CHAPTER 10

Conclusions

10.1 Current Issues

The aim of this book has been to provide a systematic review and analysis of the relationship between cognitive control and language in speakers with various language skills. Language skill variations have been examined along two dimensions: language ability and bilingual proficiency. The goal in this chapter is to highlight both general and specific associations between children's cognitive control and language skills within an integrative framework. Although the cognitive control literature has shown extensive growth over the past decade, many theories and conceptual constructs still focus on adults, and there is less information about the development of the cognitive control processes in children. Furthermore, most developmental research has been conducted with typically developing (preschool to school-age) children, providing little information about those at the two ends of the language ability continuum (i.e., children with language talent and children with language impairment) or concerning children who speak minority languages or nonstandard dialects.

As discussed in various chapters of this book, cognitive control performance is influenced by a number of age- and language-related factors, such as children's language input/intake, frequency of use, and age of acquisition, among others. These contributing factors further interact in complex ways with culture and socioeconomic status (SES). Unfortunately, very few studies on cognitive control in children have taken these interactions into consideration. There are many reasons for these limitations in the literature; therefore, the following sections provide examples of major issues and offer solutions to selected problems by identifying and describing patterns of the relationship between various cognitive control components and language.

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10.1.1 Critical Questions

The heterogeneity of the participants and the shortage of sufficiently sensitive, valid tasks are among the most challenging issues for research on cognitive control in children with various language skills. Moreover, these two sets of problems are closely linked because on the one hand, the low level of conceptually driven, well-controlled tasks is a major factor for inadequate selection of participants and the vast heterogeneity of the groups; on the other hand, this diversity hinders the development of sensitive and specific tasks. Even though the following suggestions may seem counterintuitive, we need to extend our research to include children who speak nonmainstream languages; come from various social and cultural backgrounds; and exhibit a range of language skills, in order to identify developmental patterns of domain-general and language-specific cognitive skills. Cross-linguistic studies of grammar in children with DLD have shown us the effectiveness of this approach. Data from a number of languages support distinct theoretical accounts, but there has been no conceptual model that could explain all the performance patterns and error types of children with DLD across languages. The vulnerability of specific linguistic structures differs across languages, and there is an association between general cognitive-linguistic functions and language-specific features (Leonard, 2014; Marton & Yoon, 2014).

In order to create comprehensive models that describe and interpret the relationship between cognitive control and language and develop efficient intervention methods that target both language and cognitive control skills together, we must understand why certain language structures are more vulnerable in one language than in others and determine how those particular structures are linked to different cognitive control components. To achieve these goals, seemingly opposing processes have to be integrated. We must broaden the language spectrum to include young speakers of various languages at a variety of proficiency and ability levels. We also have to design more child-friendly and culturally sensitive tasks, while resolving the issues related to task impurity to enhance our diagnostic and classification accuracy and to decrease the inconsistencies in findings across studies. It is critical to develop new tasks that can assist us in disentangling children's language abilities and levels of proficiency to enhance our identification and classification of children with language talent, particularly in groups that speak minority languages, and to increase the diagnostic accuracy for bilingual children with DLD and children who are emerging bilingual speakers (e.g., English Language Learners [ELL]).

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The initial steps toward the integration of cognitive and linguistic approaches in language learning aptitude tasks are in the right direction, but more research is needed with children who come from various language backgrounds. Our preliminary findings suggest that nonverbal or minimally verbal cognitive control tasks could significantly increase the classification power for bilingual children with DLD and children with language differences, such as ELL. Thus, we should integrate experimental research with individual-differences approaches, even though these two have traditionally been viewed as fundamentally different in the literature (see more details further on).

Simultaneously, task impurity can be decreased by developing tasks through empirical studies that are designed to explore how the control processes are affected in different language groups by the manipulations of conditions, trials, and item types. These manipulations, however, have to correspond to conceptually predetermined control processes and components. A clear match between the targeted cognitive control components and the measures provided by the experimental task must be established. Thus, the boost in diversity has to occur concurrently to the increase in specificity in identifying the underlying mechanisms that are targeted by particular tasks.

10.1.2 Interactions between Cognitive Control and Language

Analysis of the relationship between cognitive control and language has revealed both general and specific patterns. The data on language input and exposure indicate that children's intake of speech-language is highly influenced by their lower- as well as higher-level cognitive functions, such as perception, attention, and memory, in addition to their overall language knowledge and linguistic experience (Badger, 2018; Rowe, 2015). These interactions, however, are also linked to children's cultural background, SES, and other social factors, such as immigration or minority group status (see Figure 4.2 in Chapter 6).

As described in Chapter 7, independent cultures are characterized by analytic cognition and field independent attention, whereas interdependent cultures show more holistic cognition and field dependent attention, as indicated by both behavioral and neurophysiological findings (Chua et al., 2005; Kafetsios, 2019). These differences must be considered when examining the learning styles and strategies of children with different language skills. For example, ELL students are often viewed as students who only need to learn English, so teachers and policy-makers may not consider

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these children's social-cultural background or life experiences. The conceptual framework of intersectionality (language, class, ethnicity, etc.) and policy emphasizes the relevance of the multiple dimensions in ELL students' sociolinguistic background (Jiménez-Castellanos & García, 2017). Thus, the interaction between cognitive control and language is part of a dynamic system that is highly influenced by variations in local and global contexts, such as the social environment and cultural background, as well as by children's previous sociolinguistic-economic experiences. Therefore, it is critical for these influential factors to be considered along with language ability in the evaluation of children's cognitive control skills and the procedures for selecting participants in cognitive control studies.

Moreover, control processes also interact with motivation and emotions, particularly in social situations. These processes have received less attention in the cognitive control literature in children than the core cognitive control components, even though they play critical roles in goal-directed behaviors and in solving conflicts (Inzlicht et al., 2015). As discussed in previous chapters, behavioral regulation involves both emotional and cognitive control. For instance, while negative experiences lead to reduced memory performance, the increase in cognitive control may neutralize negative emotions without impairing memory functions (Gross, 2002; Ochsner & Gross, 2005). Considering that children's ability to regulate emotion is closely linked to their social relationships with peers and positive peer relations are critical during childhood, we need to pay more attention to the interactions between cognitive control and emotions in the future. This is even more critical for children with DLD, who show weaknesses in initiating and maintaining peer relationships and friendships (Conti-Ramsden & Botting, 2004; Marton et al., 2005). Their social problems are certainly related to their language impairment but are further influenced by their difficulties in cognitive control, such as perspective taking, resisting distraction, and poor working memory. While negative social and emotional experiences may contribute to low-level motivation (e.g., "learned helplessness"), positive emotional experiences and friendships could result in increased motivation. An in-depth discussion of the relationship between cognitive control and motivation was beyond the scope of this work, but we know that intrinsic motivation determines quality of learning, the selection of learning strategies, and overall academic achievement (Di Domenico & Ryan, 2017; Singh, 2011).

Another universal feature of the relationship between cognitive control and language can be captured by the reversed pattern of cognitive control

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performance between children with DLD and their typically developing peers or children with a language talent and by significant differences along the language proficiency continuum from emerging bilingual speakers to balanced highly proficient individuals. Despite some inconsistencies in the literature, the overall picture shows that better language abilities and higher levels of language proficiency are associated with more advanced cognitive control skills, especially in attention, memory, monitoring, and resistance to interference (e.g., Abutalebi et al., 2013; Iluz-Cohen & Armon-Lotem, 2013; Marton et al., 2012; 2019). Particular aspects of language, such as vocabulary, show notably strong relationships with certain cognitive control components, especially with working memory and interference control (Gathercole, 2006; Marton et al., 2014). There is converging evidence on the close link between working memory and interference control, as demonstrated by one of the latest accounts explaining the capacity limitations in working memory within an interference model (Lewandowski et al., 2008; Oberauer, 2009). Interference control and vocabulary scores were linked in children who differed in their language abilities (i.e., children with DLD and their typically developing peers) and in their level of bilingual proficiency (Bialystok & Feng, 2009; Marton et al., 2014). Children with larger vocabularies produced fewer interference errors than their peers with smaller vocabularies. Bilingual children showed superior performance compared to their monolingual peers in a conflict paradigm when the difference in expressive vocabulary was included in the analysis (Carlson & Meltzoff, 2008). In addition to vocabulary, language comprehension has also shown strong relationships with working memory and interference control in adults (Van Dyke & Johnson, 2012).

One cognitive control component that appears to be more independent from children's language status, especially after the preschool years, is response inhibition. A number of studies have demonstrated that children with different language abilities and levels of bilingual proficiency perform similarly on tasks of response inhibition (Bonifacci et al., 2011; Laloi et al., 2017; Marton et al., 2012). This contrasting pattern between response inhibition and resistance to interference along the language continuum is particularly interesting in light of the outcomes from the latent variable analysis by Friedman and Miyake (2004). That study suggested a close link between prepotent response inhibition and resistance to distractor interference but no strong association with proactive interference. In contrast, the findings on the relationship between working memory and interference control typically reveal a link to proactive interference.

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Age may be a reason for these dissociations between the findings by Freidman and Miyake and studies on response inhibition and interference control along the language continuum. The latent variable analysis included data from 220 adults (Friedman & Miyake, 2004), whereas the studies that showed no difference in response inhibition but indicated a strong effect in both resistance to distractor and proactive interference involved children (e.g., Laloi et al., 2017; Marton et al., 2012; 2014). Moreover, these childhood studies included participants with sundry language skills (monolingual and bilingual children, children with DLD and with typical language development), whereas no data on adult participants' language abilities or levels of bilingual proficiency were presented in the study by Friedman and Miyake (2004). Therefore, it is crucial for future research to examine the unity and diversity of these inhibitory functions from a developmental perspective along the language continuum.

10.2 Future Research

10.2.1 Using an Individual-Differences Approach

To reduce the inconsistencies in findings related to the substantial heterogeneity of participant groups in both the bilingualism and the language impairment literatures, we must use an individual-differences approach more frequently. Research over the past decades has provided us with a large amount of data showing the critical contribution of heterogeneity to the inconsistent findings in group studies. Procedures for matching and counterbalancing specific participant characteristics have their own limits. Therefore, applying an individual-differences approach to our designs and examining more variables along various continua, rather than within categories, may allow us to more efficiently explore the interactions among the different language and cognitive components as well as the contributions of culture and children's life experiences (Kaushanskaya & Prior, 2015; Marton, 2019). Dynamic and flexible, the individual-differences approach has the potential to capture the cultural and linguistic richness in children's speech-language. Language scientists have already suggested that the examination of associations and dissociations across the language subsystems (vocabulary, grammar, etc.) and their relationship with different cognitive processes from an individual-differences perspective may reveal important information about the underlying architecture of the language system (Kidd et al., 2018).

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Taking an individual-differences approach need not mean giving up on the application of experimental methods, as suggested by some scholars in the literature; conversely, it may encourage researchers to create and study novel and innovative research questions. This approach is not tied to specific measurement types, as previously thought (Sackett et al., 2017). As recommended by Goodhew and Edwards (2019), we can modify experimental tasks to fit into individual-differences designs in order to examine variations among participants along particular dimensions and to test individual-level reliability. This can be achieved by applying continuous measures whenever possible, to capture the spectrum of essential components and processes related to diversity. This approach requires a different mindset because unlike in traditional studies, researchers have to view variability in performance as key information. For example, cognitive control skills may be measured using continuous variables across multiple contexts to capture individual differences, and then statistical models may be used to identify specific patterns (Friedman & Robbins, 2022).

Adapting an individual-differences approach is particularly important for studies on language and cognition across populations because the group-designs (i.e., the comparison of bilingual children to monolingual peers or children with DLD to typically developing groups) strengthen the deficit-model thinking among scholars – a perspective that often leads to the stigmatization of minority, diverse, or so-called atypical groups (Garivaldo & Fabiano-Smith, 2023). Variations in error patterns, learning potentials and strategies, and trade-offs in performance (e.g., trade-off between speed and accuracy), all provide researchers with critical details about human goal-directed behavior. The application of an individual-differences approach and the weakening of deficit-model thinking may lead the bilingualism literature toward diminishment of the "native speaker" bias as well, which is a specific form of the monolingual bias (De Houwer, 2023). This old view idealized monolingualism and contributed to many negative attitudes toward people with diverse language skills (e.g., emerging bilingual speakers and speakers of nonstandard dialects).

Moreover, an individual-differences approach may also dilute the negativity bias among scholars. There is evidence at the behavioral as well as the neural level that negative stimuli have stronger effects on both lower- and higher-level processing than does equally strong positive information (Norris, 2021). A more dynamic and flexible approach that uses diversity as a rich resource may help us to develop a more nuanced and tolerant view and an inclusive attitude towards language variations. To that end, significant changes in mentality toward diversity among researchers, teachers,

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clinicians, and policy-makers should be encouraged through the practice of interprofessional collaborations.

10.2.2 Interprofessional Collaborations

The term "interprofessional collaboration" is used in this section with a broad meaning including interdisciplinary collaborations, multidisciplinary coordination, and transprofessional teamwork (Reeves et al., 2017). Interprofessional collaborations are based on regular discussions and interactions among professionals from different disciplines who value each other's knowledge, expertise, and contributions to the populations with whom they are working. To better understand the dynamic relationship between language and cognitive control, scholars must continue synthesizing behavioral and neural approaches. For instance, as described in Chapter 2, findings from behavioral studies suggest a gradual separation of cognitive control functions throughout childhood and adolescence. Concurrently, at the neural level, both segregation and integration of brain connectivity are apparent. Interprofessional collaboration is needed to identify the specific processes in brain networks that affect and shape the developmental course of differentiation across cognitive control components. An individual-differences approach using a variety of tasks could help an interprofessional team to better explore how brain networks become more task-specific with development.

Collaborations, however, may be adversely affected by differences in training, perspectives, attitudes, and misunderstandings about the roles of each professional within the team, especially in hierarchically structured settings where unequal power relations might exist (Baker et al., 2011). Interprofessional education may be needed to highlight that in teams, particularly in interdisciplinary ones, all professions have their own and equally important roles. As demonstrated in Chapter 9, the lack of interprofessional collaborations led to the widespread use by educators and clinicians of certain cognitive training strategies and techniques without verified effectiveness. Thus, clients have paid for products and interventions that had questionable outcomes. Seeing these negative examples, researchers from both fields, neuroscience and education, have started collaborations to link basic research findings to educational practice (Hruby, 2012). These interprofessional collaborations inspired the development of numerous neuroscience-based approaches for educational and clinical practices.

Finally, the dissemination of results across disciplines is critical. Publishing interdisciplinary work requires, not only the presentation of

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each discipline's perspective, but the integration and synthesis of ideas and methods. The research community has to make every effort to overcome publication biases. Researchers and practitioners must have confidence that their work can be published, even if they report unexpected or contradictory results, particularly if the research involved disadvantaged communities, speakers of minority languages, and participants from ethnically and culturally diverse backgrounds.

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