and symptom severity) all contributed small, non-significant variance to WCC style, with no single predictor predominating. Clearly, further research is needed to better understand these findings. Taken together, these results support proposals that executive abilities contribute to global/local focus, and could contribute to narrative deficits in general.

Perhaps the most striking finding was the fact that participants with OO did not differ from TD participants in global/local focus, whereas both groups (TD, OO) differed from the HFA group. This result is consistent with two possibilities: First, the OO group may *never* have shown the global/local focus that characterized the HFA group's performance. Their typical processing style may have been present throughout development, including the period when they had active symptoms of ASD; indeed, this is consistent with the possibility that this kind of processing style may have been instrumental in, or at least consistent with the possibility of their improvement. A second possibility, and one that seems more consistent with other data showing a high degree of similarity between HFA and OO groups early in development (Eigsti and Fein 2013; Mraz et al. 2009), is that participants with OO had a global/local focus similar to the HFA group early in development, but that this focus has changed over time, potentially in tandem with the loss of other symptoms. This would suggest that the OO group has "overcome" local focus, much as they "overcame" ASD symptoms. Further, this explanation warrants careful investigation of intervention differences between groups (see Orinstein et al. 2014) to explore the role of intervention in focus change. Longitudinal data of global/local focus would be especially helpful in teasing apart these explanations.

While the current findings are highly consistent with prior research on detail focus in ASD, there are important differences. First, prior research on narrative deficits in ASD has focused primarily on story narrative, whereas the

current study included brief verbal descriptions. Similarly, studies of global/local processing style have often focused on performance on embedded figures, block design, and homographs tasks. The finding that global/local processing can reveal group differences, even in a very brief speech sample of 60 s across six trials, suggests that the effect is a robust one. Future research examining the relationship between performance on this type of verbal description and classic central coherence tasks, such as the homographs or ambiguous sentences tasks, will enhance our understanding of this cognitive style in HFA. Note also that while we chose to look at HFA as a comparison group to OO based on cognitive similarities early in development, WCC findings are found across individuals with ASD at all intellectual levels. Further research using this task across heterogeneous subgroups of ASD would provide better understanding of its robustness. A second difference is that verbal descriptions in this study were generated under conditions of cognitive load. We anticipated that the more demanding dual task would be most likely to reveal even very subtle effects in the OO group; in some regards, this dual-task paradigm mimics typical social interactions, in which communication must be coordinated with motor activities such as eating, walking, or driving.

This study provided evidence in support of WCC theory in short, descriptive speech samples by individuals with HFA, and found additional support for executive dysfunction explanations. Additionally, the current data suggested that individuals with OO do *not* display the WCC processing style, suggesting that phenotypic characteristics of ASD may remit along with diagnostic symptoms (see also Eigsti and Fein 2013). Future research should examine these processes longitudinally, to provide a clearer picture of the interaction between ASD symptoms and other phenotypic characteristics as they change with time and intervention.

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