Editorial

New Digital Technologies for Diagnosis and Rehabilitation of Neurodevelopmental Disorders

Francesca Borasio [1,2], **Sara Mascheretti** [1,3] **and Maria Luisa Lorusso** [1,*]

1   Unit of Neuropsychology of Developmental Disorders, Scientific Institute IRCCS E. Medea, 23842 Bosisio Parini, Italy; francesca.borasio@lanostrafamiglia.it (F.B.); sara.mascheretti@lanostrafamiglia.it (S.M.)
2   Department of Psychology, Catholic University of the Sacred Heart, 20123 Milan, Italy
3   Department of Brain and Behavioral Sciences, University of Pavia, 27100 Pavia, Italy
*   Correspondence: marialuisa.lorusso@lanostrafamiglia.it

In recent years, partly due to the SARS-CoV-2 pandemic, the use of new technologies in clinical activity has increased. Due to the complexity of neurodevelopmental disorders (NDDs) and of their assessment, treatment technology can play a relevant and sometimes crucial role. On one hand, tele-health applications allow for the assessment of several cognitive skills without requiring children to frequently and repeatedly access clinical services. On the other hand, new technological developments can also offer completely new approaches to in-person assessment and rehabilitation.

The aim of this Special Issue is to offer an updated overview of the multidisciplinary work on new technological solutions for the assessment of cognitive skills in children with NDDs, and their empowerment, allowing for flexible and yet highly accurate and reliable management of their clinical needs. The ten studies collected here provide new, interesting perspectives on the role of new technologies in the assessment and treatment of children with different NDDs.

The contribution of Alduais and colleagues [1] does not directly address the use of technology in assessment or treatment but, rather, focuses on the role of scientometric research methods applied to the collection of information about specific pathological conditions. This rather new technique exploits digital technology to create profiles of the pathologies that may guide diagnostic processes. As described in the article, the goal of scientometrics is to explore the numerical aspects of generating, disseminating, and using scientific information in order to better understand the mechanisms governing scientific research on a given topic in a given period and may provide deeper insight into the social aspects of scientific enterprises. The authors apply scientometric techniques to the study of pragmatic language impairments. They highlight the importance of gathering data from multiple sources and including a diverse range of scientometric indicators in order to generate more detailed and informative insights. Such an approach could ensure that scientometric studies are more comprehensive and reliable and may further help in identifying knowledge gaps and supporting evidence-based decision making within the scientific and clinical communities.

Four studies explore the use of digital technology in assessment procedures; among these studies, three specifically address the challenges of tele-assessment. Rivella et al. [2] present a new tool for the tele-assessment of executive functions (TeleFE) in children aged 6–13. More precisely, the authors compare the remote and in-person modality of TeleFE, showing no significant effect of the assessment modality. The paper further addresses the advantages and limitations of tele-assessment procedures, listing among their shortcomings (i) the difficulty of using them with children under 6–7 years and (ii) the need to monitor the child's behavior during the remote test in order to be able to immediately detect their difficulty and support them in facing it. The use of question-naires as additional, integrative measures is also supported. In the study by Eikerling

and colleagues [3], a new web-based platform called MuLiMi was designed and implemented for the early identification of the risk of developmental language disorders (DLDs) in bilingual children through a battery of tests administered (either remotely or in person) in the child's L1 and L2, selected according to specific clinical markers in each language. The results showed that the scores obtained on MuLiMi screening tasks were significantly associated with those obtained on standardized language tests and could reliably contribute to DLD risk identification. Moreover, the study shows how remote assessment can also be applied to children as young as preschool age, provided that parents, teachers, or other caregivers support and assist the child through the screening procedures. This study, too, highlights the desirability and usefulness of integrating the results of direct assessment with parents' and teachers' questionnaires. Tan et al. [4] provide an overview of the use of the Alif–Ya Assessment Battery, which was specifically designed for the identification and diagnosis of intellectual disabilities in Saudi Arabian children and adolescents based on various theories of intelligence. The results show the potential of computerized assessments to accurately, efficiently, and easily evaluate different cognitive processes in multiple clinical settings. Some of the subtests showed a greater sensitivity to the presence of intellectual disorders, whereas others suffered from the presence of floor or ceiling effects in given age groups. Nonetheless, the results generally illustrate how the use of flexible combinations of hardware types and operating systems may provide clinicians with a greater capability to work with children under new and emerging circumstances and may also allow children with special learning and clinical needs to maintain access to clinical services for assessment and treatment from a distance and under non-conventional conditions. Finally, the technology applied by Borsos and colleagues [5] for automatic emotion recognition is particularly innovative but, at the same time, particularly challenging. The authors explored the test–retest reliability of a specific automated emotional facial expression analysis (AEFEA) software package (Noldus FaceReader 8.0—FR8) in typically developing children and children with autism spectrum disorder. Although the test–retest reliability of FR8 was not perfect, it was generally high. Together, these results call for further investigation of the putative factors affecting test–retest reliability, possible ways to improve it, and the possible relationships between data reliability and validity. An interesting suggestion from this study concerns the potential of repeated analyses that can lead to the "stabilization" of emotion intensity datasets in at least some of the cases where the FR8 initial reliability is low. More generally, the paper draws our attention to the need for a thorough investigation of the psychometric properties of AEFEA systems.

Complementary to the use of technologies for assessment, other articles address the issue of technologies applied to intervention. Two systematic reviews and three original research papers focus on the usefulness of technologies in empowerment programs and home-based activities. Marinelli and colleagues [6] review studies on serious games (SGs) used to improve learning and cognitive skills. SGs have been found to be effective in enhancing reading and metaphonological skills in children with learning disorders and ensuring high levels of engagement and enjoyment, even if generalization to untrained activities is not always satisfactory, and the range of abilities addressed is still limited. Moreover, the gamification aspects, such as the graphics and user interface, should be improved. The systematic review by Panero and colleagues [7] focuses on innovative digital technologies in the characterization of neuromuscular and movement disorders. Wearable devices have proven to be a suitable solution for physical activity monitoring during daily routines, home monitoring, and tele-rehabilitation. Among the putative objective measures, inertial measurement units have allowed the assessment of remediation outcomes in individuals with Duchenne muscular dystrophy.

The use of tangible user interfaces (TUIs) for the Internet of Artefacts (IoA) for health applications (in particular, for speech and language therapy) has been explored by Santos et al. [8]. The results from a systematic literature review, a focus group, and a nationwide

questionnaire are used to determine the system requirements for an artefact prototype to be developed for children with speech sound disorders (SSDs). The literature review has led the authors to identify technological solutions (including Internet of Things—IoT, TUI, and applications), a social approach, and/or gamified activities as the main solutions that could be adopted under the intervention or post-intervention approach. Focus groups and questionnaires showed clearly that therapists wish to have access to more and better-designed tools, including TUI and IoT; however, these tools should allow for the personalization, localization, and translation of activities and should not disrupt the social fabric of the home environment. A randomized, controlled non-inferiority trial conducted by Zwitserlood and colleagues [9] among children with developmental language disorders (DLDs) showed that a vocabulary intervention using the "My PlayHome" tablet game had a similar efficacy to that achieved via an intervention using real objects. Cancer et al. [10] investigated the contribution of the visual component (i.e., the presence of a visual cue supporting rhythmic synchronization) to the training transfer effects of Rhythmic Reading Training (RRT), a music- and rhythm-based computerized intervention program for developmental dyslexia. The results showed significant reading improvements in both RRT conditions compared to the no-treatment condition, while no significant differences were found between the visual–auditory and the only-auditory conditions of RRT in reading, rapid naming, phonological, rhythmic, and attentional abilities.

We believe and hope that this Special Issue can provide readers with useful insights into the topic of technology applied to the assessment and treatment of NDDs and can inspire possible future steps in research and intervention.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Alduais, A.; Alfadda, H.; Allegretta, S.; Trivkovic, T. Pragmatic Language Impairment: A Scientometric Review. *Appl. Sci.* **2023**, *13*, 9308. [CrossRef]
2. Rivella, C.; Ruffini, C.; Bombonato, C.; Capodieci, A.; Frascari, A.; Marzocchi, G.M.; Mingozzi, A.; Pecini, C.; Traverso, L.; Usai, M.C.; et al. TeleFE: A New Tool for the Tele-Assessment of Executive Functions in Children. *Appl. Sci.* **2023**, *13*, 1728. [CrossRef]
3. Eikerling, M.; Andreoletti, M.; Secco, M.; Luculli, B.; Cha, G.; Castro, S.; Gazzola, S.; Sarti, D.; Garzotto, F.; Guasti, M.T.; et al. Remote Screening for Developmental Language Disorder in Bilingual Children: Preliminary Validation in Spanish–Italian Speaking Preschool Children. *Appl. Sci.* **2023**, *13*, 1442. [CrossRef]
4. Tan, M.; Li, N.; Mourgues, C.; Hart, L.; Qataee, A.; Grossnickle, M.; Errato, C.; Grigorenko, E. Using Technology for the Efficient and Precise Assessment of Cognitive Skills in Countries with Limited Standardized Assessment Instruments: A Report on the Case of Saudi Arabia. *Appl. Sci.* **2022**, *12*, 1617. [CrossRef]
5. Borsos, Z.; Jakab, Z.; Stefanik, K.; Bogdán, B.; Gyori, M. Test–Retest Reliability in Automated Emotional Facial Expression Analysis: Exploring FaceReader 8.0 on Data from Typically Developing Children and Children with Autism. *Appl. Sci.* **2022**, *12*, 7759. [CrossRef]
6. Marinelli, C.V.; Nardacchione, G.; Trotta, E.; Di Fuccio, R.; Palladino, P.; Traetta, L.; Limone, P. The Effectiveness of Serious Games for Enhancing Literacy Skills in Children with Learning Disabilities or Difficulties: A Systematic Review. *Appl. Sci.* **2023**, *13*, 4512. [CrossRef]
7. Panero, E.; D'Alessandro, R.; Cavallina, I.; Davico, C.; Mongini, T.; Gastaldi, L.; Ricci, F. Wearable Inertial Devices in Duchenne Muscular Dystrophy: A Scoping Review. *Appl. Sci.* **2023**, *13*, 1268. [CrossRef]
8. Santos, J.; Vairinhos, M.; Rodriguez, J.; Jesus, L.M.T. Home-Based Activities for Children with Speech Sound Disorders: Requirements for a Tangible User Interface for Internet of Things Artefacts. *Appl. Sci.* **2022**, *12*, 8971. [CrossRef]

9.   Zwitserlood, R.; Harmsel, M.t.; Schulting, J.; Wiefferink, K.; Gerrits, E. To Game or Not to Game? Efficacy of Using Tablet Games in Vocabulary Intervention for Children with DLD. *Appl. Sci.* **2022**, *12*, 1643. [CrossRef]

10.   Cancer, A.; De Salvatore, M.; Granocchio, E.; Andreoli, L.; Antonietti, A.; Sarti, D. The Role of Auditory and Visual Components in Reading Training: No Additional Effect of Synchronized Visual Cue in a Rhythm-Based Intervention for Dyslexia. *Appl. Sci.* **2022**, *12*, 3360. [CrossRef]