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Bilingualism in Autism: Language Learning Profiles and Social Experiences

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Abstract

Bilingualism changes how people relate to others, and lead their lives. This is particularly relevant in autism, where social interaction presents challenges. Understanding the overlap between the social variations of bilingualism and autism could unveil new ways to support autistic people. This research aims to understand the language learning and social experiences of mono-, bi- and multilingual autistic people. A total of 297 autistic adults (mean age = 32.4 years) completed an online questionnaire including general demographic, language history and social life quality self-rating items. The sample included 89 monolingual English speakers, 98 bilinguals, and 110 multilinguals, with a wide range of language profiles. Regression models were used to analyse how bilingualism variables predicted social life quality ratings. In the full sample, age negatively predicted social life quality scores while the number of languages known positively predicted social life quality scores. In the multilingual subset, age negatively predicted social life quality scores, while third language proficiency positively predicted social life quality scores. This is the first study describing the language history and social experiences of a substantial sample of bilingual and multilingual autistic adults. It provides valuable insight into how autistic people can learn and use a new language, and how their bilingualism experiences shape their social life.

Lay abstract

Bilingualism changes the way people relate to others. This is particularly interesting in the case of autism, where social interaction presents many challenges. A better understanding of the overlap between the social variations of bilingualism and autism could unveil new ways to support the social experiences of autistic people. This research aims to understand the language learning and social experiences of autistic people who speak one, two or more languages. A total of 297 autistic adults (aged between 16 and 80) completed an online questionnaire that included general demographic questions, social life quality self-rating (SLQ) questions, language history questions, and open questions about the respondents' bilingualism experience. Respondents had a wide range of language experiences: there were 89 monolingual English speakers, 98 bilinguals, 110 respondents knew 3 languages or more, all with a wide range of abilities in their languages. In the full group, younger respondents were more satisfied with their social life, and respondents with many languages were more satisfied with their social life than respondents with few languages. In the multilingual group, younger respondents were more satisfied with their social life, and the more skilled in their 3rd language the more satisfied with their social life. This is the first study describing the language history and social experiences of a large group of bilingual and multilingual autistic adults. It highlights how autistic people can encounter a new language, learn it, use it in their daily life, and how their bilingualism experiences shape their social life.

Introduction

The social processes differences characteristic of autism can impact the quality of daily life and social life of autistic people, regardless of the cultural environment. Studies conducted in Europe and Asia showed that when rating their quality of life across multiple domains, autistic adults give the social life domain the lowest score (Kamp-Becker et al., 2010; Lin, 2014; Lin & Huang, 2017) – unlike neurotypical adults, who rate all domains as equally satisfying (Lin, 2014). Consistently, autistic adults rate their social life quality significantly lower than do neurotypical adults (Jennes-Coussens, Magill-Evans, & Koning, 2006; Kamio, Inada, & Koyama, 2013; Kamp-Becker et al., 2010; Lin, 2014; Lin & Huang, 2017; Schmidt et al., 2015; van Heijst & Geurts, 2015; Vincent et al., 2019). Since social life activities are a positive predictor of general quality of life for autistic adults (Mason et al., 2018; Schmidt et al., 2015) it is essential to understand the factors contributing to a more satisfying social life for autistic people. Bilingualism and multilingualism are among the relatively unexplored factors.

Bilingualism is a skill shared by half the world's population (Grosjean, 2010) with an inherent social and interactive dimension (Bialystok, 2007). There is a wide range of bilingual profiles described in the neurotypical population, and the term can be applied to all people who know two or more signed or spoken languages, learned simultaneously or sequentially, with varying proficiency levels. Defining a threshold above which one can be considered as bilingual is a sensitive matter, requiring agreement on both the relevant metric (e.g. proficiency in second language, age of acquisition of second language) and threshold. Definitions vary between authors and fields, which may explain some of the conflicting results found in bilingualism research (Luk & Bialystok, 2013). Different bilingualism parameters seem to influence different neurocognitive processes, and relevant contributing elements of bilingualism include the number of languages known (Schroeder & Marian, 2017), age of acquisition of each language (Johnson & Newport, 1989), proficiency in each language (Perani, 1998), or language-switching habits (Verreyt et al., 2016).

The linguistic and cognitive effects of bilingualism in autism are still poorly understood, compared to what is known in the neurotypical population. With rising autism prevalence and increases in the

global bilingual population (de Oliveira, 2015) it is timely to chart the effect of bilingualism on the social life of autistic people. Anecdotal self-reports of bilingualism and multilingualism among autistic adults suggest that learning and using multiple languages may have a positive role in creating and sustaining good quality of life (Tammet, 2017). However, there is a lack of systematic research on bilingualism in autistic adults. Data from autistic children, while also limited, indicates that simultaneous bilinguals perform as well as age-matched monolinguals on linguistic measures and show no delay in language (Drysdale et al., 2015; Hambly & Fombonne, 2012; Kay-Raining Bird et al., 2016; Reetzke et al., 2015). Bilingualism may not only be harmless for cognitive processes in autism, but has even been suggested to have a positive influence, especially regarding social and communication skills (Iarocci et al., 2017; Uljarević et al., 2016). Despite the positive account presented by these – albeit preliminary – findings, parents still report a lack of support from practitioners and services when it comes to raising autistic children speaking more than one language (Kay-Raining Bird, Lamond, & Holden, 2012; Hampton, Rabagliati, Sorace, & Fletcher-Watson, 2017). This may be because bilingualism is still often perceived as entailing a heavy cognitive load (Park, 2014).

Indeed, autism is associated with a wide range of language abilities. While some autistic people are minimally- or non-verbal, others have typical (Brignell et al., 2018) or enhanced (Hyltenstam, 2016) language skills, with or without peculiar speech patterns (Gernsbacher et al., 2016). The presence of these linguistic capacities in many autistic people suggests that learning and achieving fluency in more than one language is also possible for autistic people, as it is for their non-autistic peers. Nonetheless, to date research on bilingualism in autism reports in majority only two profiles of autistic bilinguals. Most studies focus on autistic children raised in bilingual environments (Hampton et al., 2017) and describe the language (Drysdale et al., 2015; Hambly & Fombonne, 2012, 2014; Ohashi et al., 2012; Petersen et al., 2012; Reetzke et al., 2015; Valicenti-McDermott et al., 2013; Zhou et al., 2019) or cognitive (Iarocci et al., 2017) development of the autistic child. At the other extreme of the bilingual experience, a handful of case studies focus on autistic polyglots and describe their linguistic (Bates,

1997; Hyltenstam, 2016; Smith & Tsimpli, 1991; Tsimpli & Smith, 1991; Vulchanova, Talcott, Vulchanov, & Stankova, 2012; Vulchanova, Talcott, Vulchanov, Stankova, et al., 2012)(Bates, 1997; Hyltenstam, 2016; Smith & Tsimpli, 1991; Tsimpli & Smith, 1991; Vulchanova, Talcott, Vulchanov, & Stankova, 2012; Vulchanova, Talcott, Vulchanov, Stankova, & Eshuis, 2012) or cognitive (Hyltenstam, 2018; Tsimpli & Smith, 1998) abilities. As such, the current literature on autistic bilinguals does not reflect the diversity of language history profiles extensively described in the non-autistic population (Grosjean, 2010).

The current study explores language profile diversity in the autistic bilingual population, and assesses the potential influence of bilingualism on the self-reported social habits and quality of life of autistic adults. The first aim is to richly characterise a substantial sample of autistic bilingual adults, describing their language learning history, current use and proficiency. We predict that the language history profiles existing in the bilingual autistic population will be more diverse than those currently described in the literature, with various levels of learning experiences and uses. The second aim is to examine the relationship between aspects of bilingualism (e.g. age of acquisition, proficiency) and self-perceived social life quality.

Methods

Participants

The final sample includes 297 participants (Table 1, and see Survey Data Management for data exclusion criteria), clinically diagnosed with autism (n = 237) or self-identified as autistic (n=60). The mean age was 32.4 years (range: 16 – 80), with a mean age at diagnosis of 26.4 years (range: 2 – 78). The gender distribution is 58.2% female, 22.6% male, and 19.2% not listed or not disclosed. The study was conducted in the UK, and the recruitment strategy targeted residents of the UK, resulting in 48.8% of respondents being UK residents. The recruitment flyer was clearly advertising this study as focusing on bilingualism, but was also encouraging the participation of monolingual and multilingual autistic adults. It was circulated around universities and autism networks in the UK (see below in Procedure).

However, the recruitment flyer was also circulated online through social media, which led to the participation of non-UK residents as well (51.2 % of the respondents). Notably, 27% of the respondents were residents of the United States of America, 4% residents of Canada, and 4% residents of Germany. All other countries represented no more than 2% of the sample (see Table 1 for further details about the countries of origin and residence of the respondents). The survey was circulated in English, and so required reading and writing proficiency in that language, and participants had to be 16 years or over to participate. Participants were not compensated for their participation in the study.

Table 1. *Respondents' Demographic Characteristics*

Demographics	
Age in years, M (SD, range)	32.4 (12.0, 16 - 80)
Gender, N (%)	
Female	173 (58.2)
Male	67 (22.6)
Other gender identity	50 (16.8)
Not disclosed	7 (2.4)
Diagnosis, N (%)	
Diagnosed	237 (79.8)
Self-identified	60 (20.2)
Age of diagnosis, M (SD, range)	26.4 (14.5, 2 - 78)
Highest Education, N (%)	
Less than an undergraduate degree	138 (46.5)
Undergraduate degree or higher	159 (53.5)
Country of birth, N (%)	
UK	122 (41.1)
Non-UK, English-speaking [a]	108 (36.4)
Europe, non-English speaking [b]	45 (15.2)
Outside Europe, non-English speaking [c]	21 (7.1)
Country of residence, N (%)	
UK	145 (48.8)
Non-UK, English-speaking [d]	105 (35.4)
Europe, non-English speaking [e]	37 (12.5)
Outside Europe, non-English speaking [f]	10 (3.4)
Non-UK-born UK-residents, N (%)	22 (7.4)
Age of arrival in the UK, M (SD, range)	17.8 (10.5, 0.7 – 36)

Note: Sociodemographic characteristics of the respondents (n = 297).
a = Australia (6), Canada (14), Ireland (4), USA (84). b = Belgium (4), Czech Republic (1), Estonia (1), France (6), Germany (14), Italy (2), The Netherlands (4), Norway (3), Poland (1), Spain (4), Sweden (5). c = Algeria (1), Argentina (1), Bahrain (1), Brazil (1), Curacao (1), Hong Kong (1), Indonesia (1), Israel (1), Mexico (2), Paraguay (1), Puerto Rico (1), Singapore (3), Taiwan (1), Trinidad & Tobago (1), Turkey (2). d = Australia (5), Canada (13), Ireland (6), USA (81). e = Belgium (2), Estonia (2), France (6), Germany (12), Italy (1), The Netherlands (4), Norway (2), Spain (3), Sweden (4), Switzerland (1). f = Curacao (1), Israel (1), Mexico (1), New Zealand (1), Paraguay (1), Singapore (2), Thailand (1), Trinidad & Tobago (1), Turkey (1).

Design

This study was a cross-sectional survey design using self-report measures to explore correlations between bilingualism and social life quality.

Measures

The Autism & Bilingualism Census (ABC, Digard & Fletcher-Watson (2019)) is an online survey, created in SurveyMonkey and it is available to view at https://osf.io/pksm2/. The ABC was created for this research, and designed to capture data from monolingual, bilingual and multilingual autistic adults. It consists of 4 sections:

- Section A: General demographic information;
- Section B: General life satisfaction and social life quality;
- Section C: Language history;
- Section D: Open-ended questions;

Section A collected demographic information about the respondents such as age, countries of birth and residence, highest education level, and autism diagnosis.

Section B focused on social experiences including social life habits (such as the making and maintaining of friendships, or online and in-person engagement in social activities), and quality of life. It was composed of 4 blocks of statements addressing General life satisfaction (5 statements), Current mood (11 statements), Social life quality (12 statements), Personality (6 statements). This section was inspired by pre-existing validated quality of life and quality of social life questionnaires: the WHOQOL

(The Whoqol Group, 1995) – versions of which have been previously used with autistic populations (Jennes-Coussens et al., 2006; Kamio et al., 2013; Kamp-Becker et al., 2010; Lin, 2014; Lin & Huang, 2017; Mason et al., 2018; Vincent et al., 2019), the WHODAS 2.0 (Üstün et al., 2010), the Goldberg Depression Scale (Goldberg et al., 1988), the European Social Survey (ESS Round 8: European Social Survey Round 8 Data, 2016), and the Satisfaction with Life Scale (Diener et al., 1985). Items were composed, drawing on these scales (see Table S1 in Supplementary Material), but tailoring the wording and content to the population being recruited. Participants rated their agreement with each statement on a 7-point Likert scale (from "strongly disagree" to "strongly agree"). Participants' ratings were converted to a 7-point scale for subsequent analysis (range: 1 – 7). All blocks but the current mood block only contained positive statements ("I can easily make new friends"), and for these blocks the conversion scores matched the original Likert scale. The current mood block only contained negative statements ("I feel anxious"), and these were reverse-scored, so that a high score indicates high satisfaction in all measured domains.

Section C focused on the respondents' language history and use. This section drew on pre-existing validated language history and language use questionnaires: the Bilingualism and Emotions Questionnaire (Dewaele & Pavlenko, 2001), the Language History Questionnaire (Li et al., 2006), the Language Experience and Proficiency Questionnaire (LEAP-Q, Marian, Blumenfeld, & Kaushanskaya (2007)) and the Bilingual Language Experience Calculator (BiLEC, Unsworth (2013)). For each language known, respondents were asked how old they were when they first encountered the language and in what context they encountered it. Participants self-rated their current proficiency on a 9-point Likert scale (from "Not at all" = 0 to "Excellent" = 8) in 4 standard language skills: oral expression, oral comprehension, written expression, written comprehension. Respondents also indicated on a 7-point Likert scale (from "Never" = 1 to "Always" = 7) the frequency with which they used each language with their friends, family, and other people in their environments, both currently and while learning the language, and the current frequency of use of each language for a selection of mental and communication tasks (e.g. "Do maths", "Swear") and daily activities ("Watching TV"). Participants

could provide information for up to 7 languages, each language being covered in a separate page of the survey. If they knew more than 7 languages, they were offered the possibility to list any other languages they knew, without providing further details.

Section D involved open-ended questions asking about the respondents' language learning experience, their perception of the importance of language learning, and how these were influenced by autism. Open-ended comment boxes were also available for each language for the participants to provide, if needed, more details about their past and current use of the language. The qualitative data from these items are not covered in this report.

Procedure

The study was approved by the PPLS Research Ethics Committee of the University of Edinburgh. The consent form was built into the online survey and participants provided consent by completing the first page of the survey, which was a pre-requisite for progression to further questions. Respondents were recruited between February and March 2017, with a recruitment flyer circulated via autism charities and networks across the UK, disability services of UK universities, and social media. Participants completed the questionnaire online by themselves, on their own devices, in their own time.

Survey Data Management

A total of 491 responses were recorded by SurveyMonkey. No catch item or repeated item was used, but the requirement to type the name of each language known, and the multiple open-ended questions allowed us to ensure no bot-like response was present in the final sample. In addition, responses were excluded if they:

- Did not provide full information for at least their first language (179 responses), as this could indicate the respondent had not actually completed the questionnaire and had dropped out after

completing the consent form, but before providing all the necessary information to be included in the analysis. This high dropout rate was in all likelihood due to the length of the questionnaire;

- Listed information about several languages on one page (2 responses), as it was unclear which language was associated with the proficiency and use reported;
- Failed to provide adequate information about diagnosis or self-identification of autism (7 responses);
- Did not list English as any of their languages, or indicated a general English proficiency strictly less than 3 ("Slightly less than adequate") (5 responses), as this suggests that the respondent might not fully understand the questions of the survey;
- Were duplicate responses from the same participant (1 response): in this case the second and more complete response was retained for analysis

Several variables were created based on the participants' responses.

Language proficiency: For each language, proficiency was calculated as the average of 4 self-rated standard language skills (oral expression, oral comprehension, written expression, written comprehension).

Number of languages reported (N language R): Each respondent provided data on a number of languages ranging from 1 to 7. This was further converted into a categorical variable (N language R-group) for analysis: monolingual (one language reported), bilingual (two languages reported) and multilingual (three languages or more reported).

Number of languages known with medium to high proficiency (N language P): For each participant, this was the number of languages reported with a proficiency equal to or over 3 ("Slightly less than adequate"). This threshold was defined as indicating that the respondents had a more than basic grasp of the language. This discrete variable ranged from 1 to 7. This was further converted into a categorical variable (N language P-group) for analysis: monolingual (proficient in one language), bilingual (proficient in two languages) and multilingual (proficient in three or more languages).

Age of acquisition: Participants were asked "how old were you when you first encountered L2" and the answer to this question was defined as age of acquisition.

Language order: Participants reported their languages in varying orders (e.g. by increasing age of acquisition, or by decreasing proficiency). Languages were reordered by age of acquisition, with the 2nd language being the first language learned after the native language. Thirteen participants did not report a specific age of acquisition in years for some of their languages. In this case, answers were re-coded as missing data, but in most cases reordering of the languages by age of acquisition was still possible (e.g. where the respondent replied "infancy" for age of acquisition).

Balance: Relative proficiency between the first (L1) and second (L2) languages was calculated as the absolute difference between the first and second language proficiency. A score of 0 indicated a balanced proficiency, a score of 7 indicated a complete dominance in one of the languages. The same balance was calculated between the first and third (L3) languages.

Acquisition context: For each language, respondents indicated frequency of use with different interlocutors and in different contexts. The home environment included 5 item scores (parent 1, parent 2, siblings, other people in the household, other members of the family), the school environment included 1 item (school), and the community environment included 2 item scores (friends, community). Not all respondents assigned a score to all items (e.g. respondents without siblings did not report a score for this item). The maximum score reported in an environment was the score assigned to that environment. The main context of acquisition was identified as the environment with the highest score. When the main (highest-scoring) context had a score strictly under 3 ("Occasionally"), the main context was re-coded as "independent", highlighting the fact that the respondent mostly learned the language independently, and didn't use it in the home, the school, or the community.

Current context: The main context of current use was identified in the same manner as the main context of acquisition. For this variable, the home environment included 7 item scores (parent 1, parent 2, siblings, partner, children, other members of the family, flatmates), the school/work

environment included 1 item (school/work), and the community environment included 2 item scores (friends, community). For the respondents' first language (L1) only, the community environment featured only one item (community) due to an error when building the online survey. When the main context had a score strictly under 3 ("Occasionally"), the main context was re-coded as "independent", as above.

Social life quality (SLQ) scores: For each block of statements in section B, internal consistency was measured using Cronbach's Alpha. Each block showed high internal consistency (general life satisfaction: α = 0.88, current mood: α = 0.86, social life: α = 0.83, personality: α = 0.7). For each participant, the scores in each block were therefore averaged to provide a single sub-scale score for that block. The SLQ score is derived from the social life quality sub-section, and is the outcome variable used in the analysis described below.

The anonymised dataset and analysis script will be made available at https://osf.io/vd53u/ (Digard, Sorace, Stanfield, & Fletcher-Watson, 2019).

Community involvement

Community involvement in the study was modest. We consulted informally with Autistic advisors affiliated with the authors' lab group, including one trilingual autistic advisor, when formulating the original questions and design for the project. However, most autistic people only engaged with the study as participants.

Analysis Methods

Sociodemographic characteristics and social life quality predictors were determined by descriptive analyses. Then, linear regression models computed using R (version 3.5.3) and R studio (version 1.2.1335) were used to determine how language profiles predict social life quality. The available predictors varied with language group: for example, monolingual people do not have data on age of acquisition of additional languages, and do not have data on balance between L2 and L1. Therefore,

the analysis deployed three different linear regression models, applied to specific samples of respondents. For each model, all the applicable predictors were first entered, and a stepwise regression with both forward and backward selection was then used to obtain the optimal model. The three optimal models were validated using 10-fold cross-validation.

Model 1 was applied to all 297 respondents to investigate how bilingualism and multilingualism predicted the self-rated social life quality of autistic adults, relative to monolingual peers. Relevant predictors available for these respondents were entered: respondent age; N language R; N language R-group; N language P; N language P-group.

Model 2 was applied to the bi- and multilingual respondents (n = 196, participants who reported 2 languages or more), to investigate how specific features of the bilingual experience predicted the self-rated social life quality of autistic bilingual adults. Relevant predictors available for these respondents were entered: respondent age; N language R; N language R-group; N language P; N language P-group; L2 age of acquisition; L2 proficiency; L2/L1 balance.

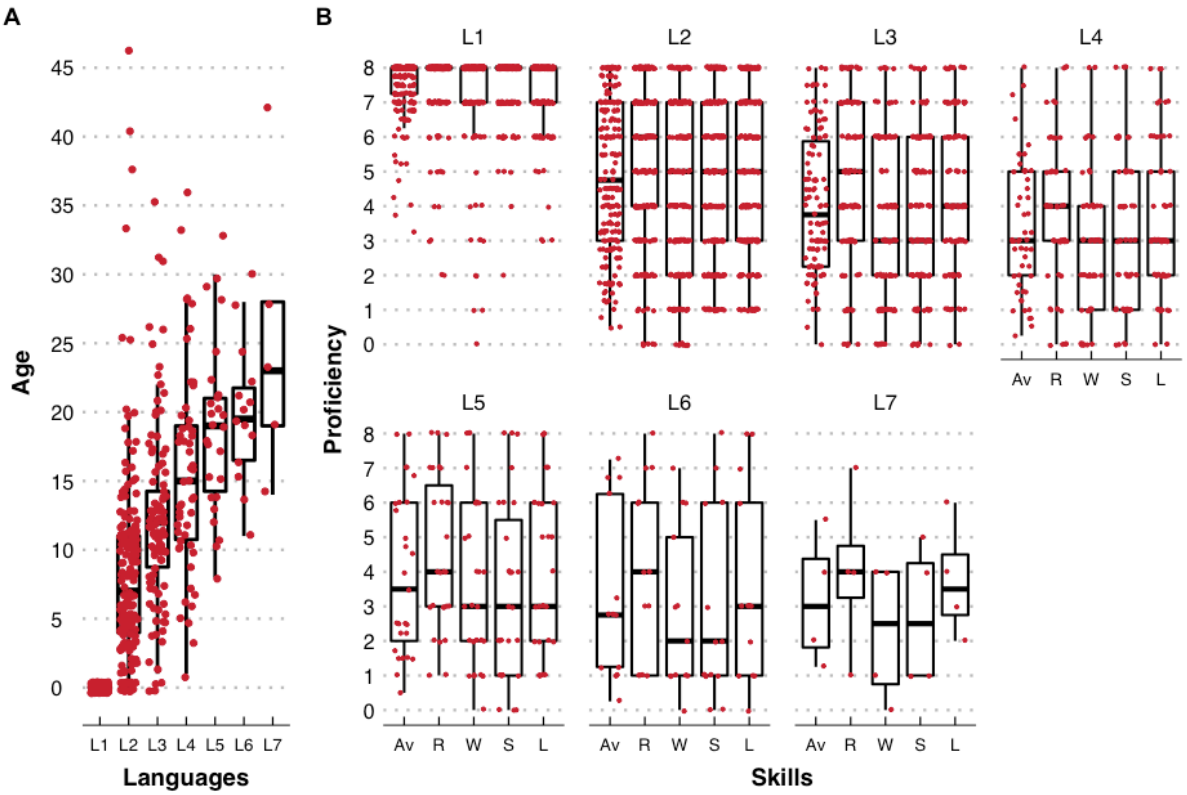
Model 3 was applied to the multilingual respondents (n = 108, participants who reported 3 languages or more), to investigate how specific features of the multilingual experience predicted the self-rated social life quality of autistic multilingual adults. All the predictors available for these respondents were entered: respondent age; N language R; N language P; L2 age of acquisition; L2 proficiency; L2/L1 balance; L3 age of acquisition; L3 proficiency; L3/L1 balance.

Results

Language Profiles

The language characteristics of the sample are reported in Figure 1 and Table 2. The acquisition context and the current context for the respondents who reported more than one language are presented in the supplementary materials (Table s2).

Figure 1. *Age of acquisition and proficiency of the languages reported*



A. Age of acquisition: boxplot and scatterplot of the distribution of the reported ages of acquisition for the languages (L) 1 to 7, ranked by age of acquisition for each respondent.

B. Language proficiency: boxplot and scatterplot of the self-rated average (Av) and detailed (reading = R, writing = W, speaking = S, listening = L) proficiency for the languages 1 to 7, ranked by age of acquisition for each respondent (Digard et al., 2019).

Table 2. *Respondents' Language Characteristics (n = 297)*

A. Number of languages			B. Age of acquisition and proficiency			
	R, n (%)	P, n (%)		Languages (N)	Age in years, M (SD, range)	Proficiency, M (SD, range)
1 lang.	89 (30.0)	121 (40.7)	Monolinguals	L1 (89)	0 (0, 0 - 0)	7.3 (1.1, 3 - 8)
2 lang.	98 (33.0)	104 (35.0)	Bilinguals and Multilinguals	L1 (208)	0 (0, 0 - 0)	7.6 (0.8, 3.3- 8)
3 lang.	56 (18.9)	43 (14.5)		L2 (208)	8.0 (6.9, 0 - 46)	4.9 (2.2, 0.5 - 8)
4 lang.	26 (8.8)	20 (6.7)		L3 (110)	12.3 (6.5, 0 - 35)	4.1 (2.0, 0 - 8)
5 lang.	14 (4.7)	6 (2.0)		L4 (54)	15.6 (7.5, 1 - 36)	3.5 (1.9, 0.3 - 8)
6 lang.	9 (3.0)	1 (0.3)		L5 (28)	18.9 (6.3, 8 - 33)	3.9 (2.3, 0.5 - 8)
7+ lang.	5 (1.7)	2 (0.7)		L6 (14)	19.9 (5.2, 11 - 30)	3.2 (2.5, 0.3 - 7.3)
				L7 (5)	25.2 (10.7, 14 - 42)	3.1 (1.7, 1.3 - 5.5)

C. Age of acquisition – Age groups distribution, n (%)

Language (N) [b]	Birth (age = 0)	Early childhood (age = 1 – 5)	Late childhood (age = 6 – 10)	Adolescence (age = 11 – 17)	Early adulthood (age = 18 – 30)	Adulthood (age > 30)
L1 (297)	297 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
L2 (196)	23 (11.7)	61 (31.1)	54 (27.6)	46 (23.5)	8 (4.1)	4 (2.0)
L3 (108)	4 (3.7)	10 (9.3)	25 (23.2)	52 (48.2)	14 (13.0)	3 (2.8)
L4 (52)	0 (0.0)	4 (7.7)	9 (17.3)	18 (34.6)	19 (36.5)	2 (3.9)
L5 (26)	0 (0.0)	0 (0.0)	2 (7.7)	8 (30.8)	15 (57.7)	1 (3.9)
L6 (14)	0 (0.0)	0 (0.0)	0 (0.0)	4 (28.6)	10 (71.4)	0 (0.0)
L7 (5)	0 (0.0)	0 (0.0)	0 (0.0)	1 (20.0)	1 (20.0)	3 (60.0)

Note. Some percentages do not sum up to 100% due to cumulative rounding effects.

A. Number of languages: Number and proportion of respondents who reported (R) or were proficient (P) in 1, 2, 3, 4, 5, 6, or 7 or more languages (lang.).

B. Age of acquisition and proficiency: Age of acquisition (Age) and proficiency reported by the respondents in languages (L) 1 to 7.

C. Age of acquisition – Age groups distribution: Number and proportion of respondents who acquired their languages (L) 1 to 7 at birth, during early childhood, late childhood, adolescence, early adulthood and late adulthood.

[a] Reported sample sizes (N) reflect the number of respondents who provided useable age of acquisition data (in years).

In our sample of 297 autistic adults, 98 reported knowing 2 languages, 56 reported 3 languages, and 54 reported 4 or more languages (Table 2a). Proficiency in the 2nd language ranged from 0.5 to 8, with a mean of 4.9 (SD = 2.2), and proficiency in the 3rd language ranged from 0 to 8, with a mean of 4.1 (SD = 2.0) (see Table 2b). When considering only the languages known at a "slightly less than adequate" level of proficiency or higher, 104 respondents knew 2 languages, 43 knew 3 languages, and 29 knew 4 languages or more.

Ages of acquisition for the 2nd language ranged from 0 to 46 years (mean = 8.0 years, SD = 6.9) (see Table 2c). Twenty-three respondents (11.7% of the respondents who reported an age of acquisition for L2) reporting learning L2 from birth, and 61 (31.1%) between age 1 and 5, which indicates that 42.9% of the respondents who reported an age of acquisition for L2 fit the profile of simultaneous or early bilingualism generally reported in the field of bilingualism in autism research. Nonetheless, 46 (23.5%) reported acquiring their L2 during adolescence (between age 11 and 17), and 12 (6.1%) after age 18. Ages of acquisition for the 3rd language ranged from 0 to 35 years, with a mean of 12.3 years (SD = 6.5). While, based on the ages of acquisition of L3 reported, adolescence is the largest age group for the learning of L3 (48.2%), 14 respondents (13.0%) reported learning L3 before age 5, and 17 (15.7%) reported learning L3 after age 18.

Social Life Quality

The SLQ results are displayed in table 3. After stepwise regression, model 1 included the following predictors: respondent age; N language P-group. Model 1 was applied to the full sample of respondents (n = 297) to investigate the relationship between the predictors (respondent age, N language P-group), and SLQ scores. The data met the assumptions of homogeneity and linearity and the residuals were appropriately distributed. The post-hoc power was high, at 92.7%, and the model was a significant predictor of SLQ scores ($F_{2,294} = 8.016$, $p = 0.0004$). There was a significant relationship between age and SLQ score ($\beta = -0.01$, $p = 0.003$), and between N language P-group and SLQ score (β

= 0.19, p = 0.0067), together accounting for 4.53% of SLQ score variance, with a small effect size (f^2 = 0.047). There was a decrease of 0.014 points in the SLQ score per extra year of participant age, indicating lower social life quality for older respondents. There was an average increase of 0.19 points in the SLQ score from monolingual to bilingual groups, and from bilingual to multilingual groups, indicating higher social life quality with increasing number of proficiently-known languages, at a group level.

Table 3. *Prediction of SLQ Scores Using Multiple Linear Regression*

	Model 1					**Model 2**					**Model 3**				
SLQ, M (SD, range)	3.59 (0.98, 1.17 – 6.33)					3.65 (1.00, 1.17 – 6.33)					3.75 (1.00, 1.41 – 5.92)				
Coef.	*β*	*SE*	*CI (95%)*	*Stat.*	*p*	*β*	*SE*	*CI (95%)*	*Stat.*	*p*	*β*	*SE*	*CI (95%)*	*Stat.*	*p*
Intercept	3.68	0.21	3.27 – 4.08	17.93	**<0.001**	3.04	0.38	2.30 – 3.78	8.03	**<0.001**	4.02	0.35	3.33 – 4.71	11.41	**<0.001**
Age	-0.01	0.00	-0.02 – -0.00	-2.95	**0.003**	-0.01	0.01	-0.02 – 0.00	-1.44	0.151	-0.02	0.01	-0.04 – -0.00	-2.33	**0.022**
N language P-group	0.19	0.07	0.05 – 0.33	2.73	**0.007**	0.33	0.12	0.10 – 0.56	2.76	**0.006**					
L2/L1 pro. balance						0.06	0.04	-0.02 – 0.14	1.53	0.128					
L3 av. pro.											0.10	0.05	0.01 – 0.19	2.07	**0.041**
Obs.	297					196					103				
R^2 / adj. R^2	0.052 / 0.045					0.047 / 0.032					0.085 / 0.066				
F-statistic	8.016					3.158					4.618				
p	**0.0004**					**0.026**					**0.012**				

Note. Coef. = coefficients. β = estimates of regression β coefficients. SE = standard errors. CI = confidence intervals. Stats. = t-statistics. *p* = *p*-value. pro = proficiency. av. = average. Obs. = observations. adj. = adjusted.

After stepwise regression, model 2 included the following predictors: respondent age; N language P-group; and L2/L1 balance. Model 2 was applied to the sample of respondents who reported 2 languages or more (n = 196) to investigate the relationship between specific bilingualism parameters (N language P-group, L2/L1 proficiency balance) and age, and the SLQ scores, in the autistic bi- and multilingual population. The data met the assumptions of homogeneity and linearity and the residuals were appropriately distributed. The post-hoc power was low, at 54.9%, and the model was a significant predictor of SLQ scores ($F_{3,192}$ = 3.158, p = 0.026). There was a significant relationship between N language P-group and SLQ score (β = 0.33, p = 0.0063), as seen in model 1 with the full sample of respondents: there was an increase of 0.329 points in SLQ score from the bilingual to the multilingual groups, indicating higher social life quality with increasing number of proficiently-known languages, at a group level. In this case, there was no significant relationship between age and SLQ score (β = -0.01, p = 0.15), and between the L2/L1 proficiency balance and the SLQ score (β = 0.06, p = 0.13), even though both these predictors were selected during the stepwise regression as improving the accuracy of the model. This model accounted for 3.21% of the SLQ score variance, with a small effect size (f^2 = 0.033).

After stepwise regression, model 3 included the following predictors: age of respondent; L3 proficiency. Model 3 was applied to the sample of respondents who reported 3 languages or more (n = 103, as 5 participants had missing values in one or several of the predictors selected) to investigate the relationship between specific bilingualism parameters (L3 proficiency) and age, and SLQ scores, in the autistic multilingual population. The data met the assumptions of homogeneity and linearity and the residuals were appropriately distributed. The post-hoc power was low, at 66.2%, and the model was a significant predictor of SLQ scores ($F_{2,100}$ = 4.618, p = 0.012). There was a significant relationship between age and SLQ score (β = -0.02, p = 0.022), and between L3 proficiency and SLQ score (β = 0.10, p = 0.041), together accounting for 6.63% of SLQ score variance, with a small effect size (f^2 = 0.071). For L3 proficiency, there was an increase of 0.098 point in SLQ score per extra proficiency point, indicating that higher proficiency in a third language is associated with higher social life quality. There

was a decrease of 0.021 points in the SLQ score per extra year of participant age, indicating lower social life quality for older respondents.

Discussion

This study reveals a great diversity in the language history profiles of autistic bilingual people, and demonstrates that bilingualism has a modest but significant positive association with the self-rated social life quality of autistic people.

Our descriptive data confirm our prediction that the language history profiles of the bilingual autistic population are more diverse than those currently described in the literature. Most studies on autistic bilinguals focus on one of the two extremes of the bilingualism experience: simultaneous or early bilingual autistic children raised in a bilingual family (Drysdale et al., 2015; Hampton et al., 2017), or on autistic self-taught polyglots (Hyltenstam, 2016, 2018), and seems to imply that the bilingualism diversity of the autistic population does not reflect the bilingualism diversity described in the non-autistic population. Our results add to the current picture of autistic bilingualism, showing a rich diversity of language profiles. Even the sample size is striking, given that these data were collected over just two months in an English-language survey, and circulated mainly in a country with a very dominant monolingual profile. This suggests a high level of interest in this research area from the autistic population. Responses reveal a broad range of numbers of languages known, with variable proficiencies in those languages. Similar to their non-autistic peers, autistic people can know several languages without necessarily becoming highly proficient polyglots. While some participants were raised in bilingual or multilingual households, we also revealed that successful acquisition of a second language can also occur later in life, and even in adulthood. Likewise, childhood trilingualism is also possible in autism, as well as the late acquisition of a third language during adolescence or adulthood, which could be linked to the study of foreign languages at school. To the best of our knowledge these language experiences have not yet been presented in autism research. Taken together, while this study, especially targeting bilingual and multilingual autistic adults, does not claim that this sample is

representative of the whole autistic population in term of proportion of language profiles (for example in term of number of languages known), our results show that a wide diversity of language profiles does exist.

Overall our research suggests that there are areas of language research in autism that require greater investigation. For example, there is a need for better comprehension of the cognitive impact of early multilingualism – not only bilingualism – in autism, as well as more research into the potentially specific support needs of families with autistic children growing up in a multilingual setting. With language acquisition also occurring after childhood, it is interesting to consider the cognitive skills required for late language acquisition in autism, as well as best practices to support language learning for autistic people outside of the family environment.

In models investigating monolingual, bilingual and multilingual respondents, respondents with proficiency in two or more languages rated their social life as more satisfactory than their monolingual peers, though this effect is modest. Reinforcing this link, we also found that social quality of life was higher for the multi-lingual group compared with bilingual people. In addition, balanced proficiency between languages also contributed to the fit of our model of social quality of life. Taken together, these results indicate a possible dose-dependent relation between language proficiency and quality of life, such that increasing language knowledge is associated with increasing social life quality. However, there are apparent limits to this effect. There was no evidence that knowing 4, 5 or more languages is associated with even higher satisfaction with social life – though reducing power in this necessarily-smaller group would also influence that result. In addition, older respondents were less satisfied with the quality of their social life. This aligns with previous findings on social and psychological quality of life in autism (Mason et al., 2018), though a recent meta-analysis reported no association between age and general quality of life in autism, indicating that other factors may be more influential predictors (Kim & Bottema-Beutel, 2019). This argument is also relevant when taking into account the small proportion of the social life quality ratings explained by the models (3.2% to 6.6%). While our results show that bilingualism does have a small but significant influence on the social

life quality of autistic adults, other factors, such as coexisting conditions or current family support (Kamio et al., 2013; Lin & Huang, 2017; Vincent et al., 2019) may have a greater impact.

What is the mechanism of these effects of bilingualism? One possibility is that acquiring proficiency in multiple languages requires cognitive and social resources that also confer quality of life benefits in the social domain. However, we found no predictive value of age of acquisition in our models, partly puncturing this notion. If cognitive skills were the underlying cause of both language proficiency and better social life quality, we might expect these effects to be especially pronounced in people who had mastered a second language late in life, rather than those who were raised in bilingual households. Put another way, if there is a positive influence of bilingualism on social life during childhood, acquiring a second or third language later in life seems to carry the same benefits in terms of social life habits. This suggests that an alternative mechanism, such as the social interactive benefits accrued from knowing multiple languages, opening up new communication and communities, is also worth probing in future research.

Limitations

The results of this study are necessarily restricted by the limitations of the cross-sectional, self-report methods used, making it impossible to draw causal inferences, and the circulation of the survey in English. For example, recent male-to-female ratio estimates in autism approach 3:1 (Loomes et al., 2017), and thus are at odds with the gender distribution in our sample, hindering its representativity. However, this overrepresentation of females reflects a regularly reported bias in online studies (Sax et al., 2003; Smith, 2008), including online studies with autistic respondents (Deserno et al., 2017). In addition, for proficiency ratings, it is possible that respondents had a variable and heterogenous understanding of what is an average or a good language proficiency. Although studies have shown that self-rated proficiency is generally accurate compared to standardised language testing (Brantmeier et al., 2012; Edele et al., 2015), this has not been verified in autism. Furthermore, our recruitment strategy focused on the United Kingdom (UK), though some respondents living in other

countries were included. The UK is de facto a monolingual country with high immigration, meaning that our data may reflect the experience of a specific population defined not just by language knowledge and autism but also by high rates of immigration. The country of residence was not included in the analysis because of the distribution of the data. Indeed, 48.8% of the respondents were UK residents, and most other countries contributed 1 to 6 data points (2% or less of the respondents). The only exceptions were the United States of America, with 27% of the responses, and Canada and Germany, each with 4% of the responses (see Table 1 for a detailed account of the countries of origin and residence of the participants). Future research could explore the cultural differences in social life quality in relation to language knowledge, particularly contrasting monolingual and bilingual environments. Indeed, while the diversity of our sample is a strength, more focused examinations of the specific impact of bilingualism in specific demographic or linguistic sub-samples would be of interest. Lastly, as discussed above, several potential confounds linked to social life quality have not been accounted for in the present model, such as gender, level of education, relationship status, maternal support, aggressive behaviours, comorbid psychiatric conditions, and mental health conditions (Kamio et al., 2013; Lin & Huang, 2017; Mason et al., 2018).

Conclusion

This study reveals for the first time the range and complexity of language learning profiles amongst autistic people. We observe an impressive diversity of experiences of language learning across the lifespan, and variability in both proficiency and context of use. Autistic bilinguals and multilinguals are not all linguistic savants, nor all raised in multilingual households. Many have learnt one or more second languages at school or independently, and use them with moderate proficiency, as non-autistic people do. In addition, through statistically robust analyses, we find evidence that proficiency in two or more languages is associated with better self-rated social quality of life for autistic people. The consequences of these results for family decision-making, language education, and lifelong learning should be explored in future studies.

Declaration of Conflict of Interests

Authors declare that there is no conflict of interest.

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Supplementary Materials

Supplementary Materials s1: Autism & Bilingualism Census

The full ABC questionnaire is available at https://osf.io/pksm2/

Supplementary Materials s2: Development of the Autism & Bilingualism Census

The Autism & Bilingualism Census (ABC) was a new online survey designed by the authors. It consists of 4 sections: Section A, General demographic information; Section B, General life satisfaction and social life quality; Section C, Language history; Section D: Open-ended questions. Section B included 4 sub-sections: Social life quality, General life satisfaction, Current mood, and Personality. Only the subsection The SLQ score used as outcome variable in the study is derived from the Social life quality sub-section only. Content for section B Social life quality and section C were inspired by existing, open-access and free-to-use measures of relevant domains. Questions were created drawing on the wording of these measures but adapted to provide a consistent response-format across items, and to be more specifically relevant to the target population (i.e. autistic adults) and research question. For example, items designed to measure language use and exposure in our adult sample were partially inspired by the BiLEC, which was designed to capture these phenomena in children. The table below provides a detailed mapping of ABC survey items against the original measures that inspired the survey. The table covers all items contained within ABC survey sections that are analysed in the current report. We do not claim to replicate the reliability or validity of the original measures in our novel survey, but merely to illustrate how our survey design was grounded in the relevant literature.

1. **Social life quality**

As detailed above, the Social life quality sub-section of the ABC comprised 12 items within Section B of the survey (General life satisfaction and social life quality). Item scores from this section were used to build the Social Life Quality score used as outcome measure in the present study. Supplementary

Table 1 presents a direct comparison between the phrasing of the previously published questionnaires and the ABC Social life quality items. The questionnaires reviewed during design of this section were: the ESS = European Social Survey (ESS Round 8: European Social Survey Round 8 Data, 2016); the WHODAS 2.0 = World Health Organization Disability Assessment Schedule 2.0 (Üstün et al., 2010); and the WHOQOL = World Health Organization Quality of Life assessment (The Whoqol Group, 1995).

2. Language history

The Language History section of the ABC comprised 13 questions characterising language history, encompassing acquisition, proficiency, exposure, use and anything else. Each of the respondent's languages (first to seventh language) were addressed in a separate page, that included all these items. Supplementary Table 1 presents the example question set for the 2nd language. As each ABC item was inspired by multiple questionnaires, this table does not present a direct comparison of the phrasings used. The questionnaires reviewed during design of this section were: the BEQ = Bilingualism and Emotions Questionnaire (Dewaele & Pavlenko, 2001); the BiLEC = Bilingual Language Experience Calculator (Unsworth, 2013); the LEAP-Q = Language Experience and Proficiency Questionnaire (Marian, Blumenfeld, & Kaushanskaya, 2007); the LHQ = Language History Questionnaire (Li et al., 2006)

Table s1. *Construction of the Autism & Bilingualism Census – Social life quality scale and Language History*

	A. Social life quality		
ABC section	ABC item wording	Source Questionnaire	Source Questionnaire item wording
Social life quality	I am satisfied with my personal relationships.	WHOQOL	How satisfied are you with your personal relationships?
	I find it easy to work with other people.	*n/a, new item*	
	I often meet socially with friends, family members or colleagues.	ESS	How often do you meet socially with friends, relatives and work colleagues?
	I have several friends and/or family members with whom I can discuss intimate and personal matters.	ESS	Do you have a friend or relative with whom you can discuss intimate and personal matters?
	I engage online in social activities and/or organisations related to my interests.	*n/a, new item*	
	I participate in person in group activities and/or organisations related to my interests.	ESS	Compared to other people your age, how often would you say you take part in social activities?
	I like to get involved in activities with people I know.	WHODAS 2.0	In the past 30 days, how much of a problem did you have in joining in community activities (for example festivities, religious or other activities) in the same way as anyone else can?
	I like to get involved in activities with people I don't know.		
	I can easily make new friends.	WHODAS 2.0	In the past 30 days, how much difficulty did you have in making new friends?
	I can easily maintain a friendship.	WHODAS 2.0	In the past 30 days, how much difficulty did you have in maintaining a friendship?
	I get along with people who are close to me.	WHODAS 2.0	In the past 30 days, how much difficulty did you have in dealing with people who are close to you?
	I can easily deal with people I do not know.	WHODAS 2.0	In the past 30 days, how much difficulty did you have in dealing with people you do not know?

ABC section	B. Language history ABC item	Questionnaires
2nd Language	What is your second language (L2)?	
	How old were you when you first encountered L2?	BEQ, BiLEC, LHQ
	How did you first encounter L2?	BEQ, BiLEC, LHQ
Current proficiency	How well do you speak L2?	BEQ, BiLEC, LHQ, LEAP-Q
	How well do you understand spoken L2?	BEQ, BiLEC, LHQ, LEAP-Q
	How well do you write L2?	BEQ, LHQ, LEAP-Q
	How well do you understand written L2?	BEQ, LHQ
Past exposure	Past exposure: While learning L2, how much did you speak it with ...? - your mother / or guardian 1 - your father /or guardian 2 - your brothers and sisters - other adults in the household - other members of your family - your friends - people at school / work - people in the community	BiLEC, LHQ, LEAP-Q,
Current use	Current use: With people, do you use L2 …? - with your mother / or guardian 1 - with your father /or guardian 2 - with your brothers and sisters - with your partner - other members of your family - your friends - at school / work - with your flatmates - people in the community	BEQ, BiLEC, LHQ, LEAP-Q
	Current use: In your mind, do you use L2 to ...? - express emotions - swear - remember some information - do maths - think	BEQ, LHQ
	Current use: Do you use L2 when ...? - reading - watching TV / listening to the radio - using computers - tablets - doing other activities outside of home	LHQ, LEAP-Q
Open-ended	Is there anything else you wish to tell us about your L2 past exposure / past or current use?	
Next language	Do you know any other languages?	

Supplementary Materials s3: Language history of the respondents

Table s3.

Respondents' Acquisition and Current Contexts of Use

L	A. Acquisition context, N (%)					B. Current context, N (%)				
	Home	School	Com.	Indep.	Tot.	Home	S/W	Com.	Indep.	Tot.
L2	202 (97.6)	2 (1.0)	2 (1.0)	1 (0.5)	207	201 (96.6)	3 (1.4)	3 (1.4)	1 (0.5)	208
L2	50 (24.0)	86 (41.3)	19 (9.1)	53 (25.5)	208	73 (35.3)	46 (22.2)	13 (6.3)	75 (36.2)	207
L3	13 (11.8)	29 (26.4)	17 (15.5)	51 (46.4)	110	15 (13.6)	24 (21.8)	7 (6.4)	64 (58.2)	110
L4	5 (9.3)	16 (29.6)	5 (9.3)	28 (51.9)	54	6 (11.1)	6 (11.1)	4 (7.4)	38 (78.4)	54
L5	1 (3.6)	10 (35.7)	1 (3.6)	16 (57.1)	28	5 (17.9)	5 (17.9)	0 (0.0)	18 (64.3)	28
L6	2 (14.3)	3 (21.4)	0 (0.0)	9 (64.3)	14	2 (14.3)	1 (7.1)	0 (0.0)	11 (78.6)	14
L7	1 (20.0)	0 (0.0)	0 (0.0)	4 (80.0)	5	1 (20)	0 (0.0)	0 (0.0)	4 (80.0)	5

Note. Some percentages do not sum up to 100% due to cumulative rounding effects.

A. Acquisition context: Number and proportion of respondents who acquired their languages (L) 1 to 7 mostly at home, at school, in the community (Com.), or independently (Indep.), and total number (Tot.) of respondents who indicated a context of acquisition for the language.

B. Current context: Number and proportion of respondents who use their languages (L) 1 to 7 mostly at home, at school or at work (S/W), in the community (Com.), or independently (Indep.), and total number (Tot.) of respondents who indicated a current context of use for the language.