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Do Polyglots Have Exceptional Language Aptitudes?

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Abstract

Recent years have witnessed a growing interest in case studies and surveys by researchers of second language acquisition (SLA) and cognitive (neuro-)science to probe into the group of exceptionally talented multilingual learners or polyglots who can understand and speak an impressive number of multiple foreign languages other than their own mother tongue. The current paper reviews these latest developments and elucidates the phenomenon of (hyper-)polyglottism by tracing and analyzing its definitions and synthesizing and highlighting the key findings of case studies and large-scale surveys. Specifically, we aim to illuminate the complex and intricate relationships between hyperpolyglots' exceptional multilingual talents and their individual differences in language aptitude and other cognitive abilities such as IQ, personality traits, motivational characteristics, and language genetic variations, as well as their brain mechanisms and neural networks. The present paper calls upon concerted efforts from multiple disciplines to determine the critical cognitive abilities and pivotal developmental stages underlying the exceptional performance of these multilingual talents and hyperpolyglots.

Keywords: *Polyglot, Hyperpolyglot, Language Aptitude, Individual Differences, Language Gene, Language Network*

Introduction

“Language aptitude” refers to a set of specific and superior cognitive abilities or potentials that people demonstrate when learning a second or foreign language as opposed to their peers (cf., Carroll, 1990; Doughty, 2019). Language aptitude research in the modern era began with the publication of the Modern Language Aptitude Test (MLAT) by psychologist John Carroll and his colleague, Stanley Sapon, in 1959 (Spolsky, 1995; Stansfield & Reed, 2004). The subsequent 60 years of development are intermingled with both popularity and marginalization of the language aptitude concept (Wen et al., 2017; Wen et al., 2019; Wen et al., 2022). For example, the 1950s were the heyday, but the 1970s and 1980s were regarded as the low tide for language aptitude research. It was not until the beginning of the 21st century that language aptitude managed to regain renewed steam from applied linguistics (especially second language acquisition researchers), educational psychology and cognitive science, and neuroscience (Reiterer, 2018; Wen et al., 2019).

In the last two or three years, language aptitude research has witnessed exponential growth in terms of publications of both empirical papers and theoretical pieces (Doughty & Mackey, 2021; Li & Dekeyser, 2021; Vuong & Wong, 2019; Wen et al., 2022). Researchers from different perspectives have explored aptitude’s multiple components and characteristics, the development and application of aptitude test batteries, and aptitude’s independent and interactional role with other individual differences and teaching methods in predicting or modulating L2 learning outcomes (Li, 2015; Skehan, 2015). Multi-perspective theoretical explorations and experimental investigations are also being conducted extensively (e.g., Doughty & Mackey, 2021; Granena, 2020; Li & Dekeyser, 2021; Reiterer, 2018; Wen et al., 2019; Wen et al., 2022).

There are also new trends emerging in the recent research on language aptitude (Wen et al., 2022). Among these new trends, some applied linguists and cognitive (neuro) scientists have begun to pay more attention to the special individuals or groups of individuals who are learning and speaking multiple languages, i.e., polyglots or hyperpolyglots. Research on these multilingual talents is not new in theoretical linguistics and psychology (Smith & Tsimpli, 1991; Smith et al., 2010, 2013) but has attracted attention from applied linguists and neuroscientists as an emerging perspective on language aptitude (Biedroń & Pawlak, 2016; Biedroń & Birdsong, 2019; Erard, 2012, 2019; Griffiths & Soruç, 2020; Hyltenstam, 2016, 2018, 2021; Moyer, 2021). Given this emerging trend, the purpose of the current paper is to examine their definitions and summarize key findings of relevant case analyses and investigations of these multilingual learners to tease out the underlying characteristics of their language aptitude in tandem with other cognitive abilities such as intelligence and personality as well as their genetic variations, brain mechanisms, neural networks, and other individual difference factors such as L2 learning motivation and L2 identity. We aim to further analyze the theoretical and pedagogical implications of this research on the process and outcomes of their learning of an exceptional number of languages.

Definition of Polyglots and Hyperpolyglots

Throughout history, we have seen or read from time to time the records of linguistic “geniuses” who are proficient in speaking many different foreign languages, ranging from the famous Chinese-American linguistics professor at UC Berkeley (e.g., Chao Yuanren) to the teenage boy who speaks 16 languages to sell souvenirs to international tourists in Cambodia (<https://www.youtube.com/watch?v=hoBcruz1Gac>). In academia, these multilingual-talented individuals are known as "polyglots" or "hyperpolyglots", depending on the number of languages they master. Unless otherwise specified, this paper will use 'polyglots' (Hyltenstam, 2021: 56) as a cover term for closely-related concepts of hyperpolyglots and multilingual talents in the discussion.

In the 19th and early 20th centuries, the term polyglot only referred to people who were fluent in just more than one language (Paradis, 1989, p. 117). Later, with the popularity of professional terms such as bilinguals and multilinguals, the definition of polyglot was redefined. Richard Hudson, a linguist at University College London (UCL), believed that because in some European countries multilingual communities tend to use 5-6 languages for everyday communication, almost everyone was a polyglot. To avoid this confusion, he proposed the concept of "hyperpolyglot" to distinguish from 'multilingual talents'. By definition, 'hyperpolyglots' refer to those individuals who can speak or master six or more languages fluently, other than their own mother tongue (Hudson, 2012, p. 24). At present, most scholars tend to accept Hudson's point of view, that "hyperpolyglots" refer to those who are learning and mastering at least 6 new languages (L2) after adolescence, and these foreign languages should be at an intermediate or advanced level [for example, at least one in the B1 level of the Common European Reference Framework (CERF)]. That is to say, polyglots are individuals who can use these languages with relative fluency and break barriers in communication and oral interactions (Hudson, 2012, 2016; Hyltenstam, 2016, 2018, 2021; Erard, 2012, 2019; Jouravlev et al., 2020).

There are many multilingual talented language geniuses in ancient and modern China and abroad (see Erard, 2012; Hyltenstam 2016, 2018, 2021; Adriana & Birdsong, 2019). Some famous examples include Popes John Paul II and Benedict XVI, as well as writers James Joyce, Tolkien, and Anthony Burgess, and also professional linguists such as Rasmus Kristian Rask, who is believed to speak 25 languages and can read in 35 languages. Griffiths & Soruç (2020) noted that Professor Andrew Cohen, an expert on learning strategies in the field of second language acquisition (SLA), is also an authentic hyperpolyglot who is proficient in 13 foreign languages including Chinese through self-study. Cohen has also presented and published related articles at international conferences about his multilingual talents (Cohen & Li, 2013). In addition, there are many polyglots who are diplomats, the most famous being Emil Krebs who mastered 68 languages in speech and writing and studied 120 other languages (Wikipedia). Today, with the increasing frequency of international communication, it is believed that there will be more and more examples of such polyglots (Erard, 2012). In recent years, relevant groups have organized international multilingual annual conferences and gatherings¹ and held multilingual competitions and other activities². These conferences and gatherings attract

hundreds of multilingual groups from all over the world to gather together, communicate, and share the fun and techniques in learning their multiple languages.

In the past, people believed that a multilingual person who is proficient in many foreign languages must be gifted/talented, that is, have an extraordinarily high language aptitude. Otherwise, it seems impossible to explain their exceptional multilingual talents. But, is this actually the case? Many people are very curious about the reasons for the success of hyperpolyglots. They want to understand whether the key to the success of these multilingual language “geniuses” is determined by language genes or intelligence level? Or, was their fluency with languages achieved through hard work and deliberate practice? At the same time, how is the language aptitude structure of these exceptional multilingual talents different from other ordinary people (such as monolinguals, bilinguals, or multilinguals in Singapore and some European countries)? In order to answer this series of questions related to multilingualism, some researchers in linguistics, applied linguistics, and cognitive science have begun to conduct systematic and in-depth investigations and follow-up analyses of hyper-polyglot individuals and groups in recent years (Smith & Tsimpli, 1993; Erard, 2012; Pawlak & Biedroń, 2016; Hyltenstam, 2016, 2018, 2021). Related research in these areas has gradually attracted the attention of researchers in second language acquisition and cognitive sciences. In the past two or three years, the study of these individuals has developed new perspectives on language aptitude (Doughty & Mackey, 2021; Griffiths & Soruç, 2020; Hyltenstam, 2021).

Polyglots’ Profile of Language Aptitude and Cognitive Abilities

In the 1950s, John Carroll, a pioneer scholar of language aptitude, designed the Modern Language Aptitude Test (MLAT; Carroll & Sapon, 1959) through complex factor analyses and identified four important aptitude components essential for successful foreign language learning. These four cognitive abilities include phonetic coding ability, grammatical sensitivity, inductive learning ability, and associative memory ability (Carroll, 1990). Carroll's MLAT and the four-factor aptitude model provide a solid theoretical basis and assessment instrument for ensuing language aptitude research, until now. Then, in 1998, Skehan combined grammatical sensitivity and inductive learning ability into language analysis ability (LAA). Skehan pointed out that these three factors (phonetic coding ability, language analytical ability, and memory ability) can be used to specifically examine and explain the overall foreign language performance of L2 learners. Among these factors, a notable feature of talented or gifted L2 learners is their exceptional (verbal) memory for lexical retention and obsession with "linguistic forms" (e.g., in the ‘idiot savant’ case, Christopher). Moreover, these talented polyglots generally "have a large number of lexicalized exemplars, their memory systems have considerable redundancy, their lexical expressions are very diverse", and they usually have "exceedingly abnormal memory, especially retention of verbal material" (ibid., p. 233). Skehan also noticed that although these polyglots have an amazing memory for linguistic materials, their abilities in language input or central processing do not seem to be particularly prominent (ibid.).

In recent years, Hyltenstam focused on the study of L2 skills among polyglots in several publications (2016, 2018, 2021). After a comparative survey of 94 polyglots, he found that these

multilingual individuals have the following features (2018, pp. 173-174; see also 2021, p. 57): (1) high level of linguistic competence; (2) high level of language awareness; (3) high level of specific motivation; (4) high level of learning autonomy and self-regulation; (5) high level of cognitive function; (6) high level of systematizing ability; and (7) highly developed insight of sensory details. The results of the survey show that to become a multilingual prodigy, the coordination and cooperation of multiple skills are required to achieve ultimate success (Hyltenstam, 2021). These views are similar to the concept of *aptitude complexes* advocated by Robinson (2005).

Nevertheless, regarding the question of language aptitude, most multilingual talents tend not to admit they have the aptitude for languages (Griffiths & Soruç, 2020). In her memoir *Polyglot: How I learnt language* (2008), the Hungarian multilingual prodigy and translator Kato Lomb (1909-2003) opposed the idea that "language learning requires a talent" (Lomb, 2008, p. 19). She devotes an entire chapter entitled "The linguistic gift" to describe her personal observations and related anecdotes. The author takes the position that there is no such thing as linguistic genius or talent. She believes that complaints like "I don't have a talent for languages" usually just mean that some people have trouble remembering some new words after a few trials. She also postulates that individual differences are not intrinsic or biologically based, but instead depend on the individual's specific learning situation and relevant background. For example, because each person has different resources, time, and motivation, we thus can expect different learning outcomes. These beliefs are illustrated in her so-called "*Ten Commandments*" or "*Ten Requests*" (Lomb, 2008, p. 159) on language learning. For example, Commandment X says, "Be firmly convinced that you are a linguistic genius. If the facts demonstrate otherwise, heap blame on the pesky language you aim to master, on the dictionaries, or on this book, not on yourself." (ibid: 161).

In 2012, Michael Erard, an independent news columnist contributor from California, interviewed 172 hyperpolyglots who were proficient in more than 6 languages and concluded that some of their characteristics were similar to those proposed by Skehan (1998). There are similarities and differences in the language aptitude model. For example, these multilingual "geniuses" seemed to learn grammatical structures and phonological rules very quickly and were especially good at sentence pattern recognition and oral expression. In addition, Erard (2019) found that some of the hyperpolyglots who mastered more than 10 foreign languages were influenced by meta-linguistic knowledge and learner self-awareness. Clearly, future research on hyper-polyglottism should also distinguish the nature of language aptitude from the acquired learning process in which learners' proficiency improves through training or deliberate practice.

Erard (2019) also stated that hyper-polyglottism has other qualities that have not been adequately addressed in the previous literature. For example, these multilinguals can reactivate previously learned vocabulary and language structures very quickly and efficiently. Moreover, they can switch between various languages proficiently and freely in their daily language repertoires. These polyglots seem able to learn languages anytime, anywhere, and keep changing their learning methods as they age for better results. Of course, not all hyper-polyglots have the

same set of talents. For example, some can imitate the pronunciation of native speakers, but not all of them can perform this task. Some seem to be more focused on learning multiple foreign languages within the same typologies. This finding raises another question that needs to be further explored by the academic community, that is, whether there is a group of learners who are particularly suitable for learning certain types of foreign languages (Dediu, 2015).

To sum up, the in-depth observations and survey results of polyglots mentioned by Erard show that although these polyglots demonstrate some similarities or overlaps with language aptitude, we cannot directly use their aptitude profile or test scores to explain their multilingual talents. In the future, it will be necessary to further clarify the relationships between the four essential components of language aptitude identified by Carroll and the characteristics of (hyper-) polyglots. In addition, it will be necessary to explore further other cognitive abilities of polyglots and investigate the interaction between their cognitive abilities and different learning and teaching methods. For example, many previous studies in the field of second language acquisition have noted that the *frequency* of language use is one of the main keys in the early stage of foreign language learning (Ellis, 2002). At the same time, the affordances of learning resources are also very important. Learning a foreign language involves the use of many teaching materials and multiple experiences with a language. Even if a person has a talent for languages, it is difficult to achieve much if he/she has no opportunities to come into contact with speakers of that language, to buy books to read in that foreign language, and perhaps not even able to travel to the countries whose languages are being learned. Fortunately, the advent of the Internet has greatly increased individuals' exposure to foreign languages. Of course, the efficiency of language learning is also a key point. In the past, many people learned grammar, vocabulary, and syntax mechanically through books (as in the traditional teaching method of grammar-translation), which runs counter to the natural course of (native) language learning in which language is used as a means of communication. Thus, the currently prevalent functional- or usage-based approaches may hold better promise in lending their implications to language teaching and education (e.g., Tyler, 2010).

The Personality Characteristics and Motivation of Polyglots

Tim Keeley from the School of Intercultural Management, Kyushu Sangyo University in Japan is proficient in more than 30 languages, making him a real hyper-polyglot by all measures. He has been active in participating in polyglot gatherings and publishing papers on foreign language learning (Keeley, 2014, 2019). He believes that in addition to having an effective learning languages method, the learner's personality is also a key factor in determining success in foreign language learning. For example, Keeley argues that the process of learning a foreign language involves a re-shaping of one's self-identity and that the best linguists are mostly '*linguistic chameleons*' who are adept at acquiring new personalities. According to Keeley, learning a foreign language requires the learner to substitute roles and formulate new connections in memory and the process may also create neurological barriers and cause confusion with one's native language. In a questionnaire study, Keeley (2014) examined the 'ego-permeability' (i.e., the self-permeability of linguistic boundary) of Chinese learners of Japanese to find out whether

they have an open mind to accept foreign linguistic input readily. As he hypothesized, those with higher Japanese proficiency generally have higher scores in self-permeability (which means they allow the permeation of foreign languages and cultures). In addition, Keeley pointed out that multilingual learners should have a meta-linguistic awareness to distinguish each language, culture, and related experience in their heads in order to use these languages without confusion (cf. Hyltenstam, 2021).

Conventional wisdom generally holds that our primary purpose in learning and using language is for purposes of communication and building up interpersonal connections. But many polyglots seem to defy this rule as quite many of them are not masters of communication, with some being extroverts while many of them are introverts or even tend to be autistic (e.g., Christopher as described in Skehan, 1998). Some are keen on capturing linguistic signals as fun games. Neuroscience research has also found that the mode by which polyglots process information is indeed different from ordinary people who do not speak that many foreign languages. For example, their brain-based language networks are much more efficient (e.g., Jouravlev et al., 2021). In addition, the majority of the polyglots are almost exclusively male, all have highly selective memory (reserved only for collecting verbal materials), and many have even developed symptoms of Autism Spectrum Disorder (ASD; Biedroń, 2019; Biedroń & Birdsong, 2019; Hyltenstam, 2018 & 2021), though as Fedorenko (2022) cautioned in her interview that we also need to be aware of the differences in the gender-based encouragement culture that has explained this imbalance.

Cognitive and Genetic Traits of Polyglots

Biedroń (2019) explained that multilingual talents share certain characteristics with other gifted people, including cognitive factors such as extraordinary verbal memory (especially memory for words), high analytical ability, excellent executive function, and superior speech skills. But, there has been little research conducted on the intelligence (IQ) of polyglots. Existing case studies show that their IQs are unevenly distributed, although their verbal intelligence seems to dominate (Biedroń, 2012). In terms of learning styles, polyglots seem to be effective systematizers (cf. Baron-Cohen, 2002), that is, they are good at organizing and systematizing learning language resources and materials. They enjoy discovering patterns and rules, making predictions, and looking for exceptions (Hyltenstam, 2021).

One may ask if a polyglot's linguistic talent is linked to some kind of gene? Researchers generally believe that this type of research is challenging to conduct due to several difficulties (e.g., Erard, 2019). First, to conduct genetic research on polyglots or hyperpolyglots, a large number of participants would be needed, and they are hard to come by. Second, even when some individuals may indeed possess a multilingual gene, they may not have the ability to leverage their multilingual talents due to other factors such as the lack of language environment, lack of educational resources, and lack of enthusiasm for language learning. Of course, the biggest challenge for the study of polyglots is that although researchers have found many genes related to language impairment (Mountford & Newbury, 2017), they have not found genes related to the

stability of language ability (St. Pourcain et al., 2014). So far, gene linkage and candidate gene sequencing studies have found that 22 genes are associated with language disorders, but only three are monogenic drivers (FOXP1, FOXP2, and TM4SF20) of language disorders (Mountford & Newbury, 2017). Gene mutations cause a lack of a certain encoded protein, which in turn leads to language barriers (ibid.). Such genetic variants are found in a single family only (e.g., the K.E. family in London; Fisher et al., 2003) and are unlikely to recur (Graham & Fisher, 2015).

In addition to focusing on language disorders and genes, there are also researchers exploring the relationship between language ability and genes. Harlaar et al. (2014) explored the genetic mechanism of 12-year-old children's receptive vocabulary ability. Although there were as many as 2329 participants, no genes were found to be significantly related to this ability. The authors concluded that there is not a specific gene associated with language ability. In the same year, St. Pourcain et al. (2014) conducted a genetic study of lexical expression ability in 8889 infants, ages 15-18 months, and 10,819 infants, ages 24-30 months. They found an association with a single nucleotide polymorphism (nucleotide sequence polymorphism due to a single nucleotide change) at the 3p12.3 site near the gene ROBO2.

Some researchers have taken a different approach, suggesting that language disorders and developmental disorders often co-occur, so they have explored whether there is some kind of genetic defect shared between the two. Working memory is most closely related to multilingualism, so some researchers have also explored genes related to working memory ability (Friedman et al., 2008; Blokland et al., 2011). Friedman et al. (2008) studied the genetic association of three executive functions in twins: the capacity to inhibit or suppress dominant responses, the capacity to update working memory representations, and the capacity to switch between tasks. They found that these three executive functions were derived from a highly heritable factor (99%), and therefore believed that an individual's executive control abilities may be genetically determined. Blokland et al. (2011) combined functional magnetic resonance imaging (fMRI) scanning technology and genome-wide association analysis to study the gene associated with the working memory-based *N-back* task and found that the single nucleotide polymorphism of the gene BANK1 could explain 5.5% of the variation found in the supramarginal gyrus (SMG). Meanwhile, the authors also found that 31 different other single nucleotide polymorphisms (SNPs) were significantly associated with changes in the cerebral blood oxygen ratio.

From this point of view, although genetic research of polyglots has just started and has faced various challenges such as large sample size requirements, progress has been made in the past decade, especially with the combination of neuroscience technology and genetic analysis methods. The behavior-brain-gene association of communication provides scientific evidence for understanding the underlying reasons for the multilingual advantages (Dediu & Ladd, 2020; Wong et al., 2020). Future research thus could link polyglottism with language aptitude, including accurately defining its neural phenotype, obtaining genetic samples, and exploring whether the presence of associated genetic variants in the genome has significant phenotypic statistical power. That said, the study of gene-language phenotypes is still in its infancy (see

Erard, 2019 for details) and faces numerous challenges (Mountford & Newbury, 2017). Research on the genetic components of polymorphic genes and language aptitude still needs to be clarified, and the human genome, at least so far, has not identified a signal between genetic variation and any linguistic abilities (St Pourcain et al., 2014). Moreover, although some progress has been made in the development of genetic phenotypes, most are still unknown, so it is necessary to further explore the opportunities and challenges of gene exploration for polyglots and multilingual talents.

Brain Mechanism and Neural Network of Polyglots

Early research on polyglots usually applied qualitative research methods, especially the case study approach, supplemented by online or on-site questionnaires (Erard, 2012, 2019; Hyltenstam, 2016, 2018, 2021; Noprival et al., 2021), coupled with the use of long-term in-depth, follow-up observations and interviews with individual multilingual talents (e.g., Smith & Tsimpli, 1991, 1993; Smith et al., 2010, 2013). In recent years, some researchers have begun to use fMRI to analyze the brain mechanism and language neural networks of polyglots, and have achieved some encouraging results (Jouravlev et al., 2021).

For more than a decade, Dr. Evelina Fedorenko (2022) of MIT has used fMRI to observe the brain activity of monolingual/native, bilingual and multilingual language speakers, including polyglots and hyperpolyglots. Her team found that when participants were tested in their native language, there was less cortical activity corresponding to language processing, indicating that language comprehension among polyglots was less effortful. But as the processing of a new language became more difficult, more neural activity was detected. When language processing became increasingly difficult, especially when the input was inexplicable words (meaningless babbling), the brain activation level dropped again, representing that the brain may have completely "abandoned" making further efforts to process.

Regarding findings related to polyglots, the researchers found that polyglots' processing of unfamiliar languages seemed to be more relaxed (i.e., less responsive) than their typical counterparts. So, the authors speculated that polyglots' multilingual advantage may come from the *efficiency* of their brain networks rather than their superior language abilities per se (cf. Gibson et al., 2019). No matter how difficult the language, they only need to use a *smaller* area of the brain regions to process language than a typical person. That is to say, language processing engages fewer brain tissues among polyglots which in turn consume less neural energy/resources. Another generalization drawn by Fedorenko's team is that some people may believe that learning a foreign language makes a person smarter, but there has been no supporting evidence for this assumption coming from her MIT lab's years of research which generally showed polyglots' IQ and reasoning ability were at comparable levels with typical speakers.

In a recent study of polyglots, Fedorenko and collaborators (Jouravlev et al., 2021) set out to compare multilingual processing among these polyglots/hyper-polyglots with native monolinguals processing as controls. The study recruited 17 native English-speaking polyglots (who were proficient in more than 4 foreign languages in addition to native English) living in the

Boston area of the United States, including 9 hyperpolyglots (proficient in 10-55 languages), all of whom had at least one foreign language at an advanced level. The purpose of the study was to examine whether the neural markers of the language networks of polyglots are different from monolingual controls. For this study, the authors also aimed to examine whether the difference between multilingual and non-multilingual language networks is domain-specific (limited to language networks only) or is reflected in the entire high-level cognitive level, that is, domain-universal or not. The most significant finding of the study was that both the polyglots and the control group are demonstrating similar patterns in their activations of two brain networks, namely the multiple demands (MD) network and the default mode network (DMN). However, polyglots tend to use fewer neural resources to process language, in terms of both degree and scope of neural activation, and this difference is selective, both spatially and functionally for language processing. The researchers postulate that the reduction in activation in language networks is driven by experience, and thus the acquisition and use of multiple languages make language processing generally more efficient.

In the latest large-scale study involving 45 languages in 12 language families (Malik-Moraleda et al., 2022), the group of researchers found that all native languages activated large areas of the participants' left frontal, temporal and parietal cortex in the brain. It was also found that this language-related neural network was stronger and correlated more in the left than the right hemisphere when participants listened to the story (*'Alice in the wonderland'*) in their native languages. Finally, such a 'universal' network was also selective in language processing in that it responded more to linguistic signals (native language) than domain-general inputs (such as spatial working memory or arithmetic tasks).

Theoretical and Practical Implications and Future Research

To sum up, we can tentatively conclude that the exceptional performance of these multilingual talents or polyglots is closely related to their internal cognitive individual differences as well as external learning conditions. These findings can serve as the basis for additional research. First, future researchers should draw on perspectives from different disciplines and adopt advanced research methodologies and assessment tools such as eye-tracking techniques, electrophysiology methods (e.g., ERP), functional neuroimaging technologies (e.g., fMRI), high-density electrocortigraphy (ECoG; Zhu et al., 2022), and even genome sequencing (Erard, 2019; Reiterer, 2018; Vuong & Wong, 2019; Wong et al., 2020). These methodologies and tools can collect data for rigorous triangulation and in-depth investigations into the characteristics and functioning mechanisms of foreign language learning among polyglots, including impacts of cognitive abilities and underlying mechanisms and their predictive validity at different development stages, etc. Looking to the future, genetic and longitudinal follow-up studies will be critical to find out whether the multilingual brains of polyglots are already different at birth or early in development. This initial characterization of multilingual language networks among polyglots opens the door to future research into the cognitive and neural architecture of multilingual “genius”, including how this architecture changes with language experience. This type of research can undoubtedly

broaden the approaches, research scope, and ultimate goals of linguistic research, thus injecting new impetus into second language acquisition research in language aptitude and polyglots.

Second, we believe that *interdisciplinary* perspectives will become the norm for the future development of language aptitude and polyglot research, which will pave the way for designing *personalized* foreign language learning and teaching (Vuong & Wong, 2019). Specifically, the theoretical framework of "personalized learning" aims to identify learners' genetic, neural, behavioral, and other aspects of individual differences in language learning through modern science and technology. Future research needs to probe into these language aptitude factors to establish predictive validity, conduct a comprehensive analysis to describe the learner's language aptitude profile, and then create an optimal personalized teaching model or tutoring program (Vuong & Wong, 2019). The primary advantage of this 'personalized' theoretical framework is that it can fully mobilize the research affecting foreign language learning at different levels, by tracing the causal relationship between its biological variability and language learning results, thus optimizing the conditions for language learning.

Notes

1. Polyglot Conference, Polyglot Gathering, LangFest are the world's three largest annual multilingual gatherings. Polyglot Gathering is held alternately in Eastern European countries every May, and LangFest is held in Monterey, Canada every August. In 2019, the "Polyglot Conference" was held in Asia for the first time and it brought together more than 400 multilingual talents, language fans, linguists, and scholars from all over the world to gather in Fukuoka, Japan. The conference lasted three days featuring language and cultural activities, workshops, and thematic lectures by multilingual research experts, discussing language learning experiences, motivating each other in language learning, and sharing their learning perspectives, experiences, and anecdotes.
2. The International Linguistic Olympiad (IOL) is one of the 13 Olympiad competitions in the world, and its influence continues to expand. Only 6 countries and 9 teams took part in its first event in 2003, which has now gradually expanded to 29 countries and 49 teams last year. Teams are divided into individual competitions and team competitions. Participants must pass the selection competition of their country or region to participate in the IOL. In 2019, the Hong Kong Polytechnic University hosted the first Hong Kong Linguistics Olympiad and organized the Asia-Pacific Linguistics Olympiad in Hong Kong.

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Ethics Declarations

Competing Interests

No, there are no conflicting interests.

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