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Comparing the writing skills of autistic and nonautistic university students: A collaboration with autistic university students

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Abstract

The writing skills of autistic university students have received very little empirical attention. Previous research has suggested that autistic people may struggle with writing, in part, due to challenges with Theory of Mind. However, other research indicates that Theory of Mind difficulties are far from universal in autism, varying across developmental and social contexts. Through a participatory research approach, autistic university students contributed to the current study examining the writing strengths and challenges of autistic ($n = 25$) and nonautistic ($n = 25$) university students. Autistic participants demonstrated more advanced writing skills, more perfectionistic attitudes about writing, and heightened nonverbal intelligence relative to nonautistic students. Autistic students did *not* exhibit reduced Theory of Mind skills. Although heightened nonverbal intelligence and being autistic were both initially predictive of writing quality, autism was no longer associated with writing quality after accounting for nonverbal intelligence. Findings suggest that autistic university students may often have enhanced cognitive and writing skills but may face challenges overcoming perfectionism. This research highlights the value of participatory collaborations with autistic students for identifying strengths that can help autistic students succeed in college.

Lay abstract

We do not know very much about the writing skills of autistic university students. Studies with autistic children and teenagers show that some autistic young people have difficulties writing. Other autistic people are talented writers. In fact, some autistic people would rather write than speak. Good writers often imagine other people's points of view when writing. Autistic people sometimes have difficulties understanding others' points of view. Yet, autistic people often work much harder to understand others' points of view than not-autistic people do. We collaborated with autistic university student researchers to see if autistic university students are better or worse at writing than nonautistic students. Autistic university students in our study were better writers than nonautistic students. Autistic students in our study had higher nonverbal intelligence than nonautistic students. Autistic students also put themselves under more pressure to write perfectly than nonautistic students did. Autistic students did not show any difficulties understanding other minds. This study shows that some autistic university students have stronger writing skills and higher intelligence than nonautistic university students. Yet, autistic students may be too hard on themselves about their writing. Fun activities that help students explore their ideas without pressure (like theater games) may help autistic students be less hard on their writing. Teachers can help autistic students express themselves through writing by encouraging them to write about their interests, by giving them enough time to write, and by letting them write using computers if they want to. This study shows that collaborations with autistic people can help us understand strengths that can help autistic people succeed.

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As the number of autistic university[1] students increases (Bakker et al., 2019), a growing literature highlights challenges they may face with social interactions, self-advocacy, executive functioning, and emotion regulation (Anderson et al., 2017; Elias & White, 2018; Gelbar et al., 2014; Gurbuz et al., 2019; S. L. Jackson et al., 2018). Although writing is often essential for academic and professional success, the writing skills of autistic university students have received very little empirical attention. Specialized strategies to help autistic university students improve their writing have begun to emerge, despite limited prior research identifying specific difficulties that they may need help overcoming (Cherney, 2017; Gerstle & Walsh, 2011; L. G. Jackson et al., 2018). Extant research, largely anecdotal, consists of an account of an autistic university student who struggled to adapt his writing for diverse audiences (Jurecic, 2007), accounts of some autistic students exhibiting writing difficulties which researchers attributed to executive functioning and motor differences (Blamires & Gee, 2002; Cai & Richdale, 2016; VanBergeijk et al., 2008), and reports from autistic university students of difficulties organizing the writing process, despite grammatical strengths ($n=9$; Dubin, 2014). However, many autistic adults report that they communicate particularly effectively through writing (Blamires & Gee, 2002; Cai & Richdale, 2016; Davidson & Smith, 2009; Gillespie-Lynch et al., 2014; Gurbuz et al., 2019; Tomlinson & Newman, 2017). Indeed, a multiple-choice assessment of first-year students at a private university in the Netherlands revealed *enhanced* foundational writing skills (e.g. grammar and vocabulary) among autistic ($n=97$) relative to nonautistic students with ($n=2252$) and without other disabilities ($n=24{,}794$; Bakker et al., 2019).

The current study examines writing produced by autistic and nonautistic university students to determine if autistic university students exhibit specific difficulties and/or strengths in their writing. Autistic university students contributed to hypothesis development and data analysis and are coauthors. Participatory research involving autistic students remains very rare (Hotez et al., 2018; Searle et al., 2019; Vincent et al., 2017), despite increasing recognition that participatory approaches improve social validity (e.g. Fletcher-Watson et al., 2019; Nicolaidis et al., 2013).

Do autistic people experience specific challenges in writing?

Prior writing research has focused primarily on autistic elementary and secondary students' scores on standardized assessments (Zajic & Wilson, 2020). Such research has revealed substantial variability in writing skills, including clinically significant writing challenges (e.g. Mayes & Calhoun, 2006), writing scores in the average range, albeit with high variability (e.g. Griswold et al., 2002; Myles et al., 2003), and average to above average performance among gifted youth (e.g. Foley-Nicpon et al., 2012). These patterns mirror variations in IQ, aligning with evidence that written expression and IQ are often associated among autistic youth (Mayes & Calhoun, 2003b, 2008). In some studies, writing skills were lower than would be expected based on IQ (Mayes & Calhoun, 2003a, 2006). However, autistic people with intellectual disabilities are underrepresented in extant research (Keen et al., 2016).

Prior studies have assessed writing skills using a wide variety of timed assessments that commonly require handwriting (Zajic & Wilson, 2020). Therefore, autistic students' performance on writing assessments may be influenced by motor and processing speed differences (see related critiques of intelligence tests; Dawson et al., 2007). Indeed, motor differences are increasingly recognized as a central aspect of autism that is associated with language development (Donnellan et al., 2013; Fournier et al., 2010; Kapp, 2013; LeBarton & Landa, 2019; Leonard et al., 2015). Autistic people often experience motor and/or attentional differences that can make it challenging to communicate through handwriting (Church et al., 2000; Grace et al., 2017; Kushki et al., 2011; Mayes et al., 2018; Zajic et al., 2018). A recent meta-analysis revealed that autistic participants wrote more slowly and produced less legible handwritten texts comprising fewer words relative to nonautistic participants (Finnegan & Accardo, 2018).

These findings align with Mayes and Calhoun's (2003b) speculation that discrepancies between IQ and writing scores, when apparent among autistic youth, may arise from graphomotor and attentional atypicalities. Although Mayes and Calhoun recommended technological accommodations in 2003 (and again in 2018) to help autistic people communicate their thoughts, research on writing in autism has continued to rely primarily on handwritten assessments. This is problematic because handwriting difficulties may limit one's ability to express ideas (Berninger & Amtmann, 2003). Indeed, handwriting fluency and oral language skills predicted writing quality among autistic children (Dockrell et al., 2014). A reliance on solely handwritten assessments remains a key limitation of prior research about writing in autism.

H. M. Brown and Klein (2011) began to address this limitation by asking autistic people to *type* two essays about interpersonal conflicts. Participants were given unlimited

time to complete these tasks. Autistic adolescents and adults ($n=16$) produced shorter narrative, but not expository, texts than nonautistic individuals ($n=16$). Group differences in spelling, syntax, and mental/emotional state terms were not observed. Autistic students' writing received poorer quality ratings than writing produced by nonautistic students with large effect sizes. Autistic students were less likely to provide background information, exhibited difficulty staying on topic, and switched abruptly between ideas. Autistic participants also exhibited difficulties with Theory of Mind (ToM, assessed via the Social Attribution Task; Klin, 2000). In the full sample, ToM was correlated with writing quality and length (albeit with numerous one-tailed tests).

These findings are consistent with research linking ToM to narrative skills in autism (e.g. Capps et al., 2000). ToM difficulties may lead autistic storytellers to struggle to take on the perspective of audience members, leading to limited contextual information and connections (Colle et al., 2008; Diehl et al., 2006; King et al., 2014; Losh & Capps, 2003). However, autistic people with developed language skills often do not struggle with ToM (Barendse et al., 2018; Happé, 1995; de Villiers, 2007). Indeed, autistic adults describe actively considering others' perspectives but struggling to translate their ideas into language that "neurotypicals" would understand (Tomlinson & Newman, 2017). When autistic ($n=25$) and nonautistic ($n=22$) youth without language disabilities were asked to type a persuasive essay about computer use, no group differences in ToM, cohesiveness, spelling, or grammar were observed (H. M. Brown et al., 2014). Autistic students produced shorter texts that were rated lower in overall quality than texts produced by nonautistic students. Their writing exhibited less syntactic but greater lexical complexity. ToM was *not* associated with writing quality for autistic participants.

Brown and colleagues' work reduced graphomotor barriers that may prevent some autistic people from expressing themselves effectively through handwriting. The specific topics that participants were asked to write about may have contributed to divergent associations between ToM and writing quality across studies. Indeed, Barnes and colleagues (2009) found that autistic adults used fewer mental state terms (and produced shorter texts) than nonautistic adults when asked to write about moral dilemmas but not when asked to write about their interests. Given that autism is partially defined by strong attachments to one's interests, autistic people may engage more fully with writing tasks when asked to focus on topics that they select, rather than on researcher-initiated topics that may not be of interest to them. In addition, Sivertson (2010) found that five autistic students produced higher quality texts when given opportunities to write about their interests relative to when they had to respond to teacher-provided prompts.

Study aims and hypotheses

Our initial hypothesis, rooted in the aforementioned research linking ToM difficulties with difficulties constructing narratives, was that autistic university students would exhibit difficulties with ToM which would be associated with writing challenges. We hypothesized that autistic students would produce shorter texts than nonautistic students due to perfectionistic tendencies that have been anecdotally reported (e.g. Gurbuz et al., 2019; Kapp et al., 2011) and that we have observed among some autistic students in a mentorship program that we run. To begin to understand the processes that make it difficult for some autistic students to begin and continue writing, we examined underlying attitudes toward writing that have been associated with writing achievement in past research with nonautistic students: perfectionistic attitudes about writing, seeking to avoid negative feedback, and reduced writing self-efficacy, or belief in one's ability to carry out one's goals (MacArthur et al., 2016; Shell et al., 1989).

Through dialogue with a participatory researcher, we realized that our initial hypotheses and coding scheme were overly deficit oriented, particularly given increasingly strong critiques of the reduced ToM account of autism (e.g. Milton, 2012; Nicolaidis et al., 2018). Therefore, we decided to invite two autistic students in our mentorship program to independently develop their own hypotheses and coding scheme, without reference to our hypotheses, coding scheme, or prior literature (which might bias them in a deficit-oriented direction). One autistic coder hypothesized that autistic students would produce more specific and creative writing yet would rely more on first-person narration, due to reduced ToM, than nonautistic students. The other autistic coder did not generate a specific hypothesis.

Method

Participants

All participants were recruited from a public urban university in the United States with nonselective admissions criteria. The university offers both associate degree and bachelor's degree tracks, which may contribute to the large number of identified autistic students at our institution, as autistic students often start out in associate degree programs (Wei et al., 2014). All participants completed institutional review board approved consent forms before participating.

Autistic university students in a mentorship program ($n=25$; 92% male) for autistic students and students with other disabilities completed assessments as part of a program evaluation. Our mentorship program has a participatory culture, meaning that autistic students and students with other disabilities are encouraged to transition from being mentees to becoming mentors, public speakers, and/

or researchers within the program. Autistic students were informed that assessments would be used to improve the mentorship program. Participation was voluntary; autistic students received a US$25 gift card for completing assessments. All autistic students (except one) provided documentation of an autism classification (i.e. an individualized education program [IEP] and/or clinical report). The student whose paperwork did not identify him as autistic was classified as "other-health impairment" in his IEP; however, both he and his parents consistently identify him as autistic. As the inclusion of his data did not substantively alter the pattern of results, he is included in the reported results. The racial/ethnic backgrounds of the autistic participants were White, non-Hispanic (60%), Black (12%), Asian (8%), Hispanic (8%), Mixed (8%), and Pacific Islander (4%). The autistic students' majors included STEM (biology, chemistry, engineering, math, computer science; 36%), liberal arts and sciences (the name of the associate degree track; 24%), English or communication (16%), psychology (12%), business or accounting (8%), and political science or history (4%).

Nonautistic students were recruited through the psychology subject pool and received course credit for participating. They were informed that assessments would be used to improve a mentorship program. We recruited a nonautistic sample that was matched to the autistic sample in terms of gender.[2] When asked if they had any diagnoses, two potential participants in the control sample reported an attention-deficit/hyperactivity disorder (ADHD) diagnosis and were excluded from the control sample. This resulted in a one-to-one gender-matched, nonautistic sample ($n=25$; 92% male). The racial/ethnic backgrounds of this gender-matched nonautistic sample were Black (36%), White, non-Hispanic (32%), Hispanic (28%), and Asian (4%). The nonautistic students' majors included STEM (biology, chemistry, engineering, math, computer science; 32%), business or accounting (20%), English or communication (16%), psychology (12%), political science or history (8%), liberal arts and sciences (4%), music (4%), and undecided (4%).

Measures

Participants completed online surveys as well as computerized and in-person assessments. Online surveys collected information about participant demographics, self-reported autism traits, and attitudes about writing. Computerized assessments included an online task believed to assess ToM and a writing assessment. In-person assessments included a nonverbal intelligence test and a reading comprehension test.

Demographic survey. Participants were asked to indicate their race, gender, age, diagnoses, and their own educational level. They also reported their mother's educational level (an index of socioeconomic status [SES] ranging from some high school to a doctorate).

Multicomponent measure of writing motivation. This measure was developed for college students and assessed writing-related motivations across seven subscales: writing self-efficacy, writing affect, mastery goals, performance achievement goals, performance-avoidance goals, beliefs in writing content, and beliefs in writing conventions (MacArthur et al., 2016). This study focuses on overall writing self-efficacy, which has been associated with writing achievement in past research with college students (e.g. Shell et al., 1989), and the two subscales of the multicomponent measure of writing motivation that were associated with writing achievement in the study establishing the measure, beliefs in writing conventions, and performance-avoidance goals. Writing self-efficacy assesses how individuals feel about their own abilities to plan, generate, organize, and revise their writing, and higher scores indicate more organized writing habits (e.g. "I can write a good persuasive essay."). Beliefs in writing conventions assess how individuals feel about different grammatical aspects of writing, and higher scores indicate more perfectionistic attitudes about writing (e.g. "Good writers do not make errors in grammar."). Performance-avoidance goals assess the degree to which individuals seek to avoid unfavorable judgments about their writing (e.g. "When I'm writing in this class, I'm trying to hide that I have a hard time writing."). Sample-specific internal consistencies were acceptable to excellent for autistic and nonautistic groups (beliefs in writing conventions: $\alpha=0.84$ autistic, 0.75 nonautistic; performance-avoidance goals: $\alpha=0.94$ autistic, 0.91 nonautistic; overall writing self-efficacy: $\alpha=0.96$ autistic, 0.93 nonautistic).

Social Responsiveness Scale-2. The Social Responsiveness Scale-2 (SRS-2) Adult Form is a 65-item Likert-type scale measure of autistic traits in individuals aged 19 years and older (Constantino & Gruber, 2012). Higher scores on the SRS-2 indicate heightened autistic traits. The SRS-2 is a well-established, reliable, and valid assessment of autistic traits (Constantino & Gruber, 2012). Sample-specific internal consistencies were excellent for both groups ($\alpha=0.96$ autistic, 0.92 nonautistic).

Reading the Mind in the Eyes. Reading the Mind in the Eyes (RMIE) is considered to be a measure of advanced ToM where participants select one of the four words to match each of the 36 pairs of eyes depicting varied emotions (Baron-Cohen et al., 2001). Higher scores indicate better ToM. Although many of the studies utilizing RMIE do not report its internal consistency (including the study that established it as a measure; Baron-Cohen et al., 2001), prior research has indicated its internal consistency is fairly poor (Olderbak et al., 2015). Since we assessed

RMIE through an online module, internal consistency of the measure could not be evaluated in the current study.

Test of Nonverbal Intelligence-4. The Test of Nonverbal Intelligence-4 (TONI-4) is a well-validated, untimed measure of nonverbal intelligence that assesses common elements of intelligence without the confounding effects of motor or linguistic skills (L. Brown et al., 2010). Each item has response choices composed of a sequence of abstract figures with a missing figure that require participants to point to one of the four available options to fill in the missing figure in the sequence. Items become progressively more difficult, and correct answers earn one point and incorrect answers earn zero points. Validation studies showed the TONI-4 to have excellent internal consistency ($\alpha s \geqslant 0.92$) and strong convergent validity, or moderate-to-high positive correlations with other measures of nonverbal intelligence which themselves have been associated with full-scale IQ on the Wechler Intelligence Scale for Children-Fourth Edition (WISC-IV; Banks & Franzen, 2010). Standardized scores ($M = 100$, $SD = 15$) are reported for this measure.

Woodcock Reading Mastery Test–Third Edition. The Woodcock Reading Mastery Test–Third Edition (WRMT-III) Word Comprehension subscale assessed participants' ability to read words across three subtests: antonyms, synonyms, and analogies (Woodcock, 2011). The WRMT-III is a well-established, reliable, and valid measure (Woodcock, 2011). Raw total scores summed across these subtests are reported for this measure. We included this measure as an index of text-based vocabulary skills due to research linking vocabulary, ToM, and writing skills (e.g. H. M. Brown et al., 2014; H. M. Brown & Klein, 2011).

Writing task. Students were asked to type their response to the following prompt using Microsoft Word[3] on a computer:

> Please take 15 minutes to write a brief essay introducing the reader to something that you learned during the past few months that you found meaningful. In your response, share what the thing that you learned meant to you and describe whether or not you think it would mean the same thing to other people. Support your evaluation of what it might mean to other people with a specific example of what it might mean to a specific different person.

Although 15 min was the suggested amount of time to spend writing, participants were allowed to take more time to complete their essay (if needed).

Qualitative coding

Two teams of coders (one pair of neurotypical doctoral students and one pair of autistic college students) developed coding schemes. Coders applied content analysis, a theoretically flexible approach to qualitative coding that allows researchers to use different approaches to identify themes in their data, including an inductive approach (based on patterns observed in the data) and a deductive approach (based on prior research; Bengtsson, 2016; Hsieh & Shannon, 2005). Coding pairs differed in their approaches; the neurotypical coding pair applied a deductive and inductive approach, while the autistic coding pair used an inductive approach. Coding pairs obtained interrater reliability estimates using 20% of each set of essays (above 86%). A primary coder in each coding pair coded the remainder of the essays.

The neurotypical coding scheme included binary codes indexing aspects of central coherence, ToM, and responsiveness to the prompt (see Appendix 1). The autistic team coded for creativity, readability, specificity, repetitiveness, emotional evocativeness, and first-person point of view (see Appendix 2). The autistic students developed their scheme independently with guidance only on *how* to qualitatively code. The original coding scheme developed by neurotypical researchers was not shared with the autistic coders when asking them to develop their own coding scheme because the original scheme was heavily influenced by prior, typically deficit-oriented, research. We wished to see what themes the autistic students would observe in the data when not influenced by assumptions about what to look for based on prior literature.

Automated coding

The automatic scoring features of PaperRater (https://www.paperrater.com/) were used to assess the frequency of spelling errors, grammatical errors, cohesion (i.e. the general usage of transitional words), vocabulary words (i.e. the general usage of advanced words), and quality (autograder; based on spelling, grammar, word choice, style, and vocabulary). The automated quality score does not take into consideration organization, logic, or ideas and is only available for essays that are sufficiently lengthy to be scored. Due to the length requirement, six autistic and four neurotypical participants' essays could not be scored for quality. All other metrics were available for all writing samples.

Results

Analytic approach

After checking kurtosis, skew, and homogeneity of variance, independent samples *t* tests (for normally distributed variables) or Mann Whitney tests (for variables that were not normally distributed) were used to evaluate potential differences in continuous variables between autistic and nonautistic students. Chi-square tests were used for binary outcomes. Associations between writing quality and other variables of interest were examined separately in each

Table 1. Comparisons between autistic and nonautistic students.

	Autistic ($n = 25$)	Nonautistic ($n = 25$)	p value	Effect size	Confidence interval	Bayes factors BF_{10}
Age[a]	21.40 (4.63)	20.04 (2.81)	0.11	0.22	(−3.54, 0.82)	0.54
% Male[b]	92%	92%	1.00	0.00		0.56
Mother's education	*3.42 (1.21)*	*2.44 (1.23)*	*0.007*	*0.80*	*(−1.68, −.28)*	*6.15*
% Caucasian[b]	60%	32%	0.09	0.28		2.32
TONI	**100.60 (12.20)**	**89.24 (8.43)**	**<0.001**	**0.98**	**(−17.32, −5.40)**	**71.38**
Word comprehension	*60.46 (14.89)*	*49.36 (12.11)*	*0.006*	*0.82*	*(−18.88, −3.32)*	*7.10*
SRS-2 (raw score)	*71.17 (32.89)*	*49.44 (23.31)*	*0.01*	*0.76*	*(−38.05, −5.40)*	*4.78*
ToM (RMIE)	20.59 (6.16)	21.64 (4.13)	0.49	0.20	(−2.00, 4.10)	0.35
Writing self-efficacy	74.62 (19.90)	77.27 (14.72)	0.60	0.15	(−7.55, 12.86)	0.33
Performance- avoidance goals	3.01(1.65)	2.26(1.50)	0.11	0.48	(−1.67, 0.17)	0.86
Writing belief conventions	**63.16 (22.93)**	**38.22 (21.26)**	**<0.001**	**1.13**	**(−37.93, −11.96)**	**75.26**
Word count[a]	221.44 (120.56)	263.20 (129.52)	0.27	0.16	(−29.13, 112.65)	0.50
Spelling errors[a]	0.76 (1.30)	0.24 (.60)	0.09	0.24	(−0.06, 1.10)	1.07
Grammar errors	**1.80 (1.92)**	**5.00 (3.76)**	**0.001**	**1.07**	**(1.49, 4.91)**	**64.20**
Transitional words[a]	69.96 (37.40)	66.00 (21.45)	0.80	0.04	(−21.30, 13.38)	0.31
Vocabulary word count[a]	5.52 (6.46)	2.13 (2.86)	0.85	0.03	(−4.34, 2.55)	0.32
Algorithmic quality score	**76.32 (6.58)**	**69.95 (3.81)**	**0.001**	**1.18**	**(−9.77, −2.96)**	**52.67**

TONI: Test of Nonverbal Intelligence; SRS-2: Social Responsiveness Scale-2; RMIE: Reading the Mind in the Eyes; ToM: Theory of Mind.
M (*SD*). Significance reflects independent samples *t* tests for all continuous variables except those marked[a] which were not normally distributed, so were analyzed with Mann–Whitney tests[a] or which were categorical, so were analyzed with Chi-square tests[b]. Effect sizes reflect Cohen's *d*, r^a, and phi[b] respectively.
Bold items reflect p values < 0.005. Italicized items reflect suggestive p values between 0.05 and 0.005.

group using correlations. Variables that were associated with writing quality were included in linear regressions. We verified that the assumptions for linear regressions were met (i.e. approximate normality of the residuals, homoscedasticity, and absence of multicollinearity and outliers).

The large number of analyses we conducted increased the risk of Type 1 errors. However, Bonferroni corrections have been critiqued for increasing the risk of Type 2 errors, particularly when statistical power is low (Nakagawa, 2004), as it was in the current study. To address difficulties balancing Type 1 and Type 2 errors and other limitations of null hypothesis testing, researchers (and the American Statistical Association) recommend focusing on effect sizes and confidence intervals (Nakagawa & Cuthill, 2007; Wasserstein et al., 2019). Based on these recommendations, we report effect sizes and confidence intervals (for all continuous variables) using SPSS 24.0. Following Benjamin and Berger's (2019) recommendations, we describe two-tailed p values between 0.05 and 0.005 as suggestive and report Bayes factors BF_{10}, which quantifies the likelihood of the alternative hypothesis relative to the null hypothesis (obtained using JASP; Wagenmakers et al., 2018), for all group comparisons.

Comparing the writing of autistic and nonautistic students

Autistic students exhibited higher nonverbal intelligence (TONI-4) relative to nonautistic students (with a large effect size; Table 1). Findings suggested that language comprehension (WRMT-III), self-reported autistic traits (SRS-2), and SES were heightened among autistic relative to nonautistic students. Autistic and nonautistic students did not differ in ToM (RMIE), overall writing self-efficacy, or performance-avoidance goals. However, autistic students reported heightened beliefs about writing conventions (perfectionistic attitudes) relative to their nonautistic peers (with a large effect size). This pattern remained apparent when differences in nonverbal intelligence were controlled for. No differences in text length or use of transitional phrases were observed. However, autistic students made fewer grammatical errors than nonautistic students. This pattern also remained apparent when differences in nonverbal intelligence were controlled for. Autistic students' writing received higher automated quality ratings than writing produced by nonautistic students (which was attributable to differences in nonverbal intelligence, as discussed below). Bayesian *t* tests revealed "very strong evidence" for heightened nonverbal IQ (NVIQ), beliefs in writing conventions, grammatical strengths, and overall writing quality among autistic relative to nonautistic students (Bayes factors between 10 and 100; Wagenmakers et al., 2018).

The neurotypical coders' qualitative coding scheme revealed no group differences in the writing produced by autistic college students and the gender-matched, nonautistic control group (see Table 2). This coding scheme revealed no evidence that autistic students experienced

Table 2. Qualitative coding scheme developed and employed by neurotypical coders.

	Autistic students ($n=25$) %	Nonautistic students ($n=25$) %	p value	Effect size	Bayes factors BF_{10}
Central coherence related codes					
Big picture message	84	92	0.67	0.12	0.68
Logical narrative structure	36	60	0.16	0.24	1.38
Introductory thesis present	96	96	1.00	0.00	0.69
Support for thesis	88	88	1.00	0.00	0.49
Conclusion full circle	52	60	0.78	0.08	0.40
Perspective taking related codes					
Conveys another perspective	84	72	0.50	0.14	0.65
Conveys 2+ unique perspectives	20	48	0.07	0.30	2.97
Conveys reasons for perspectives	32	40	0.77	0.08	0.42
Addresses each aspect of prompt					
Introduces something learned	88	100	0.24	0.25	2.13
Shares what means to writer	72	72	1.00	0.00	0.38
Shares what means to others	64	52	0.39	0.14	0.55
Provides specific example	36	36	1.00	0.00	0.36

Analyses reflect chi-square tests. Effect size represents phi.

Table 3. Qualitative coding scheme developed and employed by autistic coders.

	Autistic students ($n=25$; %)	Nonautistic students ($n=25$) %	p value	Effect size	Bayes factors BF_{10}
Creativity	16	0	0.11	0.29	3.95
Readability	83	88	1.00	0.06	0.50
Specificity	57	57	1.00	0.00	0.35
Repetitiveness word-wise	91	100	0.11	0.29	3.95
Repetitiveness sentence-wise	76	92	0.25	0.22	1.33
First-person point of view	92	88	1.00	0.07	0.57
Elicits emotions	*54*	*84*	*0.016*	*0.36*	*8.47*

Analyses reflect chi-square tests. Effect size represents phi.
Italicized items reflect suggestive p values between 0.05 and 0.005.

specific difficulties exploring others' perspectives or creating a big picture narrative through their writing. Similarly, no clear group differences emerged based on the criteria chosen by the autistic coders (see Table 3). Of interest, only autistic participants' writing was endorsed as creative (albeit infrequently at 16% for the autistic students compared to 0% for the nonautistic students). Findings were also suggestive of autistic students' writing samples being coded as less likely to have an emotional impact relative to their nonautistic peers' writing (indicated by Bayes factors between 3 and 10 that indicate "moderate evidence" for reduced emotional impact).

Associations between student characteristics and writing quality and length

Among autistic students, writing quality was associated with nonverbal intelligence and word comprehension (Table 4). Word comprehension was negatively associated with beliefs in writing conventions. Evidence suggestive of a positive association between word comprehension and both nonverbal intelligence and SES was observed. Evidence suggestive of positive associations between ToM and both word comprehension and writing quality emerged. Evidence suggestive of a positive association between beliefs in writing conventions and writing self-efficacy was observed. Evidence suggestive of a negative association between nonverbal intelligence and being White emerged.

Among nonautistic students, no associations were observed between writing quality scores and associated variables of interest. Word comprehension was positively associated with both ToM and nonverbal intelligence. Evidence suggestive of a positive association between word comprehension and age was also observed. Evidence suggestive of a negative association between writing quality and writing length was observed. No associations were noted between writing sample quality or length with

Table 4. Correlations with writing produced by autistic and nonautistic college students.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
1. Writing quality		*−0.47 (0.03)*	0.20 (0.38)	0.31 (0.17)	0.23 (0.33)	−0.11 (0.63)	0.23 (0.32)	0.19 (0.41)	−0.21 (0.36)	0.31 (0.18)	−0.17 (0.47)
2. Word count	0.14 (0.58)		0.04 (0.87)	−0.20 (0.34)	−0.05 (0.82)	0.24 (0.24)	0.01 (0.97)	−0.07 (0.74)	0.33 (0.11)	0.09 (0.69)	0.18 (0.38)
3. RMIE	*0.62 (0.008)*	0.12 (0.60)		0.37 (0.07)	**0.60 (0.001)**	0.08 (0.72)	0.31 (0.14)	−0.32 (0.12)	0.16 (0.43)	−0.13 (0.54)	0.21 (0.32)
4. TONI	**0.72 (0.001)**	0.17 (0.42)	0.37 (0.09)		**0.62 (0.001)**	−0.11 (0.59)	0.24 (0.25)	−0.21 (0.32)	−0.17 (0.42)	0.27 (0.19)	0.17 (0.42)
5. Word comprehension	**0.66 (0.002)**	0.15 (0.50)	*0.53 (0.01)*	0.46 (0.02)		−0.04 (0.86)	−0.04 (0.84)	−0.34 (0.10)	0.31 (0.13)	0.12 (0.58)	*0.49 (0.01)*
6. Self-efficacy	−0.16 (0.54)	−0.01 (0.97)	0.02 (0.95)	−0.01 (0.99)	−0.40 (0.07)		0.28 (0.18)	−0.13 (0.55)	0.36 (0.08)	−0.05 (0.80)	0.11 (0.61)
7. Belief conventions	−0.47 (0.06)	−0.34 (0.12)	−0.34 (0.16)	0.04 (0.25)	**−0.72 (0.001)**	*0.43 (0.04)*		−0.14 (0.51)	0.03 (0.88)	*0.42 (0.04)*	0.11 (0.61)
8. Goal avoid.	−0.17 (0.50)	−0.30 (0.16)	0.15 (0.52)	−0.21 (0.33)	−0.02(0.92)	−0.06 (0.79)	0.06 (0.78)		−0.37 (0.07)	−0.11 (0.59)	−0.29 (0.17))
9. SES	−0.14 (0.57)	0.07 (0.76)	0.25 (0.28	−0.02 (0.92)	*0.41 (0.05)*	−0.35 (0.11)	−0.23 (0.30)	−0.01 (0.98)		−0.04 (0.86)	0.30 (0.15)
10. Race	−0.32 (0.18)	0.05 (0.80)	0.10 (0.67)	−0.52 (0.008)	0.01 (0.95)	−0.19 (0.40)	0.02 (0.94)	0.19 (0.39)	*0.42 (0.04)*		−0.01 (0.96)
11. Age	0.16 (0.51)	0.09 (0.67)	0.10 (0.65)	0.10 (0.63)	−0.01 (0.96)	0.08 (0.72)	−0.34 (0.13)	0.04 (0.88)	−0.39 (0.06)	*−0.45 (0.02)*	

RMIE: Reading the Mind in the Eyes; TONI: Test of Nonverbal Intelligence; SES: socioeconomic status.
Autistic students below diagonal; nonautistic students above. Cells are formatted as Pearson's r (p value).
Bold items reflect p values <0.005. Italicized items reflect suggestive p values between 0.05 and 0.005.

writing self-efficacy, beliefs in writing conventions, performance-avoidance goals, SES, being White, or age for either group.

Predictors of writing quality

A regression predicting grammatical errors (available for all participants) from autism classification and nonverbal intelligence (TONI-4), $F(2,47)=7.22$, $p=0.002$, adjusted $R^2=0.20$, revealed that autism classification ($\beta=-0.44$; $p=0.004$) remained associated with reduced grammatical errors after nonverbal intelligence was accounted for ($p=0.59$). In contrast, a regression predicting automated overall writing quality (available for 19 autistic participants and 21 nonautistic participants) from autism classification and nonverbal intelligence, $F(2,37)=21.22$, $p<0.001$, adjusted $R^2=0.51$, revealed that autism classification ($p=0.06$) no longer explained unique variance in overall writing quality after accounting for nonverbal intelligence ($\beta=0.58$; $p<0.001$). A follow-up regression predicting writing quality from autism classification, nonverbal intelligence, word comprehension, and ToM, $F(4,33)=11.58$, $p<0.001$, adjusted $R^2=0.53$, revealed evidence suggestive of an association between nonverbal intelligence and writing quality ($\beta = 0.38$; $p = 0.03$) and no relationships with autism classification ($p=0.09$), word comprehension ($p=0.18$), or ToM ($p=0.48$).

Discussion

Autistic university students who participated in this study demonstrated more advanced structural writing skills (during a short task wherein they were asked to write about a topic that interested them), more perfectionistic attitudes about writing, and heightened nonverbal intelligence relative to their nonautistic peers. Reduced grammatical errors and heightened perfectionistic attitudes among autistic relative to nonautistic students were *not* attributable to differences in nonverbal intelligence. However, enhanced overall writing quality scores *were* attributable to heightened NVIQ among autistic relative to nonautistic participants.

Our findings mirror evidence from a recent paper (Bakker et al., 2019) that autistic students at a selective university in the Netherlands exhibited heightened writing skills on a multiple-choice test relative to their nonautistic peers with and without other disabilities. By utilizing the university's information and enrollment systems to examine characteristics of all first-year students, Bakker and colleagues overcame the reliance on convenience samples that is a key limitation of most prior research about autism in university (including our study). Autistic students exhibited heightened academic writing proficiency across all domains of the Dutch academic writing assessment. However, direct assessments of students' writing were not conducted and nonverbal intelligence was not assessed.

Our findings extend upon Bakker and colleagues' findings at a selective private university in the Netherlands by providing evidence that autistic students at a nonselective urban university in the United States exhibit enhanced writing skills relative to their nonautistic peers and by providing evidence that enhanced nonverbal intelligence contributes to their writing strengths. Although heightened nonverbal intelligence among autistic relative to nonautistic participants could be attributable to sampling differences, prior research suggests that autistic people may have particular strengths in abstract visual reasoning (e.g. Mottron et al., 2006; Stevenson & Gernsbacher, 2013), a skill assessed via the NVIQ test used in our study.

Our findings extend upon prior research demonstrating associations between full-scale IQ and writing quality among school-age autistic children (Mayes & Calhoun, 2003b, 2008) by suggesting that nonverbal intelligence may scaffold the development of writing skills among autistic students. This association is not specific to written language, as shown by prior research finding that nonverbal intelligence is also predictive of spoken language development among young autistic children (Wodka et al., 2013). In the current sample, nonverbal intelligence was associated with overall writing quality for autistic but *not* for nonautistic students. Future research using cross-lagged designs should assess if nonverbal intelligence plays a uniquely important role in the development of writing skills in autism.

Evidence that autistic students may experience academic strengths relative to nonautistic students was also apparent in another recent study. Using the Freshman Survey, distributed to incoming university students throughout the United States, Sturm and Kasari (2019) obtained a sample of 2211 incoming autistic freshmen. After matching autistic and nonautistic students in terms of gender, income, race, university selectivity, and depression, they found that autistic students reported heightened intellectual self-confidence (a composite variable representing intellectual, writing, mathematics, and academic skills) but reduced interpersonal self-confidence relative to their nonautistic peers. This study, however, did not directly assess writing skills or intelligence.

Evidence that autistic students may have unique academic strengths that could help them succeed in postsecondary settings is important to highlight, given the current overemphasis in the research literature on the challenges autistic students face. An overemphasis on challenges associated with autism can lead educators and researchers to misinterpret available evidence. For example, numerous papers and presentations about autism at university misinterpret evidence from the National Longitudinal Transition Study-2 (NLTS-2) that a large number of autistic students had not *yet* graduated from university when data collection was completed as evidence that autistic students are failing to graduate from universities at higher rates than nonautistic students. However, a more careful analysis of the NLTS-2 indicates that available data do not yet allow for assessing if autistic students are graduating at different rates than nonautistic students but do indicate that autistic students are *more* likely to persist in college and to enroll in STEM majors than nonautistic students (Wei et al., 2013, 2014).

Participatory research has been highlighted as a key strategy for overcoming assumptions about autism (Milton, 2014). Based on the current findings, autistic university students may not require additional group-level support in the development of their writing skills. However, findings suggest that autistic students may need help overcoming perfectionistic desires to get the mechanics of writing "right" on the first try. In the current study, these perfectionistic attitudes were *not* associated with writing quality or quantity, but future research should examine associations between perfectionistic attitudes and the *process* of writing to determine if perfectionistic attitudes are associated with difficulties regulating and organizing the writing process and responding to feedback. Future research should also examine if perfectionistic tendencies about academics contribute to mental health difficulties observed among many autistic university students (S. L. Jackson et al., 2018; McMorris et al., 2019). In addition, the writing task used in this study required spontaneous creation of text about a topic of interest, which may differ from the demands of college-level academic writing.

Do difficulties with ToM impact the writing of autistic students?

Contrary to our original hypothesis, autistic participants did *not* exhibit evidence of reduced ToM in their writing nor did they exhibit reduced ToM skills as assessed with the RMIE task. However, evidence suggestive of a positive association between ToM and writing quality was only apparent among autistic students. Indeed, if we examine associations between ToM and writing quality in either our autistic or our combined sample using the alpha level H. M. Brown and Klein (2011) used, our findings provide a conceptual replication of the associations between ToM and writing quality (using different measures of each) observed by H. M. Brown and Klein (2011).

Future longitudinal research could evaluate if distinct autistic learning processes might explain why there was more evidence for associations between writing quality and nonverbal intelligence, word comprehension, and ToM among autistic relative to nonautistic university students in this study. Such research should utilize cross-lagged designs and stronger measures of ToM to better understand if cognitive and/or social cognitive skills help autistic students develop writing skills or if writing helps autistic students develop social cognitive skills.

Do autistic students produce more creative and specific writing?

Although the automated rating system revealed evidence that autistic college students tended to produce writing samples of greater structural quality than writing samples produced by nonautistic college students, no significant differences in the writing produced by autistic and nonautistic college students emerged from qualitative coding. This evidence that autistic and nonautistic college students produce writing that is more similar than it is different aligns with emerging evidence from the first large-scale comparisons of autistic and nonautistic students which suggests that there are fewer differences between autistic and nonautistic college students than might have been expected based on earlier smaller scale studies (Bakker et al., 2019; Sturm & Kasari, 2019).

Although no differences between writing produced by autistic and nonautistic students emerged from the qualitative coding of the data, some evidence that autistic students may be more likely to produce creative yet less emotionally impactful writing emerged from autistic coauthors' coding. Future research using multiple writing samples derived from larger samples recruited from multiple institutions should examine the possibility that heightened creativity and/or reduced emotional impact may be more common in writing produced by autistic relative to nonautistic college students. Such research should compare the nonverbal intelligence and writing skills of autistic and nonautistic students to see if autistic students commonly exhibit heightened skills relative to their counterparts at different institutions, as our findings and recent research (Bakker et al., 2019; Sturm & Kasari, 2019) suggest is the case. It is possible that autistic students may often exhibit academic strengths as they may have had to overcome more obstacles (e.g. stigma) to enter university relative to their nonautistic counterparts.

Limitations and future directions

Although the measure of ToM used in the current study is one of the most widely used measures in autism research, it has been heavily critiqued as more indicative of language than ToM. Newer evidence indicates that it is biased against people from diverse socioeconomic and racial backgrounds (Dodell-Feder et al., 2020). Therefore, findings derived from this measure should be considered critically, and stronger measures of ToM should be used in future research. Indeed, the measures included in this study reflect only a limited number of the linguistic, cognitive, and social skills that impact the development of writing skills (see Zajic & Asaro-Saddler, 2019; Zajic & Wilson, 2020).

The reliance on community classifications of autism is a limitation, albeit one that is shared with much of the research about autistic university students (e.g. Ames et al., 2016; Hillier et al., 2018; McLeod et al., 2019; Schindler et al., 2015; Sturm & Kasari, 2019) and writing (e.g. H. M. Brown et al., 2014; H. M. Brown & Klein, 2011). Autistic students in our sample self-reported average autism symptoms above the recommended raw score of 67 that balances the sensitivity and specificity of the SRS-2 Adult Form (Bölte, 2012). Substantial variability in self-reported symptoms was observed among both autistic and the nonautistic participants. Bölte (2012) also noted less self-reported differences between autistic and nonautistic participants in their validation study than had been observed in prior work relying on other informants. Future studies about autistic university students would benefit greatly from behavioral measures of symptoms.

The autistic and nonautistic samples in the current study were not well matched in terms of nonverbal intelligence, race, and SES. To the best of our knowledge, the nonverbal intelligence of autistic and nonautistic university students has not been compared in prior peer-reviewed research. Our findings suggest that this omission should be remedied in future research as nonverbal intelligence may be a key factor underlying the development of other skills. Recent large-scale studies suggest that autistic university students are more likely to be male, White, and from high-income families than nonautistic students (e.g. Bakker et al., 2019; McLeod et al., 2019; Sturm & Kasari, 2019). Researchers should control for these demographic differences analytically while working together to develop systematic strategies to help more diverse autistic students overcome the barriers they face accessing the opportunities they deserve.

Although our reliance on short unstandardized writing samples provided preliminary insights into college-level writing skills, it left many directions open to future research. Our writing prompt could have been clearer, as indexed by the large number of autistic and nonautistic students who failed to address all aspects of it. The excessively short length of some of the writing samples led to missing automated writing quality scores. Although the suggested time limit of 15 min was provided (but not strictly enforced to alleviate potential writing anxiety), the suggested time limit may have engendered anxiety in some writers. Future writing research should utilize tasks with no time limit.

Our reliance on a short, nonstandardized writing sample limits our ability to make claims regarding generalization. However, similar patterns were observed with a multiple-choice measure of college-level academic writing skills that exhibited high internal consistency (Bakker et al., 2019; M. Kranenburg personal communication, 4 March 2020). Future research should utilize writing prompts that are more clearly aligned with the requirements of many university-level writing assignments (e.g. persuasive essays with a clear thesis and citations to support claims) and should examine key processes underlying successful writing (e.g. altering one's style to fit different contexts and responsiveness to feedback). Given that the pattern of writing skills observed among university students in the current study diverges from most research conducted with younger individuals, there is a need for standardized writing assessments that meaningfully cap-

ture writing skills across the lifespan and autism constellation (McNair & Curry, 2013).

Future participatory research with autistic college students should include autistic students in planning studies from the beginning of study design rather than inviting autistic students to amend an existing study later in the process as we did in the current study. In our ongoing research, autistic students have been involved in study design from the beginning, as recommended in recently published participatory research guidelines (Nicolaidis et al., 2019).

Conclusion

The current findings align with emerging evidence that autistic university students may often experience academic strengths relative to their nonautistic counterparts (Bakker et al., 2019; Sturm & Kasari, 2019) by indicating that some autistic university students have more advanced writing skills than their nonautistic peers. The linguistic strengths observed among autistic participants in the current study were mostly attributable to heightened nonverbal intelligence. However, both autistic and nonautistic students exhibited pronounced variability in both their writing and cognitive skills. Educators should prepare for tremendous variability in the academic skills of their autistic and nonautistic students by aligning their instructional practices with the principles of universal design (Burgstahler & Russo-Gleicher, 2015). Findings suggest that some, but not all, autistic students may benefit from structured opportunities to engage in playful explorations of multiple literacies (e.g. Dunn, 2001) wherein they explore writing through fun, multimodal, interest-driven activities to help them overcome perfectionistic attitudes.

Educators should be cognizant of potential strengths (as well as challenges) that autistic students may face. The strengths observed among autistic university students in this study diverge from the moderate writing challenges documented in many studies with younger autistic samples that typically used timed, handwritten activities that were not interest based (Zajic & Wilson, 2020). In conjunction with prior research (e.g. Barnes et al., 2009; Kim et al., 2018; Mayes & Calhoun, 2003b, 2018; Sivertson, 2010), the current findings suggest that educators should allow autistic students to express their full potential by creating opportunities for students to write about their interests, by providing sufficient time to write, and by allowing students to write using computers if they wish to. This study highlights the value of involving autistic university students in research about autism. Future participatory research may be helpful for identifying instructional strategies and assessments that are meaningful and engaging for diverse learners.

Authors' note

Emily Hotez is now affiliated to the University of California, Los Angeles (UCLA).

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Author contributions

K.G.-L. developed the idea for this study through dialogue with M.Z. and played the leading role in study design, data collection, analysis, and writing. E.H. played the leading role in developing the NT coding scheme and coding data and contributed substantially to article editing. M.Z. contributed to study design, the literature review, and contributed very substantially to article editing. A.R. obtained reliability with E.H. and helped to collect data. D.D. contributed to study design, helped collect data, and contributed substantially to article editing. K.L. and B.K. developed a coding scheme, coded the data, and edited this article. D.B. collected the original round of NT data. N.G. collected automated writing ratings and contributed to editing. All authors reviewed this article.

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Notes

1. In this article, we use the terms "university" and "college" interchangeably as both terms have the same general meaning (i.e. a postsecondary institution) in the United States. We primarily use the term "university" since in some countries, such as the United Kingdom, "college" signifies an institution that people attend before they attend university. We occasionally use the term "college" to avoid neglecting the experiences of the majority of autistic students who seek postsecondary education in the United States, most of whom, at least initially, attend a community college (Wei et al., 2014).
2. An initial sample of 24 nonautistic students (46% male) was recruited. However, reviewers of an initial version of this

article were concerned about the gender imbalance between the autistic sample and our original nonautistic sample. Therefore, we recruited a second gender-matched sample, which is the focus of all analyses in this article.

3. Autocorrect, which corrects capitalization issues and identifies spelling errors, was not disabled for this study as it is not typically disabled on university computers.

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Appendix 1

Coding scheme developed by neurotypical researchers

1. Uses nonliteral language: Figurative language can take multiple forms, such as simile or metaphor (Y/N presence or absence of nonliteral language)
2. Central Coherence Codes
   a. Big Picture: Does the piece convey a big picture message? (Y/N)
   b. Narrative Structure: Does the piece have a logical narrative structure (i.e. intro, body, conclusion)? (Y/N)
   c. Is an introductory thesis/question introduced? (Y/N)
   d. Is at least one piece of support for this thesis provided? (Y/N)
   e. Does the conclusion reflect back on the main point of the writing raised in the introduction? (Y/N)
3. Perspective Taking Codes
   a. Conveys another perspective (Y/N): Introduces another character OR vague "other" who has thoughts, ideas, and opinions about a topic
      i. Subcode: describes different people having unique perspectives (Y/N): identifies the perspective of both themselves (the writer) AND another character. These perspectives are unique from one another—not necessarily opposing but unique in some way.
      ii. Subcode: describes reason for someone else's perspective (Y/N): Moves beyond mentioning the thoughts/feelings/ideas/opinions of a second character by providing reasoning for these thoughts—either based on the character's experiences, personality, personal needs, and so on.
   b. References to internal states (e.g. thoughts/emotions) (Y/N presence or absence)
4. Addressing the Prompt
   a. Introduces the reader to something learned during the past few months (Y/N)
   b. Share what the thing learned meant to you (Y/N)
   c. Describe whether or not it would mean the same thing to other people (Y/N)
   d. Provide a specific example of what it might mean to a specific different person (Y/N)

Appendix 2. Coding scheme developed by autistic researchers.

	Yes (1)		No (0)
Creativity/Imagination (If it is imaginative, it is creative. If it could really happen, it is not that creative.)	High to moderate level of imagination (1).		Not imaginative (0).
Readability/narrative flow	In general, the narrative flows (1).		The narrative does not flow well; many of the sentences end abruptly or do not build from the sentences before them (0).
Opinion of author's point of view	It is easy to understand the author's point of view and/or experience (1)		It is not easy to understand the author's/character's point of view or experience (0).
Specificity	There is a usage of setting that makes it clear when and/or where the story takes place (1)		There is no clear usage of setting and the time and place of the story is hard to tell (0).
Repetitiveness (Word Wise)	There were one or more words or phrases that were repeated (1)		There are no words or phrases that are repeated (0)
Repetitiveness (Subject Matter)	The subject matter seems to be repeated. (1)		The subject matter is not being repeated. (0)
Emotion/Dullness of Story/Narrative	The story/narrative makes you feel a strong emotion or makes you invested in the narrative. That is easier to identify. (1)		The story/narrative does not make the reader feel any emotion. The reader is not invested in the story/narrative. (0)
Point of View (Not mutually exclusive)	Third Person	Second Person	First Person