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ORIGINAL RESEARCH

Psychometric Features of the Arabic Version of the Children's Communication Checklist (CCC2)

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Background: The Children's Communication Checklist-Second Edition (CCC-2) uniquely assesses overlooked communication elements such as pragmatics and context use, which are rarely addressed by conventional language assessments. This study focuses on the psychometric assessment of the CCC-2's Arabic version, tailored to evaluate communication challenges in Arabic-speaking children.

Aim: This study aims to validate the Arabic version of CCC-2 by testing its reliability and validity specifically for three higher-order constructs: Specific Language Impairment (SLI), Social Communication Disorder (SCD), and Impaired Behaviour within the Arabic-speaking population.

Methods: A total of 121 participants in Saudi Arabia, showcasing diverse age and gender distributions, participated in the validation process. The study employed a Reflective-Reflective Higher-Order Construct (R-R HOC) model using partial least squares-structural equation modeling (PLS-SEM) to ensure content validity and cross-cultural adaptation of the translated items. Metrics such as Cronbach's alpha for reliability and Average Variance Extracted (AVE) for convergent validity were specifically examined.

Results: The study confirmed the reliability and validity of the Arabic CCC-2, demonstrating robust psychometric properties, with Cronbach's alpha and AVE scores indicating satisfactory reliability and convergent validity across constructs. Structural model evaluation further supported the strong interrelations among the constructs of SLI, SCD, and Impaired Behaviour.

Conclusion: The results substantiate the Arabic CCC-2 as a reliable and valid tool for assessing communication challenges in Arabic-speaking children, particularly for diagnosing SLI, SCD, and Impaired Behaviour.

Implications: The validated Arabic CCC-2 has significant potential for application in clinical and educational settings and suggests directions for future research to explore its utility further in diverse clinical populations.

Keywords: Children's Communication Checklist-Second Edition, psychometric validation, language impairments, psychometric properties, construct validity

Introduction

The identification of communication weaknesses in Arabic-speaking children is vital due to their significant impact on social and educational performance. These children often encounter barriers to effective communication, which can lead to isolation, decreased self-esteem, and adverse mental health outcomes. In educational settings, poor communication skills may result in difficulty following instructions, participating in Discussions, or understanding educational material, ultimately affecting long-term academic and career opportunities. Early childhood, a critical period for language acquisition and cognitive development, underscores the need for early and precise identification of communication issues to facilitate effective interventions.

Current diagnostic tools often reflect Western cultural and linguistic norms and may not fully capture the unique aspects of the Arabic language and culture. The Children's Communication Checklist (CCC) and its updated version, CCC-2, developed by Bishop in 2003,[1] are designed to evaluate a broad spectrum of communicative skills, including

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speech, syntax, semantics, coherence, and pragmatics. However, for these tools to be effective in Arabic-speaking populations, they require cultural and linguistic adaptation to ensure they measure relevant constructs such as Specific Language Impairment (SLI), Social Communication Disorder (SCD), and related behavioral difficulties accurately.

Research underscores the significance of tailoring communication assessments to specific cultural contexts. Dall et al emphasize the link between social communication difficulties and mental health issues, advocating for early detection and targeted intervention.[2] Studies by Rice and Graham et al demonstrate the academic challenges faced by children with SLI,[3,4] while Adlof connects poor language skills with reading difficulties.[5] Further, Nudel et al and Vacas et al explore how language deficits extend beyond traditional diagnoses,[6,7] impacting children with neurodevelopmental disorders such as autism spectrum disorder (ASD), highlighting the need for assessments that can distinguish between various communication disorders, including the unique challenges posed by SCD as discussed by Izaryk et al, Mulrine and Kollia (2020), and Gabbatore et al.[8–10]

This study responds to these gaps by rigorously assessing the Arabic version of CCC-2, focusing on its reliability and validity in measuring communication challenges unique to Arabic-speaking children. By evaluating constructs such as SLI, SCD, and related behavioral difficulties, this research aims to expand the diagnostic tools available for this demographic, thereby improving their educational outcomes and social integration. The validation of CCC-2 in an Arabic context is crucial, not only for enhancing academic and social outcomes but also for contributing to the broader field of culturally responsive psychometric assessments.

Purpose of the Present Study

This study aimed to rigorously test the validity of the Arabic version of the CCC-2 by conducting a comprehensive psychometric assessment. Specifically, the investigation sought to ensure that the Arabic adaptation accurately measures communication challenges in Arabic-speaking children. The study focused on validating the CCC-2 through the assessment of SLI, SCD, and Impaired Behaviour constructs. By employing a Reflective-Reflective Higher-Order Construct (R-R HOC) model using partial least squares-structural equation modelling (PLS-SEM) for construct validity procedures, the study aimed to establish the reliability and validity of the Arabic version of CCC-2, crucial for accurate assessment and understanding of language impairments and SCDs in Arabic-speaking children.

Method

Sample

A total of 141 individuals initially engaged with the questionnaire. However, 19 participants were subsequently excluded due to incomplete responses. At the conclusion of the first section of the questionnaire, which gathers biographical information, respondents were presented with a critical eligibility question: “Is the child capable of constructing simple sentences by combining words?” This question serves as a filter, as the survey is specifically tailored for children who possess the ability to form basic sentences. Should a respondent indicate that the child is unable to do so by selecting “No”, the questionnaire system is programmed to terminate the session immediately, preventing access to subsequent sections. This automated closure ensures that only data from suitable candidates are compiled. Consequently, the aggregate number of participants who successfully completed the entire questionnaire amounts to 121, as demonstrated in the summary that follows.

Participants

The participant age distribution in the study indicates a range from 4 to 16 years old. The most represented age group is 7 years old, accounting for 14% of Participants, while the least represented are ages 14 to 16, each constituting 2.5% of the total. Ages 4, 5, and 8 each have a significant presence in the study, with each group comprising over 11% of participants. Overall, the age distribution showed a slight skew towards younger ages, with 63% of participants falling within the 4–8-year range. In the study, the distribution of participants by gender shows that males represent a majority with 80 participants, making up 66.1% of the total. Females account for 41 participants, constituting 33.9% of the Sample. This indicates a gender imbalance in the participant pool, with nearly twice as many males as females. This gender imbalance, with nearly twice as many males as females, reflects the greater accessibility and willingness of male participants in the communities where the study was conducted.

Most respondents to the questionnaire were brothers or sisters of the children (n = 83), accounting for 68.6% of the total participants. Fathers (n = 10) and mothers (n = 12) also took part, representing 8.3% and 9.9% of the responses, respectively. Instructors (n = 7) were responsible for completing 5.8% of the questionnaires, while speech therapists (n = 9) filled out 7.4%. This variety in respondents' relation to the children indicates a diverse set of perspectives included in the study.

The sample size was determined based on the guidelines for PLS-SEM, requiring a minimum sample size of 10 times the largest number of structural paths directed at a single construct, which in this case was four, leading to a minimum sample size of 40. To enhance statistical power and accommodate potential dropout, we increased this number, guided by a G*Power analysis recommending 120 participants for detecting medium-sized effects with an alpha of 0.05 and a power of 0.90. Accordingly, 141 participants were initially recruited, with 121 completing the survey, thus exceeding the threshold necessary for robust analysis. This sample size ensures sufficient power for the tests conducted, contributing to the reliability and generalizability of the study findings across Arabic-speaking pediatric populations.

Instrument and Theoretical Background

The study uses the CCC-2 by Bishop (2003).[1] CCC-2 is a refined tool designed to gauge various communication elements that conventional language assessments might miss. This evaluation instrument is composed of 70 statements spread over 10 lower- order constructs LOCs and is typically filled out by a child's parent or caretaker. However, educators or specialists familiar with the child can also contribute valuable insights. The initial 50 statements are mixed across categories and spotlight the child's communication challenges, while the final 20 statements shine a light on their communication strengths. In this study, we used the first 50 items that measure children communication weaknesses. Each construct is measured using five items that indicate the child' communication weakness. The remaining 20 items, which focus on communication strengths, were excluded as they do not align with the primary diagnostic focus of this research.

CCC-2 encompasses ten constructs essential for assessing communicative abilities in children. Speech within the CCC-2 framework refers to the fluency, articulation, and phonological aspects of verbal communication, emphasizing how sounds and words are produced. Syntax involves the rules and structures that govern sentence formation, focusing on grammar and the orderly arrangement of words. Semantics, another critical construct, pertains to the meanings of words and phrases and their correct usage within context, assessing the child's understanding and application of language meaning. Coherence measures the logical flow and clarity of communication, ensuring that the child's speech is understandable and sequentially logical. Inappropriate Initiation addresses the social appropriateness of starting conversations, highlighting situations where communication may be contextually unsuitable or awkward. Stereotyped Language looks at the repetitive or formulaic use of language, which may lack the spontaneity typical of most conversational speech. The Use of Context evaluates how effectively a child uses both linguistic and non-linguistic cues to comprehend and produce communication appropriately within various social settings. Nonverbal Communication assesses the use of body language, facial expressions, and other non-verbal signs that support or substitute for verbal communication. Social Relations examines the impact of communicative abilities on social interactions and relationships, considering how effectively a child communicates within peer groups. Lastly, Interests are assessed to determine how personal preferences and focus areas influence communication, particularly in how topics are selected and discussed in social interactions. Each of these constructs provides a comprehensive framework for identifying various aspects of communication challenges, thereby facilitating targeted interventions and support.

The first HOC is SLI that includes four LOCs: A. Speech, B. Syntax, C. Semantics, and D. Coherence. The initial four categories that focus on linguistic structure, vocabulary, and discourse are critical for effective communication. These areas are often where both autistic and non-autistic children with language deficits may struggle. SLI can present unique challenges to children as they learn to communicate effectively with others and can have a significant impact on academic achievement and social interaction.

The second HOC is SCD that includes four LOC: E. Inappropriate initiation, F. Stereotyped language, G. Contextual usage, H. Nonverbal communication. SCD, which was formerly known as semantic-pragmatic disorder or Pragmatic Language Impairment, is a HOC that includes challenges in four key areas: inappropriate initiation of communication, use of stereotyped language, difficulties with contextual usage of language, and deficits in nonverbal communication. These LOCs describe common communication difficulties faced by individuals on the autism spectrum. SCD specifically affects one's ability to understand the meaning behind language and to use language effectively within social contexts (pragmatics). Individuals with SCD face unique challenges in navigating the social use of language, which can impact their daily interactions and relationships.

The third HOC pertains to behaviours typically impacted by autism, which encompasses two LOCs: Social Interaction and Personal Interests. These constructs reflect the key areas of challenge for individuals with autism, highlighting difficulties in engaging socially and often a limited range of intense focus on specific topics or activities. These areas are crucial for understanding the behaviour patterns and needs of individuals on the autism spectrum.

The CCC-2 serves several purposes include: 1) Providing a quantitative assessment of pragmatic language challenges; 2) Screening for potential language impairments and directing those at risk towards further evaluation, and 3) Aiding in the identification of children who may require a more thorough assessment for autism spectrum disorders, noting that the CCC-2 itself is not a diagnostic tool for autism.[1,11]

In this study, we employed an Arabic self-administered online questionnaire developed to assess Arabic speaking children's communication difficulties. The questionnaire comprises three higher order constructs and ten LOCs. The first four constructs (A. Speech, B. Syntax, C. Semantics, D. Coherence) tap into fundamental aspects of language structure, vocabulary, and discourse. The next four constructs (E. Inappropriate initiation, F. Stereotyped language, G. Contextual usage, H. Nonverbal communication) address crucial facets of communication not readily captured by conventional language assessments but often impacted in children with ASD. Finally, the last two constructs (I. Social interaction, J. Personal interests) focus on broader behavioural domains typically affected in ASD. This comprehensive assessment allows for a holistic understanding of children's communication difficulties.

Each construct is measured by five items, resulting in a total of 50 questionnaire items. To enhance reliability, items from different constructs were interleaved throughout the set of 50.

A 4-point Likert scale is used for each item, prompting respondents to rate the frequency of a specific behaviour they observe in the child. The scale options are:

1. Less than once a week (or never)
2. At least once a week, but not every day
3. Once or twice a day
4. Several times (more than twice) a day (or always)

Design

The study employed a cross-sectional Design to assess the psychometric features of the Arabic version of the CCC-2. This design was chosen to provide a comprehensive snapshot of communication abilities across a diverse age range at a single point in time, facilitating broad assessments within our target demographic. A total of 121 participants, representing a diverse age range from 4 to 16 years, were engaged to validate the questionnaire. The study utilized a R-R HOC model, applying PLS-SEM for construct validity procedures. Content validity and cross-cultural validation of the translated questionnaire items were meticulously ensured. The assessment focused on SLI, SCD, and Impaired Behaviour constructs, examining reliability, convergent validity, and discriminant validity. The study rigorously verified the integrity and suitability of the CCC-2 for assessing communication challenges in Arabic-speaking children.

Procedures

Content Validity and Cross-Cultural Validation

To ensure the content validity and cross-cultural validation of questionnaire items, The CCC-2 questionnaire was initially translated into Arabic by one of our researchers, followed by a meticulous revision by a second researcher from our team.

Both individuals, who are university professors in the English Department, possess native proficiency in Arabic and are fluent in English. Their work extended beyond mere translation; they adapted the items to align with the linguistic and cultural context of Arabic speakers, incorporating examples pertinent to Arabic grammar, phonetics, and culture.

The clarity, comprehension, and cultural relevance of the translated items were then evaluated by five Arabic-speaking reviewers to ensure alignment with the intended constructs. These reviewers brought a diverse range of expertise, including a PhD in Arabic language studies, a master's degree in Arabic and Islamic culture studies, and bachelor's degrees in Islamic studies — fields that typically provide substantial grounding in Arabic language structure and usage.

Incorporating feedback from these reviewers, the first researcher refined the questionnaire further. Subsequently, the finalized version was formatted into a Google Form. All article researchers were then invited to review the items through this online platform again, ensuring the integrity of the questionnaire before its distribution. Once all researchers concurred on the questionnaire's content, it was disseminated through personal networks to friends and relatives with children, as well as to professional speech therapists within Saudi Arabia, ensuring a wide and relevant reach. The data collection commenced on the 31st of July 2023, and concluded after a span of three months. Following these Procedures help to achieve content validity and cross-cultural validation of questionnaire items.

Ethical considerations were paramount throughout the study. The research protocol received ethical approval from the university's Institutional Review Board (IRB). Prior to data collection, informed consent was obtained from the parents or legal guardians of the children referenced in the questionnaire responses. It is important to note that the children themselves did not directly participate or respond to the questionnaire. Instead, adult family members, such as parents, older siblings, or speech therapists, provided the necessary information on their behalf. All participants were presented with an informed consent form outlining the study's purpose, procedures, and their rights as participants. This form emphasized the voluntary nature of participation and the right to withdraw at any stage without repercussions. All collected data were anonymized and stored securely on password-protected university servers. These measures ensured participant confidentiality and data privacy in accordance with the Declaration of Helsinki.

Analysis Procedures

After obtaining content validity and cross-cultural validation of questionnaire items, construct validity procedures were conducted to confirm that the questionnaire items accurately measure the constructs it is intended to measure using PLS-SEM. More specifically, we utilize a R-R HOC model. This complex model structure incorporates a HOC which is comprised of several LOCs. Each LOC, as well as the overarching HOC, is reflective, indicating that the observable items are direct reflections of the constructs they measure. Any variation within the construct is, thus, directly mirrored by the associated items.

The model includes three distinct HOCs: SLI, SCD, and Impaired Behaviour. Each HOC is underpinned by several LOCs that are each measured by five distinct items as illustrated above. We follow Hair et al guidelines on how to analyse and report PLS-SEM results of reflective measurement models.[12] Researchers (eg, Willaby et al, 2015; Hair, 2019) stressed that PLS-SEM is a Method well-suited for analysing composite-based path models,[12,13] particularly when their goal is to predict within a theoretical framework, or when dealing with complex structural models that include a multitude of constructs, indicators, and relationships. It's advantageous for exploratory research aimed at theory development and is apt for models with formatively measured constructs. Also, PLS-SEM is also beneficial when working with smaller sample sizes. Additionally, it is a method of choice when data distribution is problematic, such as with non-normal distributions, and when subsequent analyses require scores for latent variables. These factors collectively guide researchers in determining the suitability of PLS-SEM for their specific study needs. Thus, the researchers employed PLES-SEM using SmartPLS statistical application Version 4.0.9.8 (Ringle et al, 2022) to analyse measurement and structural models.[14] The analysis of PLS-SEM results involved two stages (Hair et al 2019; Sarstedt et al, 2014).[12,15]

The First Stage: Measurement Model

In this study we used reflective measurement model assessment procedures. The process of assessing reflective measurement models typically involves several steps:

1. Indicator Loadings: The first step assesses each indicator's loadings on their respective construct. Loadings should ideally be above 0.708, suggesting that the construct explains a significant portion of the indicator's variance and thereby ensuring item reliability.
2. Internal Consistency Reliability: The next step is to evaluate the internal consistency reliability of the constructs, often using measures like Cronbach's alpha and composite reliability. Composite reliability is preferred over Cronbach's alpha as it takes into account the varying contributions of each indicator to the construct, leading to a more accurate reliability assessment. Values of reliability range from acceptable (0.60–0.70 in exploratory research) to good (0.70–0.90), with values above 0.95 indicating potential redundancy and posing validity concerns.
3. Convergent Validity: This step assesses whether the construct adequately explains the variance of its indicators. Convergent validity is measured using the average variance extracted (AVE), which should be at least 0.50, indicating that the construct explains at least 50% of the variance in its items.
4. Discriminant Validity: The final step is to ensure that each construct is distinct and not simply a reflection of another related construct. Discriminant validity is assessed by examining cross-loadings of items, ensuring that items load more strongly on their intended construct than on any other related constructs. This step confirms that the constructs are measuring unique aspects as intended.

The Second Stage: Structural Model

After confirming the measurement model's adequacy, the structural model is assessed for predictive relevance and the significance of path coefficients, which includes investigating indirect effects and potential moderating effects. Key aspects of this stage include:

1. Collinearity Assessment: Before examining the structural relationships, it's crucial to check for collinearity among predictor constructs, using Variance Inflation Factor (VIF) values to identify any bias in regression results. VIF values above 5 suggest collinearity concerns, though issues may also arise with lower VIF values between 3–5. Ideally, VIF values should be near or below 3. If collinearity is problematic, creating higher-order models grounded in theory may be a solution.
2. Coefficient of Determination (R^2): This metric measures the variance explained by the endogenous constructs within the model, serving as an indicator of the model's explanatory power. R^2 values are interpreted on a scale from 0 to 1, with higher values indicating greater explanatory power. Values of 0.75, 0.50, and 0.25 are generally considered substantial, moderate, and weak, respectively.
3. Effect Size (f^2): The effect of removing a predictor construct on the R^2 value of an endogenous construct is measured by the f^2 effect size. This value is related to the path coefficients' magnitude and can indicate the importance of a construct in explaining variance in a dependent construct. f^2 effect sizes greater than 0.02, 0.15, and 0.35 are considered small, medium, and large, respectively. The f^2 effect size should be reported especially if there is a discrepancy in the rank order of constructs' relevance compared to the path coefficients, or if requested by editors or reviewers. These steps ensure the structural model's robustness and its ability to capture the relationships between constructs accurately.

Results

Specific Language Impairment (SLI)

Reflective Measurement Model

A reflective measurement model was employed, assuming that the constructs are reflected by their respective indicators. Cronbach's alpha, composite reliability, and average variance extracted (AVE) were calculated to assess convergent validity and reliability. Overall, the measurement model demonstrates that most constructs have good reliability and convergent validity, with the exception of Syntax, where the AVE did not meet the recommended threshold. The constructs of Speech, Semantics, and Coherence show both high reliability and sufficient convergent validity, indicating that the items related to these constructs are appropriate measures within the SLI domain. The Syntax construct may require a review of the indicators or an increased number of items to enhance the AVE and ensure that it adequately represents the variance of the construct. However, some researchers suggest that a composite reliability greater than 0.6 can compensate for a slightly lower AVE (around 0.4). This flexibility is based on the idea that composite reliability focuses on internal consistency, while AVE considers both construct variance and measurement error (Muhamad Safiih & Azreen, 2016).[16]

Cronbach's alpha values ranged from 0.641 to 0.800, with composite reliability values slightly higher. All values meet or approach the general threshold of 0.70, demonstrating satisfactory internal consistency reliability. Table 1 illustrates the Results of SLI convergent validity and reliability of the constructs.

The discriminant validity assessment suggests that each construct within the SLI model is distinct. Overall, the loadings within constructs are strong, and cross-loadings are weaker, which is consistent with good discriminant validity. The Speech construct, in particular, shows a clear distinction from other constructs, as evidenced by the high loadings on Speech and lower cross-loadings. The results suggest that the SLI constructs are measured distinctively and appropriately represent different dimensions of language impairment. More specifically, the loadings on the Speech construct are strong, with values ranging from 0.69 to 0.83, indicating that the items are good indicators of the Speech construct. Cross-loadings with other constructs (Coherence, Semantics, Syntax) are substantially lower than the loadings on Speech, demonstrating good discriminant validity.

Loadings on the Syntax construct range from 0.42 to 0.76, showing that some items are more representative of the construct than others. Cross-loadings are lower compared to the loadings on Syntax, except for a few overlaps with Semantics, which suggests that discriminant validity may need further examination, especially between Syntax and Semantics. The inherent relationship between syntax, the arrangement of words and phrases to create grammatical sentences, and semantics, the meaning conveyed by those elements in context, is important to consider. This close association can naturally lead to some overlap when measuring these constructs through specific assessment items. The very act of structuring a well-formed sentence (syntax) often influences, and is influenced by, the intended meaning we aim to communicate (semantics). This interdependence between syntax and semantics may explain why the constructs sometimes appear interwoven in our data.

The Semantics construct shows strong loadings, with the highest being 0.79, indicating a good fit of items to the construct. Cross-loadings with other constructs are lower, supporting discriminant validity, although the closeness to the Syntax loadings could warrant additional scrutiny. The close association between these constructs is anticipated and underscores the nuanced complexity of language that must be carefully considered when assessing linguistic abilities.

The Coherence construct has high loadings, all above 0.7, suggesting that the items are highly relevant to the construct. Cross-loadings with other constructs are generally lower, which supports the discriminant validity of Coherence. Table 2 illustrates the result of SLI constructs discriminant validity.

Structural Model Evaluation

First, the VIF analysis in Figure 1 across all constructs related to speech, syntax, semantics, and coherence indicates that multicollinearity is not a significant concern in the current dataset. All VIF values are below the threshold of 5, with most being considerably lower, suggesting that the predictor constructs are relatively independent, and the regression estimates

Table 1 SLI Convergent Validity and Reliability of the Constructs

Construct	Cronbach's Alpha	Composite Reliability (rho_c)	AVE
Speech	0.8	0.862	0.557
Syntax	0.641	0.776	0.416
Semantics	0.762	0.84	0.515
Coherence	0.765	0.842	0.517

Table 2 SLI Discriminant Validity

	Coherence	Semantics	Speech	Syntax
A1 Speech 2	0.45	0.39	0.77	0.59
A2 Speech 24	0.49	0.59	0.83	0.59
A3 Speech 29	0.47	0.48	0.69	0.56
A4 Speech 38	0.38	0.49	0.73	0.53
A5 Speech 44	0.43	0.47	0.71	0.57
B1 Syntax 1	0.24	0.25	0.39	0.42
B2 Syntax 17	0.4	0.49	0.38	0.65
B3 Syntax 27	0.49	0.6	0.59	0.67
B4 Syntax 36	0.55	0.56	0.61	0.76
B5 Syntax 43	0.59	0.46	0.44	0.66
C1 Semantics 4	0.39	0.58	0.3	0.39
C2 Semantics 6	0.62	0.71	0.33	0.52
C3 Semantics 12	0.58	0.79	0.59	0.61
C4 Semantics 32	0.59	0.77	0.62	0.57
C5 Semantics 46	0.58	0.72	0.42	0.59
D1 Coherence 10	0.73	0.62	0.39	0.49
D2 Coherence 25	0.63	0.53	0.41	0.46
D3 Coherence 40	0.77	0.59	0.49	0.62
D4 Coherence 48	0.72	0.49	0.42	0.51
D5 Coherence 50	0.73	0.54	0.42	0.51

Notes: The shaded cells highlight values that exceed a specific threshold, indicating stronger discriminant validity in the corresponding areas.

are stable This allows for a high degree of confidence in the structural model evaluation and the subsequent interpretation of the path coefficients derived from it.

In order to examine path coefficients' significance, the researchers run bootstrapping to assess the path coefficients' significance and evaluate their values. The path coefficients between SLI and all four LOCs are very high (all above 0.850), which suggests a strong positive relationship. The T statistics are well above the threshold of 1.96 for a 95% confidence interval, indicating that the path coefficients are highly significant ($p < 0.001$). The R-squared values indicate a strong model fit, with Coherence, Semantics, Speech, and Syntax explaining a substantial proportion of variance within the SLI construct (76.5%, 81%, 72.6%, and 82.3%, respectively). The adjusted R-squared values are very close to the original R-squared values, which suggests that the model has good predictive relevance and is not overfitted.

There are significant and strong correlations between the SLI construct and the four LOCs, with the highest correlation being between SLI and Syntax ($r = 0.907$), followed by Semantics ($r = 0.900$), Coherence ($r = 0.874$), and Speech ($r = 0.852$). The correlations between the constructs are positive, suggesting that as one construct increases, the others also tend to increase. The f-squared effect sizes are substantial, indicating that SLI as an independent variable has a large effect on the dependent variables Coherence, Semantics, and Syntax. The effect size on Speech is moderate compared to the others, but still significant.

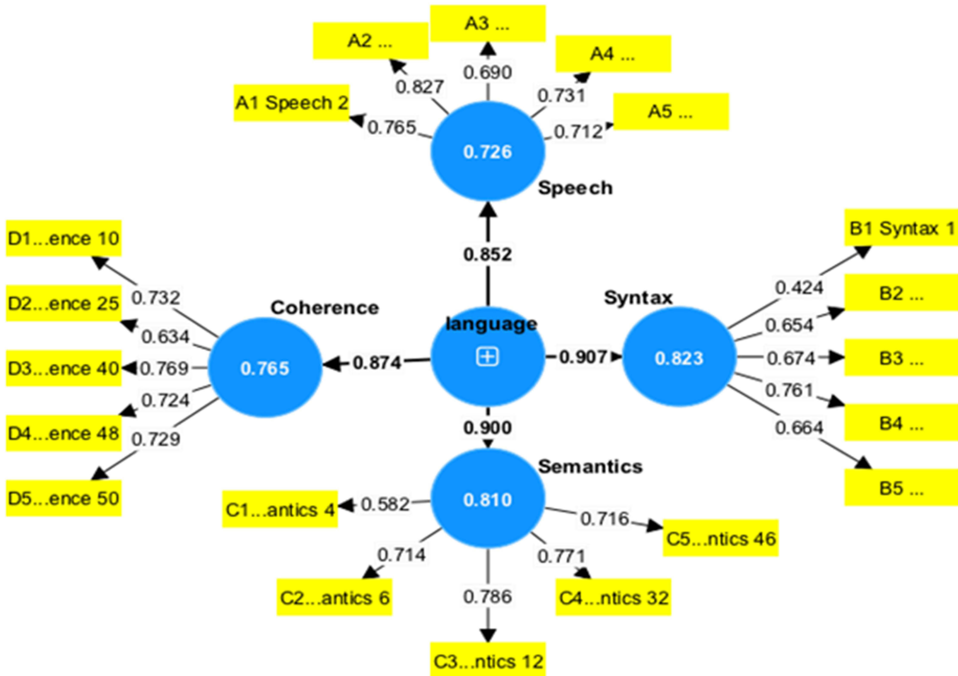

Figure 1 SLI Structural Model.

These results suggest that the SLI construct has a significant and strong relationship with the constructs of Coherence, Semantics, Speech, and Syntax in the context of the model analysed. The high R-squared values and significant path coefficients indicate that SLI is a major explanatory factor for these aspects of language impairment. The findings provide strong support for the theoretical model being tested and offer robust evidence for the impact of SLI on various dimensions of language abilities. Table 3 illustrates the results of SLI structural model evaluation.

Social Communication Disorder (SCD)

Reflective Measurement Model

The evaluation of the reflective measurement model indicates satisfactory levels of reliability and convergent validity across the majority of the constructs. Inappropriate initiation displayed Cronbach's alpha of 0.728, composite reliability of 0.821, and AVE of 0.481, indicating satisfactory reliability and a moderate level of explained variance. Stereotyped language showed Cronbach's alpha of 0.702, composite reliability of 0.807, and AVE of 0.457, reflecting acceptable reliability, though the explained variance could be improved. Use of context had Cronbach's alpha of 0.755, composite reliability of 0.836, and AVE of 0.506, which suggests good reliability and convergent validity, with the construct explaining over half of the variance of its indicators. Nonverbal communication demonstrated Cronbach's alpha of 0.722, composite reliability of 0.819, and AVE of 0.476, also indicating acceptable reliability and convergent validity. Table 4 illustrates the convergent validity and reliability of the constructs.

Table 3 SLI Structural Model Evaluation

HOC	F2	LOCS	R2	Path Coefficients	T Statistics (|O/STDEV|)	P value
SLI	3.25	Coherence	0.765	0.874	34.167	0.00
	4.274	Semantics	0.81	0.9	44.992	0.00
	2.65	Speech	0.726	0.852	22.135	0.00
	4.653	Syntax	0.823	0.907	48.115	0.00

Table 4 SCD Convergent Validity and Reliability of the Constructs

Construct	Cronbach's Alpha	Composite Reliability (rho_c)	AVE
E. Inappropriate initiation	0.728	0.821	0.481
F. Stereotyped language	0.702	0.807	0.457
G. Use of context	0.755	0.836	0.506
H. Nonverbal communication	0.722	0.819	0.476

Similarly, we use cross-loadings to examine the factor loadings of each item on its intended construct and on other constructs.

The items related to Inappropriate initiation (E1-E5) had higher loadings on their own construct, ranging from 0.63 to 0.75, compared to their loadings on other constructs, which did not exceed 0.50. For Stereotyped language (F1-F5), the items showed strong loadings on their intended construct, with the highest being 0.76 for item F3, indicating a clear measurement of the Stereotyped language construct. The Use of context items (G1-G5) also loaded more strongly on their own construct, with loadings ranging from 0.64 to 0.74. Nonverbal communication items (H1-H5) had the highest loadings on their construct, suggesting that they adequately capture the essence of Nonverbal communication, with loadings up to 0.76 for item H4.

Overall, the measurement models for the SCD constructs demonstrate adequate reliability and convergent validity. The discriminant validity analysis supports the distinctiveness of each construct, with all items loading more strongly on their respective constructs than on others. Table 5 illustrates the discriminant validity of the questionnaire items.

Table 5 SCD Discriminant Validity

Items	Context Use	Nonverbal Com	Stereotyped Lang	Inappropriate Init
E1 Inappropriate 21	0.34	0.32	0.33	0.63
E2 Inappropriate 35	0.50	0.45	0.36	0.75
E3 Inappropriate 37	0.42	0.44	0.46	0.63
E4 Inappropriate 45	0.43	0.50	0.32	0.73
E5 Inappropriate 50	0.45	0.43	0.36	0.73
F1 Stereotyped 11	0.42	0.38	0.69	0.27
F2 Stereotyped 18	0.49	0.30	0.65	0.31
F3 Stereotyped 23	0.55	0.46	0.76	0.54
F4 Stereotyped 30	0.49	0.48	0.67	0.29
F5 Stereotyped 42	0.33	0.39	0.60	0.34
G1 context 15.	0.74	0.48	0.37	0.40
G2 context 19.	0.74	0.36	0.50	0.30
G3 context 28.	0.72	0.49	0.52	0.51
G4 context 34.	0.72	0.52	0.54	0.56
G5 context 41.	0.64	0.52	0.48	0.41

(*Continued*)

Table 5 (Continued).

Items	Context Use	Nonverbal Com	Stereotyped Lang	Inappropriate Init
H1 Nonverbal 8	0.42	0.60	0.49	0.35
H2 Nonverbal 14	0.51	0.65	0.45	0.36
H3 Nonverbal 20	0.43	0.70	0.40	0.51
H4 Nonverbal 31	0.44	0.76	0.36	0.45
H5 Nonverbal 39	0.51	0.73	0.38	0.47

Notes: The shaded cells highlight values that exceed a specific threshold, indicating stronger discriminant validity in the corresponding areas.

Structural Model Evaluation

The VIF analysis in Figure 2 across the constructs of Inappropriate initiation, Stereotyped language, Use of context, and Nonverbal communication demonstrates that multicollinearity is not a concern in the dataset. All VIF values fall below the threshold, confirming that the predictor constructs maintain independence from each other. This ensures the validity of the regression analysis conducted on these constructs.

The results support the proposed structural model, demonstrating robust relationships between the SCD construct and its components. The effect sizes highlight the importance of constructs in influencing various aspects of communication behaviour. All path coefficients between the HOC of SCD and its LOCs (Inappropriate Initiation, Stereotyped Language, Use of Context, Nonverbal Communication) were highly significant ($p < 0.001$). This indicates a strong and consistent relationship between the HOC and its components. The f^2 effect sizes for these path coefficients ranged from moderate (1.98) to large (3.68), suggesting a meaningful impact of SCD on the LOCs. The strongest effect size was observed for Use of Context, followed by Nonverbal Communication, Stereotyped Language, and Inappropriate Initiation. The R^2 values (ranging from 0.66 to 0.79) suggest that the model explained a substantial amount of variance

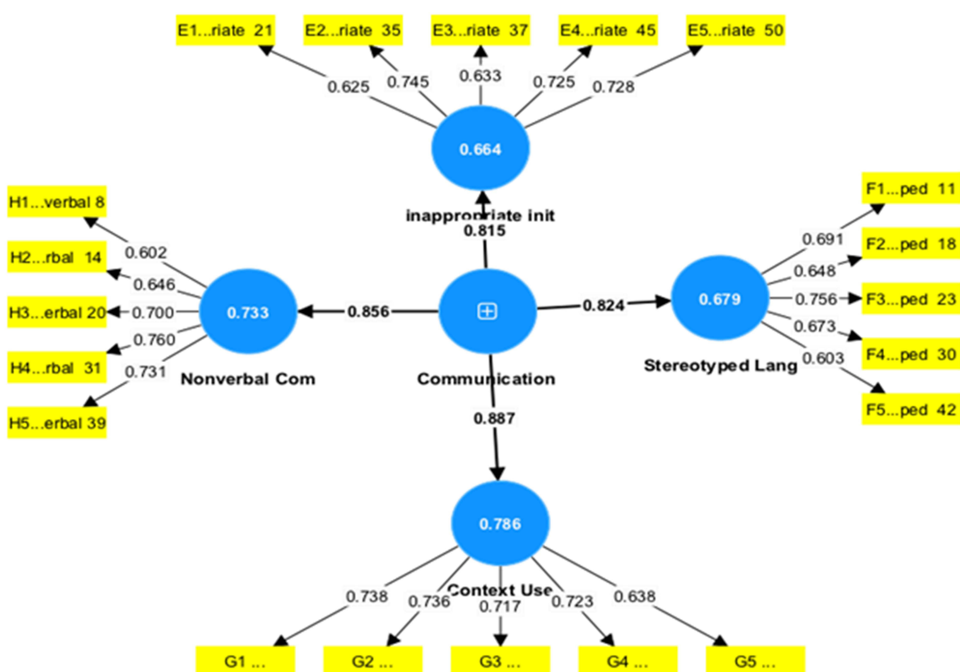

Figure 2 SCD Structural Model.

Table 6 SCD Structural Model Evaluation

HOC	F2	LOCs	R2	Path Coefficients	T Statistics (|O/STDEV|)	P value
SCD	1.98	Inappropriate initiation	0.66	0.82	19.414	0.00
	2.12	Stereotyped language	0.68	0.82	22.715	0.00
	3.68	Use of context	0.79	0.89	39.506	0.00
	2.75	Nonverbal communication	0.73	0.86	30.596	0.00

in the LOCs. This indicates that the model fits the data reasonably well. Table 6 illustrates the results of SCD structural model evaluation.

The relationships between various constructs related to communication were analysed. The SCD showed a strong positive correlation with Context Use ($r = 0.89$, $p < 0.001$), Nonverbal Communication ($r = 0.86$, $p < 0.001$), Stereotyped Language ($r = 0.82$, $p < 0.001$), and Inappropriate Initiation ($r = 0.82$, $p < 0.001$). Context Use also demonstrated a moderate to strong correlation with Nonverbal Communication ($r = 0.67$, $p < 0.001$), Stereotyped Language ($r = 0.68$, $p < 0.001$), and Inappropriate Initiation ($r = 0.62$, $p < 0.001$). Nonverbal Communication and Stereotyped Language were moderately correlated ($r = 0.60$, $p < 0.001$), as were Nonverbal Communication and Inappropriate Initiation ($r = 0.62$, $p < 0.001$). The weakest correlation was observed between Stereotyped Language and Inappropriate Initiation ($r = 0.53$, $p < 0.001$). All correlations were statistically significant.

Impaired Behaviour

Reflective Measurement Model Evaluation

The Social Relations construct demonstrated robust reliability and convergent validity, implying that the items are well-suited to measure this construct. The Interests construct, while reliable, showed a lower AVE, which may warrant a review of the items or construct definition to ensure adequate convergent validity. Social Relations construct has Cronbach's alpha (0.76) and composite reliability (0.84). The AVE (0.52) also exceeds the recommended value of 0.50, suggesting satisfactory convergent validity. While the Interests construct has the Cronbach's alpha (0.64) falls slightly below the recommended threshold, the composite reliability (0.77) and AVE (0.41) are acceptable This suggests satisfactory internal consistency and moderate convergent validity for Interests. Table 7 illustrates the convergent validity and reliability of the constructs.

Discriminant validity results were generally positive, with most items loading more strongly on their intended constructs, confirming the distinctiveness of the constructs. For the Social Relations construct, items I1 to I5 showed higher loadings on their intended construct (ranging from 0.61 to 0.82), indicating good discriminant validity. For the Interests construct, items J1 to J5 also demonstrated higher loadings on their intended construct (ranging from 0.46 to 0.72). Table 8 illustrates the Discriminant validity results of Impaired Behavior constructs.

B. Structural Measurement Model

The VIF values in Figure 3 for both constructs—Social Relation and Interests—are well within the acceptable range, indicating that the predictor constructs are independent of each other. There are no indications of multicollinearity affecting the regression analysis's validity within the constructs evaluated.

The structural measurement model presents strong evidence that the Behaviour construct significantly influences both Social Relations and Interests. The high path coefficients and corresponding T statistics confirm the robustness of these

Table 7 Impaired Behaviour Convergent Validity and Reliability of the Constructs

Construct	Cronbach's Alpha	Composite Reliability (rho_c)	(AVE)
I. Social relations	0.76	0.84	0.52
J. Interests	0.64	0.77	0.41

Table 8 Impaired Behavior Discriminant Validity

Items	I Social Relation	J Interests
I1 Social 3	0.61	0.43
I2 Social 7	0.55	0.23
I3 Social 13	0.81	0.34
I4 Social 16	0.82	0.44
I5 Social 33	0.78	0.45
J1 Interests 9	0.12	0.46
J2 Interests 22	0.31	0.66
J3 Interests 26	0.33	0.72
J4 Interests 47	0.52	0.70
J5 Interests 49	0.31	0.62

Notes: The shaded cells highlight values that exceed a specific threshold, indicating stronger discriminant validity in the corresponding areas.

relationships. The significant f-squared effect sizes further corroborate the substantial impact that the Behaviour construct has on these two facets of human interaction. The path coefficient for the relationship between Behaviour and Social Relations was 0.91, with a T statistic of 48.33, indicating a highly significant relationship ($p < 0.001$). The path coefficient for Behaviour's influence on Interests was also substantial at 0.84, with a T statistic of 26.249, again indicating a highly significant relationship ($p < 0.001$).

In Table 9, the R^2 value for Social Relations was 0.83, suggesting that 83% of the variance in Social Relations can be explained by the Behaviour construct, denoting a substantial explanatory power. The R^2 value for Interests was 0.70, meaning that 70% of the variance in Interests is accounted for by Behaviour, which is also a robust level of explanatory power. The Behaviour construct demonstrated a substantial influence on the Social Relations and Interests constructs, as evidenced by the f-squared (F2) effect sizes and path coefficients. The F2 effect size for the influence of Behaviour on Social Relations was substantial at 4.78, indicating a strong effect. The F2 effect size for Behaviour's influence on Interests was 2.33, which can be considered a moderate to strong effect.

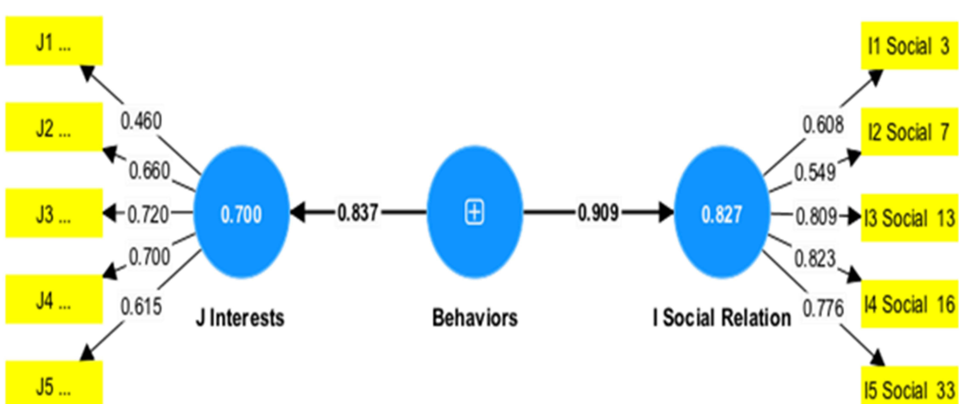

Figure 3 Impaired Behaviour Structural Model.

Table 9 Impaired Behaviour Structural Model Evaluation

HOC	F2	LOCs	R2	Path Coefficients	T statistics (|O/STDEV|)	P value
Behaviour	4.78 2.33	I Social Relation J Interests	0.83 0.70	0.91 0.84	48.33 26.249	0.00 0.00

The study's constructs showed significant intercorrelations. "Behaviours" was highly correlated with "Social Relation" (r = 0.91) and "Interests" (r = 0.84). "Social Relation" also displayed a moderate correlation with "Interests" (r = 0.53). All correlations are assumed to be statistically significant.

Discussion

The aim of our study was to validate the Arabic version of the CCC-2 to accurately measure communication challenges in Arabic-speaking children. Employing a R-R HOC model using PLS-SEM for construct validity procedures, we found that the Arabic version of CCC-2 demonstrated strong psychometric properties, particularly in assessing SLI, SCD, and Impaired Behaviour. The study's structural models confirmed the robustness of relationships among the constructs for SLI, SCD, and Impaired Behaviour, indicating strong support for the reliability and validity of the Arabic version of CCC-2, which makes it a suitable tool for assessing communication challenges in Arabic-speaking children.

VIF quantifies how much the variance of an estimated regression coefficient increases if predictors are correlated. A VIF value below 5 suggests that there is no severe multicollinearity, and the regression estimates are stable, which is conducive for a robust analysis. In our model, all constructs related to SLI, SCD, and Impaired Behaviour showed VIF values significantly lower than the threshold of 5, indicating minimal multicollinearity concerns. The VIF analysis results are pivotal in confirming the structural integrity and robustness of our model. Low VIF values indicate that each construct in the model contributes uniquely to the explanation of the dependent variables without undue influence from multicollinearity. This independence among constructs enhances the validity of the model's predictions and supports the reliability of the findings. The absence of significant multicollinearity ensures that the path coefficients derived from the model are accurate reflections of the relationships among constructs, thus underscoring the robustness of our conclusions regarding the psychometric properties of the Arabic version of the CCC-2. By ensuring that the VIF values are well within the acceptable range, we confirm that our model is robust and the findings are reliable, providing a solid foundation for the implications drawn from this study. We hope this clarification addresses your concerns, and we appreciate your guidance in improving the manuscript.

The effect sizes (f^2) calculated in our study indicate the strength of the influence one construct has over another within the model. Specifically, these effect sizes are substantial across the relationships examined, suggesting robust impacts of certain constructs on others. For instance, the high f^2 values between SLI constructs and their indicators, such as Syntax, Semantics, and Speech, underscore the significant influence of SLI on various dimensions of language abilities. The practical implications of these substantial effect sizes are manifold. Firstly, the strong relationships identified between SLI constructs and their language components support the validity of the Arabic CCC-2 as a sensitive tool for detecting specific language impairments. This finding is crucial for researchers focusing on language development and impairment, as it provides a robust methodological framework for exploring these phenomena in Arabic-speaking populations. Moreover, the clear links between constructs suggest potential areas for detailed investigation into the mechanisms of language impairments, fostering a deeper understanding of their developmental trajectories.

From an intervention perspective, the significant effect sizes indicate that changes or improvements in one aspect of language ability might lead to substantial improvements in other areas. For example, targeted interventions aimed at enhancing semantic skills could have cascading benefits on syntax and speech, as indicated by the strong effect sizes. This insight is invaluable for clinicians and educators designing intervention programs, as it highlights the interconnectedness of language abilities and the potential for holistic improvement through focused interventions. The substantial effect sizes also suggest areas for further research, particularly in developing specialized intervention programs that leverage these strong relationships between language constructs. Future studies could explore the efficacy of interventions that specifically target the most influential constructs identified in our study, providing evidence-based approaches to language therapy and educational strategies. The substantial effect sizes reported in our study not only reinforce the robustness of our methodological approach but also have significant practical implications for both research and intervention in the field of language impairment. By discussing these implications, we aim to bridge the gap between empirical research and practical application, enhancing the impact of our findings on the field.

In comparison to previous studies, our findings align with the results from (Geurts et al, 2004)[17] who investigated the ability of CCC to differentiate between children with ADHD, children with HFA, and normal controls. Similarly, our study demonstrated that CCC-2 was capable of identifying and distinguishing SLIs within the Arabic-speaking population. The study by (Helland & Heimann, 2007)[18] evaluated the usability of the Norwegian adaptation of CCC-2 in differentiating between language-impaired and non-language-impaired children, showing reasonable reliability and internal consistency values ranging from 0.73 to 0.89. We observed similar tendencies in our study, reinforcing the reliability and validity of CCC-2 in the Arabic context. Furthermore, (Helland et al, 2009; Ketelaars et al, 2009)[19,20] found that the Norwegian adaptation of CCC-2 distinguished between language-impaired and non-language-impaired children and demonstrated reasonable reliability with internal consistency values ranging from 0.73 to 0.89, which aligns with our findings regarding the reliability and validity of CCC-2 in Arabic-speaking children.

Moreover, the study by (Glumbić & Brojčin, 2012)[21] determined the factor structure of the CCC-2 in the Serbian adaptation and identified language and communication impairments in Serbian children, indicating that the CCC-2 was useful for obtaining a global inventory of deficits in the domain of language. Similarly, the research by (Costa et al, 2013)[22] translated the CCC-2 into Brazilian-Portuguese, made its cross-cultural adaptation, and assessed its internal reliability, finding that it was able to distinguish children with communication impairments from non-impaired peers and identify children who show clear pragmatic deficits despite normal scores on language measures. These studies provide evidence supporting the usability and effectiveness of CCC-2 across different linguistic and cultural contexts, reinforcing the applicability of CCC-2 in our study and its potential to accurately assess communication challenges in various populations.

Continuing on, we find that the study by (Hoffmann et al, 2013)[23] ascertained the validity and reliability of the CCC-2 in Spanish and identified children with pragmatic language impairment, aligning with our study's findings of the reliability and validity of CCC-2 in identifying communication challenges in Arabic-speaking children. Similarly, the research by (Timler, 2014)[24] explored whether children with ADHD have language and/or pragmatic difficulties compared to typically developing children using CCC-2, distinguishing children with ADHD who have language and/or pragmatic difficulties, thus showcasing the clinical utility of CCC-2. Additionally, (Crespo Eguílaz et al, 2016)[25] translated the CCC-2 into Spanish and found that it distinguished children with communication impairments from non-impaired peers, which corresponds to the usefulness of CCC-2 in our study's context.

Moreover, (Tanaka et al, 2017)[26] investigated whether the CCC-2 could identify subtypes in relation to communication impairments in Japanese children with ASD, identifying children with ASD who have language and/or pragmatic difficulties, highlighting the clinical utility of CCC-2 in the Japanese context. Similarly, (Mcgownd, 2018)[27] explored parent perceptions of their children's communication skills using the CCC-2, identifying children with pragmatic language impairment and showcasing its usefulness for research purposes and clinical use in the English-speaking population.

Furthermore, the study by (Hammond, 2019)[28] investigated the agreement between parent and teacher ratings on the CCC-2, highlighting the ability of CCC-2 to provide a holistic assessment of a child's social communication profile, particularly useful in detecting when a social communication problem exists. Other researchers used CCC-2 to identify communicative impairment, uneven pragmatic language profile, and social relations impairment in children with Sotos syndrome, demonstrating the ability of CCC-2 to identify specific communicative difficulties in a syndrome-specific manner (Lane et al, 2019).[29]

In summary, our study's findings align with a range of international studies utilizing CCC-2 in various linguistic and cultural contexts. The evidence suggests that the CCC-2 is a versatile tool that demonstrates consistent reliability and validity across different languages, cultures, and clinical populations. These findings collectively underscore the usability of CCC-2 in identifying communication challenges and pragmatic language impairments across diverse linguistic and cultural groups, including Arabic-speaking children. Therefore, CCC-2 appears to be a valuable and effective instrument for both research and clinical practice, offering a standardized and reliable means of assessing communication challenges in children across different linguistic and cultural backgrounds.

Implications for Practice

The validation of the Arabic version of the CCC-2 holds significant implications for both clinical and research settings. The demonstrated reliability and validity of the Arabic adaptation of CCC-2 offer a valuable tool for identifying language impairments and SCDs in Arabic-speaking children. This validated version can aid clinicians in accurately diagnosing and planning interventions for children facing communication challenges, while also serving as a robust instrument for researchers to explore and understand communication difficulties within this population.

Limitations

One limitation of the current study is that it solely includes participants from the typical population, without comparative analysis to clinical atypical populations in clinical settings. Future research should consider including a comparative analysis with clinical atypical populations to further validate the application of CCC-2 in diagnosing and understanding communication disorders in clinical settings. The CCC-2 is not a diagnostic tool but rather a screening tool. Therefore, relying on it to identify specific communication disorders without further comprehensive diagnostic assessments might limit the effectiveness of interventions based on these results alone. Additionally, the study's focus on the first 50 items of the CCC-2, which measure difficulties faced by participants in communication, may limit the comprehensive assessment of other potential domains or aspects of communication and behaviour that the full CCC-2 could address. The findings might be influenced by other unmeasured variables such as the children's exposure to other languages, the presence of other developmental conditions, or the quality of the educational environment. For example, children with multilingual exposure might perform differently on certain parts of the CCC-2 due to their broader linguistic and cultural experiences.

Conclusion

In Conclusion, the psychometric assessment of the Arabic version of CCC-2 has demonstrated strong reliability and validity, indicating its suitability for assessing communication challenges in Arabic-speaking children. The results support the use of CCC-2 as a valuable tool in both clinical and research contexts, offering a standardized and reliable means of identifying language impairments and SCDs within this population. While this study provides a robust foundation, future research should aim to expand the scope of participants to include clinical atypical populations and consider utilizing the complete CCC-2 to comprehensively assess various domains of communication and behaviour in this context. The study meticulously validated the CCC-2 through psychometric testing, ensuring it measures SLI, SCD, and related behavioural difficulties effectively within the cultural context of Arabic speakers. This effort not only fills a significant gap by providing a culturally adapted tool for identifying communication disorders but also facilitates early intervention strategies in clinical and educational settings. Furthermore, by setting a methodological benchmark, this study enhances the scope for future research in adapting diagnostic and assessment tools across different linguistic and cultural landscapes, thus contributing substantially to the field of applied linguistics and communication disorders.

Institutional Review Board Statement

An IRB approval was obtained by the Research Ethics Committee at King Khalid University (HAPO-06-B-001). Approval No. ECM#2023-2007.

Availability of Supporting Data

The datasets generated and/or analysed during the current study are not publicly available due to privacy of the participants and the university databases but are available from the corresponding author on reasonable request.

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Disclosure
The authors declare no conflicts of interest in this work.

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