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Cross-cultural adaptation and psychometric evaluation of the Communication Function Classification System-Thai version for individuals with cerebral palsy in Thailand

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ABSTRACT

Background: Cerebral palsy (CP) is a neurodevelopmental disorder that affects motor functions and is often accompanied by impairments such as speech and communication challenges. Functional classification systems are increasingly used to describe daily activities and participation, aiming to guide comprehensive and effective treatment planning that improves patients' quality of life. The Communication Function Classification System (CFCS) is a tool designed to describe communication functions in the daily lives of individuals with CP. Nonetheless, the absence of a Thai version of the CFCS highlighted the need for this study.

Objectives: This study aimed to translate and culturally adapt the CFCS into Thai (CFCS-TH) and to evaluate its psychometric properties, including validity and reliability, in individuals with CP in Thailand.

Materials and methods: The study was conducted in two phases: (1) cross-cultural adaptation and translation of the CFCS into Thai using a six-step forward and backward translation method, and (2) psychometric evaluation of the CFCS-TH, focusing on content validity, inter-rater reliability, and intra-rater reliability. Validity was assessed using the content validity index (CVI), while reliability was measured using weighted kappa statistics (κ). A total of 35 individuals with CP, aged 2-18 years, participated in the study. The raters included one speech-language pathologist (SLP), two physical therapists (PTs), and 35 parents, each of whom rated the level of communication function of the individuals with CP twice.

Results: The cross-cultural adaptation of the CFCS to Thai was carried out by ensuring that the language and terminology were appropriate for Thai users while maintaining the conceptual integrity and purpose of the tool. The CFCS-TH translation steps included vocabulary and syntax selection, equivalency review, and revisions from translators, an expert committee, and pretest users, followed by approval from the instrument developers. The CFCS-TH demonstrated excellent content validity, with an item-level CVI and scale-level CVI of 1.0, indicating that the CFCS-TH could measure its intended construct. Inter-rater reliability was good between the SLP and PTs (κ=0.71), good between the SLP and parents (κ=0.66), and fair between PTs and parents (κ=0.55). When separating the data by the first and second classification rounds, agreement between the SLP and PTs remained good with a slight decrease (κ=0.73 and 0.69). The SLP-parent agreement remained consistently good across both rounds (κ =0.61 and 0.66), while

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the PTs-parents agreement improved from fair to good (k=0.48 and 0.62). Intra-rater reliability was excellent for the SLP (k=0.92) and very good for PTs (k = 0.91) and parents (k=0.86).

Conclusion: The CFCS-TH is a valid and reliable tool for describing the communication functions of individuals with CP in Thailand. This tool provides a standardized framework for assessing communication performance to support clinical and research efforts aimed at intervention planning and improving the quality of life for individuals with CP.

Introduction

Cerebral palsy (CP) is a neurodevelopmental disorder caused by brain injuries or lesions during development, leading to abnormalities in motor function, movement, and muscle tone. Individuals with CP often experience co-occurring impairments, including challenges in speech, language, and communication. These challenges may stem from dysarthria and other comorbidities, such as epilepsy, intellectual disabilities, and sensory impairments, which can vary in severity, ranging from mild speech difficulties to an inability to speak.[1] However, individuals with CP can still communicate through alternative means of communication that supplement or replace spoken language.[2,3]

Modern medicine emphasizes a holistic approach to healthcare, prioritizing comprehensive care that enhances overall quality of life. The International Classification of Functioning, Disability, and Health (ICF), developed by the World Health Organization (WHO), provides a framework that categorizes individual health status or disease into three components: body structures and functions, activities, and participation. This framework has led to the widespread adoption of functional classification systems.[4, 5] For individuals with CP, classification systems often focus on communication, manual functions, and mobility. Commonly used tools include the Gross Motor Function Classification System (GMFCS)[6], the Manual Ability Classification System (MACS),[7] and the Communication Function Classification System (CFCS).[8]

Corresponding to the activity and participation components of the ICF, the Communication Function Classification System (CFCS) is a widely recognized tool developed to classify the communication performance of individuals with CP in their daily lives. The CFCS categorizes communication performance into five distinct levels, ranging from effective sender and receiver with both familiar and unfamiliar partners to seldom effective sender and receiver even with familiar partners.[9] Unlike traditional assessments that focus solely on speech or language impairments, the CFCS emphasizes functional communication, encompassing all methods such as vocalizations, facial expressions, gestures, sign language, symbols, writing, and alternative and augmentative communication (AAC). This system complements traditional speech and language assessments by enabling clinicians, educators, and parents to better understand and plan interventions tailored to the communication needs of individuals with CP.

The CFCS demonstrates high inter-rater reliability among professionals (weighted kappa score: k=0.66, 95% CI: 0.55–0.78)[10] and fair reliability between professionals and parents (k=0.49, 95% CI: 0.40-0.59). Intra-rater reliability among professionals is very good (k=0.82, 95% CI: 0.74-0.90).[10] Widely adopted worldwide, the CFCS has been translated and validated in multiple languages, including Dutch,[11] Farsi,[12] Chinese,[13] Korean,[14] and Turkish,[15] demonstrating high validity and reliability. The CFCS can integrate well with the GMFCS and MACS, helping to enhance interdisciplinary communication and therapeutic planning, making it widely used in hospitals, rehabilitation centers, and public health data collection.[16,17]

Despite the successful translations of the GMFCS and MACS into Thai, a standardized version of the Thai CFCS has not yet been established.[18,19] Therefore, the present study aimed to cross-culturally adapt the original English version of the Communication Function Classification System (CFCS) into Thai (CFCS-TH) for individuals with CP. Additionally, the study sought to evaluate the reliability and validity of the CFCS-TH in individuals aged 2-18 years with CP. The study was executed in two phases: a) the cross-cultural adaptation and translation of the CFCS into Thai (CFCS-TH); and b) the psychometric evaluation of the CFCS-TH, emphasizing its validity and reliability.

Materials and methods

Phase 1: Cross-cultural adaptation and translation of the CFCS-TH

The cross-cultural adaptation of the Communication Function Classification System into Thai (CFCS-TH) followed established guidelines proposed by Beaton *et al.*,[20] which involve six sequential s to ensure linguistic and conceptual equivalence.

1) Forward translation: Two forward translations were independently produced-one by an experienced bilingual speech-language pathologist (SLP) and the other by a professional language translator with no prior knowledge of the CFCS or medical background.

2) Synthesis of translations: An expert committee synthesized the two Thai versions into a single, harmonized draft. The committee consisted of the bilingual SLP translators from Step 1, the language

professional translators from Step 1, the principal investigator (i.e., SLP), and a research advisor, ensuring the translated version retained its original meaning and maintained linguistic appropriateness.

3) Backward translation: The synthesized Thai version was back-translated into English by two independent professional translators who had no prior exposure to the original CFCS and were not involved any of the previous steps.

4) Expert committee review: A five-member expert panel-including two forward translators from Step 1 (i.e., the bilingual SLP and a language professional), two backward translators from Step 3 (i.e., two language professionals), and an additional SLP with over 10 years of clinical experience in pediatric communication disorders who was not involved in earlier steps-evaluated the semantic, idiomatic, and conceptual equivalence of the translated content. Each item was rated using a three-level scale: -1 (not equivalent), 0 (uncertain), and +1 (clearly equivalent to the original CFCS). Suggestions for revision were also provided. The researcher then calculated the Index of Item-Objective Congruence (IOC) for each item. Items with an IOC score below 0.5 were revised according to feedback from the committee.

5) Pre-testing: Five testers-two SLPs who were not involved in any earlier steps, two occupational therapists (OTs), and one parent of an individual with CP-each of whom had at least three months of experience caring for individuals with CP, participated in the review and pilot testing of the CFCS Thai version from the previous step. Subsequently, cognitive interviews were conducted to assess the utility, clarity, and language appropriateness of the instrument, and participants also rated the overall ease of use on a five-point Likert scale, ranging from 'very easy' to 'very difficult'. All suggestions received were incorporated into the Thai pre-final version.

6) Developer review and approval: The revised pre-final version was back-translated again by an experienced translator not involved in previous steps. Both the Thai pre-final version and the new back-translated English pre-final version were submitted to the original CFCS developers for review. The finalized Thai version (CFCS-TH) was subsequently used in Phase 2 of this study to assess content validity, inter-rater reliability, and intra-rater reliability.

Phase 2: Psychometric evaluation of the CFCS-TH (validity and reliability)

Content Validity

Five expert SLPs, all of whom had not participated in any prior steps, evaluated the content of the instrument to determine its alignment with the intended measurement objectives, thereby determining its content validity. The item-level content validity index (I-CVI) and scale-level content validity index using the average method (S-CVI/Ave) were calculated based on expert ratings using a 4-point scale: 1 as not relevant, 2 as needs major revision, 3 as needs minor revision, and 4 as relevant to the measurement objective.[21,22]

Inter-rater and intra-rater reliability

As a result of the restrictions caused by the COVID-19 pandemic, access to individuals with CP and their parents was limited. Consequently, the sample size of this study was determined using the methodology for Cohen's kappa statistics that was proposed by Bujang et al. [23]. This method specifies that a five-level categorical scale with a minimum weighted kappa (k_2) of 0.4, a null hypothesis kappa (k_1) of 0, an alpha level of 0.05, and a power of 80% requires a minimum sample size of 15 participants. The target sample size was increased to 35 participants to accommodate potential classification imbalances and participant departure (estimated at 15%).

Participants, study design, and setting

Participants in Phase 1

Phase 1 included four participant groups, comprising speech-language pathologists (SLPs), translators, occupational therapists (OTs), and a parent of an individual with CP, each contributing to specific steps based on defined roles and qualifications.

Speech-Language Pathologists (SLPs): Four SLPs were directly involved in the translation process. One bilingual SLP conducted the forward translation in Step 1, participated in the synthesis in Step 2, and served as a member of the expert panel in Step 4. Another SLP from the Rajanukul Institute, who had over five years of pediatric experience, participated in Step 4 as an expert reviewer. Two others from Chiang Mai University, each with at least three months of experience caring for an individual with CP, were involved in pre-testing in Step 5. Separately, the principal investigator who oversaw the entire translation process, is also an SLP.

Translators: Four professional translators were involved in Phase 1. One translator, without a medical background, conducted the forward translation in Step 1, participated in the synthesis in Step 2, and later contributed to the expert review in Step 4. Two other translators, also without medical background, completed the backward translation in Step 3 and also participated in Step 4. The fourth independent translator carried out the pre-final back-translation in Step 6. None of the translators had prior exposure to the CFCS, and all were selected for their professional translation expertise.

Occupational Therapists (OTs): Two OTs from Chiang Mai University joined the pre-testing in Step 5, each with at least three months of experience caring for an individual with CP.

Parent of the Individual with CP: One parent participated in Step 5, meeting the criteria of Thai fluency and caregiving experience of at least three months.

Participants in Phase 2

Content-validity panel: The content validity of the CFCS-TH was evaluated by a panel of five SLPs from various institutions, including the Department of Communication Sciences and Disorders at Ramathibodi Hospital and the Sirindhorn National Medical Rehabilitation Institute, as well as private clinics and non-profit organizations specializing in augmentative and alternative communication (AAC). These experts had a minimum of 10 years of experience working with individuals with communication difficulties, including cerebral palsy, and utilizing AAC devices. Expert feedback was solicited primarily by postal mail and email. Despite follow-up reminders sent through both email and private social media messaging after the submission deadline, one expert did not respond. Consequently, the final analysis was based on the feedback provided by the four experts who completed the evaluation.

Reliability study participants: Participants in the CFCS-TH reliability study comprised two groups: individuals with CP and raters (parents, one SLP, and two PTs). Purposive sampling was employed to recruit the individuals with CP and their parents. The individuals with CP (N=35) were recruited from the Rajanagarindra Institute of Child

Development (N=15) and Srisangwan Chiangmai School (n = 20) with the following inclusion criteria: (a) individuals with CP aged between 2 and 18 years, (b) use of Thai as their primary language, and (c) provision of parental or guardian consent for participation in the study. The mean age of participants was 11 years and 1 month. The majority of subjects exhibited spastic diplegia or spastic hemiplegia. Table 1 reports general demographic data of the individuals with CP.

The parent raters consisted of 35 caregivers of individuals with CP, including 20 parents or family members and 15 homeroom teachers assigned to the boarding individuals, who met the following inclusion criteria: 1) ability to communicate in Thai, 2) fluency in reading Thai, and 3) at least three months of caregiving experience with an individual with CP. Table 2 presents the demographic characteristics of the parent raters.

Professional raters included one physical therapist (PT) from each setting and one speech-language pathologist (SLP), who also served as the principal investigator.

Table 1. General information of individuals with cerebral palsy.

Information	Number	Percentage (%)
Sex (N=35)		
Male	18	51.43
Female	17	48.57
Age (N=35)		
Under 5 years	3	8.57
5-7 years	3	8.57
7-12 years	13	37.14
12-18 years	16	45.72
Types of cerebral palsy (N=35)		
Spastic hemiplegia	7	20
Spastic diplegia	21	60
Spastic triplegia or quadriplegia	3	8.57
Other types of CP	4	11.43
Communication partners in daily life (multiple responses allowed)		
Family members (N=35)	35	100
Teachers and peers (N=35)	27	77.14
Other Individuals in daily life (unfamiliar) (N=35)	17	48.57

Table 2. General information of parents or caregivers.

Information	Number	Percentage (%)
Sex (N=35)		
Male	6	17.14
Female	29	82.86
Age (N=35)		
20-29 years	8	22.86
30-39 years	9	25.71
40-49 years	12	34.29
50 years and above	6	17.14
Education Level (N=35)		
Primary education	7	20
Lower or upper secondary education	4	11.43
Higher vocational certificate	1	2.86
Bachelor's degree	19	54.28
Postgraduate degree	4	11.43
Relationship to the individual with cerebral palsy (N=35)		
Father or mother	16	45.71
Relatives	4	11.43
Homeroom teacher	15	42.86

Research methods

The communication function level of each participating individual with CP was independently classified by one parent, one SLP, and one PT using the CFCS-TH on two occasions, with a 2-to-7-week interval between sessions. Before rating, parents received a 10- to 15-minute briefing on the tool's purpose and content, had the opportunity to ask questions, and then independently reviewed and completed the classification during the scheduled session. The professional raters independently classified the individual with CP's communication level following each therapy session.

After all data were collected, the classification results were analyzed to determine the level of agreement using weighted kappa statistics.[24] Interrater reliability analysis was conducted across three rater pairings: SLP vs PT, SLP vs. caregiver, and PT vs. caregiver. Further examination was performed by dividing interrater reliability data according to the first and second ratings. The level of agreement between each rater group was determined to increase the overall statistical power of the reliability calculations. Intra-rater reliability analysis was assessed to evaluate the consistency of each rater's classifications between the first and second ratings. The analysis was performed separately for each rater group (SLPs, PTs, and parents) to determine the stability of their classifications over time.

Ethical considerations

Ethical approval for this study was obtained from the Human Research Ethics Committees of the Faculty of Associated Medical Sciences, Chiang Mai University, Chiang Mai (Approval ID: AMSEC-65FB-003), and from the Human Research Ethics Committees of Suan Prung Psychiatric Hospital, Chiang Mai (Approval ID: SPH. IRB005/2565SCs_Ful). Data collection commenced only after receiving formal approval.

Statistical analysis

Evaluation of equivalence: In step 4 of the translation procedure, the item-objective congruence index (IOC) was used to assess the equivalence of the CFCS-TH. Items with an IOC score below 0.50 were revised according to recommendations from the expert committee.[25]

Content validity: The content validity index (CVI) was calculated at both the item level (I-CVI) and scale level (S-CVI/Ave) based on expert assessments. Items with an I-CVI below 0.78 were revised, [21, 22] and the S-CVI/Ave was required to meet a minimum threshold of 0.80.[21]

Reliability: Inter-rater and intra-rater reliability were determined by calculating weighted kappa statistics. The expected inter-rater reliability was considered acceptable at a fair level of agreement (≥0.41),[10-15] while intra-rater reliability was considered good (≥0.61)[10-

[15] based on weighted kappa values.[24] Agreement levels were classified as follows: <0.20 indicated poor agreement, 0.21-0.40 slight agreement, 0.41-0.60 fair agreement, 0.61-0.80 good agreement, 0.81-0.91 very good agreement, and >0.92 excellent agreement.[24]

Results

Phase 1: Cross-cultural translation of the CFCS-TH

The six-step cross-cultural adaptation process began with forward translations conducted by a bilingual SLP and a lay translator, ensuring linguistic accuracy by incorporating perspectives from both an expert in the field and a non-expert translator while preserving the conceptual intent of the original CFCS. Step 2 yielded a synthesized version that integrated input from both translators, resulting in a culturally appropriate preliminary draft. In Step 3, back-translation confirmed preliminary semantic equivalence with the original version and was reviewed prior to further validation steps. The subsequent steps focused on evaluating the equivalence, usability, and final approval of the translated version.

In Step 4, the Item-Objective Congruence (IOC) scores from expert reviews confirmed that the translated items were well aligned with the original instrument in both meaning and structure. Semantic equivalence ranged from 0.60 to 1.00, and conceptual equivalence scores were between 0.80 and 1.00. However, idiomatic equivalence ranged from 0.40 to 1.00, with one item requiring revision for clarity by modifying the phrase “in a typical manner” to “generally” and restructuring the sentence to improve coherence.

In Step 5, feedback from five testers indicated that they understood the classification system as intended, with usability ratings ranging from “moderately easy” (one parent) to “easy” (all four professionals: two SLPs and two OTs). Based on the testers’ suggestions, the pre-final version was revised by improving phrasing, reorganizing content to reduce misinterpretation, and eliminating ambiguous terms.

In Step 6, the original developers reviewed the back-translated pre-final version of the CFCS-TH and raised questions about the wording of certain terms. After clarification was provided, they accepted the explanations and officially approved the translation on November 10, 2022. This approval confirmed both the linguistic accuracy and cultural relevance of the Thai version and marked the successful conclusion of the cross-cultural adaptation process.

Phase 2: Psychometric evaluation of the CFCS-TH

Content validity of the CFCS-TH

The item-level content validity index (I-CVI) was calculated as 1.00 for all items, and the scale-level content validity index (S-CVI/Ave) was also 1.00. These results indicated that the CFCS-TH demonstrated excellent content validity, confirming that the tool accurately measures its intended construct.

Reliability of the CFCS-TH

Inter-rater reliability

Inter-rater reliability was initially analyzed using the combined classification data from both rating rounds. The weighted kappa values indicated good agreement between the SLP and PT (ƙ=0.71, 95% CI: 0.60-0.81), good agreement between the SLP and parents (ƙ=0.66; 95% CI: 0.54-0.77), and fair agreement between the PT and parents (ƙ = 0.55, 95% CI: 0.44-0.67), as shown in Table 3. These combined results were consistent with previous validation studies of other CFCS language versions and were included in the original thesis report.

To further investigate potential differences across time points, inter-rater reliability was also analyzed by separating the data from the first and second classifications. In the first classification round, weighted kappa values indicated good agreement between the SLP and PT (ƙ=0.73, 95% CI: 0.60-0.87), fair agreement between the SLP and parents (ƙ=0.61, 95% CI: 0.44-0.77), and moderate agreement between the PT and parents (ƙ=0.48, 95% CI: 0.32-0.65), as shown in Table 3.

In the second classification round, the agreement between the SLP and PT decreased slightly (ƙ=0.69, 95% CI: 0.53-0.84), the SLP-parent agreement remained stable (ƙ=0.66, 95% CI: 0.54-0.77), and the PT-parent agreement improved (ƙ=0.62, 95% CI: 0.47-0.77), as shown in Table 3. These results provide a more nuanced view of inter-rater agreement over time and offer further insight into the consistency and responsiveness of the CFCS-TH when used across different rater pairings.

Intra-rater reliability

The intra-rater reliability of the SLP was excellent (ƙ=0.92; 95% CI: 0.84-0.99). The PT also demonstrated excellent intra-rater reliability (ƙ=0.91, 95% CI: 0.83-1.00). Caregiver intra-rater reliability was substantial (ƙ=0.86, 95% CI: 0.73-0.99), indicating consistent classifications across sessions. Communication function classification results by raters between the first and second ratings are presented in Table 4.

Table 3. Summary of inter-rater reliability for CFCS-TH classifications between rater groups with different classification rounds.

Rater pairing	Classification round	Number of rating pairs	Weighted kappa value (k; 95% CI)	Interpretation
SLP vs PTs	Combined	70	0.71 (0.60-0.81)	Good
SLP vs PTs	First	35	0.73 (0.60-0.87)	Good
SLP vs PTs	Second	35	0.69 (0.53-0.84)	Good
SLP vs Parents	Combined	70	0.66 (0.54-0.77)	Good
SLP vs Parents	First	35	0.61 (0.44-0.77)	Good
SLP vs Parents	Second	35	0.66 (0.54-0.77)	Good
PTs vs Parents	Combined	70	0.55 (0.44-0.67)	Fair
PTs vs Parents	First	35	0.48 (0.32-0.65)	Fair
PTs vs Parents	Second	35	0.62 (0.47-0.77)	Good

Note: SLP: speech-language pathologist, PTs: physical therapists, parents: caregivers of the individuals with CP. Weighted kappa (k) values were used to assess inter-rater reliability across rater pairs, based on CFCS-TH classification results between the combined, first, and second classification rounds. The interpretation of k values was based on criteria: <0.20=poor agreement, 0.21-0.40=slight, 0.41-0.60=fair, 0.61-0.80=good, 0.81-0.91=very good, and >0.92=excellent agreement.

Table 4. Summary of intra-rater reliability for CFCS-TH classifications across rater groups.

Rater	Number of Rating pairs	Weighted kappa value (k; 95% CI)	Interpretation
SLP	35	0.92 (0.84–0.99)	Very good
PTs	35	0.91 (0.83–1.00)	Very good
Parents	35	0.86 (0.73–0.99)	Very good

Note: SLP: speech-language pathologist, PTs: physical therapists, parents: caregivers of the individuals with CP. Weighted kappa (k) values were used to assess inter-rater reliability across rater pairs, based on CFCS-TH classification results between the combined, first, and second classification rounds. The interpretation of k values was based on criteria: <0.20=poor agreement, 0.21-0.40 slight, 0.41-0.60= fair, 0.61-0.80=good, 0.81-0.91=very good, and >0.92=excellent agreement.

Discussion

The purposes of this study were to culturally adapt the Communication Function Classification System (CFCS) into Thai and to evaluate its psychometric properties through a structured two-phase approach. Phase 1 involved the cross-cultural adaptation process, which resulted in the finalized Thai version of the CFCS (CFCS-TH). Phase 2 assessed the content validity, inter-rater reliability, and intra-rater reliability of the adapted tool. The findings from both phases are examined in the following sections, concerning relevant empirical studies.

Phase 1: Cross-cultural adaptation of the CFCS-TH

The cross-cultural adaptation of the CFCS into Thai (CFCS-TH) in this study placed particular emphasis on ensuring that sentence structures and terminology were appropriate for both professionals and laypersons while maintaining the intended meaning of the original classification system. The translation process was carefully structured to preserve the conceptual integrity of the tool, with the forward-backward translation approach playing a crucial role in ensuring accuracy and balancing the perspectives of an SLP and a layperson.

In Step 4, the Item-Objective Congruence (IOC) scores from expert reviews confirmed that the translated items were well aligned with the original instrument in both meaning and structure. Most terms achieved direct semantic equivalence. However, one phrase required minor revision to ensure idiomatic clarity. Expert feedback also helped ensure that the terminology was not only linguistically appropriate but also clinically relevant, thereby enhancing the overall validity of the CFCS-TH.

In Step 5, results from the cognitive interviews indicated that testers with varied professional and personal perspectives, including one parent, two SLPs, and two OTs, generally understood the classification system as intended and offered suggestions to improve its clarity and usability. Of the five testers, four professionals (80%) rated the CFCS-TH as “easy to apply”, while the caregiver (20%) rated it as “moderately easy to apply”. These usability ratings closely align with

those reported by Soleymani et al.[12], who evaluated the Farsi version of the CFCS and found that 70% of testers rated it as "very easy to apply", 20% as "easy to apply", and 10% as "fairly easy to apply". This similarity in rating patterns supports the cross-cultural applicability and face validity of the CFCS across different language contexts. Although some descriptors involved technical language, participants reported that layout features, such as the font emphasis and use of examples, facilitated understanding of the classification levels. Feedback suggested that users were better able to distinguish among levels when they clearly understood the key variables. Based on these findings, it is recommended that a brief orientation or instructional guide be provided prior to implementation.

In Step 6, the original developers reviewed the back-translated pre-final version of the CFCS-TH and approved the Thai version without requesting any modifications, although they raised a few minor questions regarding specific word choices. This approval not only confirmed the linguistic accuracy and cultural relevance of the translation but also marked the successful conclusion of the cross-cultural adaptation process, supporting the tool's readiness for psychometric evaluation in Phase 2.

Phase 2: Psychometric evaluation of the CFCS-TH

Content validity of the CFCS-TH

The content validity evaluation of the CFCS-TH faced a limitation due to the unavailability of one expert reviewer, resulting in an analysis based on the opinions of four experts. Despite this, the number of reviewers was considered adequate for a valid assessment of content validity.[21,22] The I-CVI was 1.00 across all components, exceeding the threshold for necessary revision, while the S-CVI/Ave was also 1.00, meeting established quality criteria. Despite being based on four experts rather than five as originally planned, a hypothetical scenario assuming the lowest possible rating from the fifth expert still resulted in an I-CVI above 0.78 and an S-CVI/Ave of 0.80, both of which satisfy established validity standards. Therefore, it can be concluded that the CFCS-TH is a valid tool that effectively measures communication functions in line with its intended purpose.

In other language versions of the CFCS, concurrent validity evaluation has typically been conducted by comparing CFCS classifications with the social function subscale of the Pediatric Evaluation of Disability Inventory (PEDI)[11, 13, 14]. However, this method could not be used in this study due to the lack of a Thai version of PEDI or any other standard Thai-language tool for comparison.

Reliability of the CFCS-TH

Inter-rater reliability

When analyzing inter-rater reliability, weighted kappa statistics revealed that the CFCS-TH exhibited moderate to good reliability across different rater groups. These findings indicate that the CFCS-TH has acceptable inter-rater reliability, aligning with the original CFCS, which also demonstrated moderate to good agreement. When compared to other language adaptations of the CFCS, inter-rater reliability findings ranged from moderate to excellent. The results of this study closely matched those reported in the CFCS-NL (Dutch version) by Zwart *et al.*,[11] where inter-rater reliability among SLPs was also classified as good (k=0.78, 95.5% CI: 0.66–0.89). The findings were further corroborated by studies of the CFCS-FS (Farsi version) by Soleymani *et al.*,[12] and the CFCS-KR (Korean version) by Choi *et al.*,[14] both of which demonstrated very good agreement between SLPs and therapists (k=0.81-0.87). These levels of agreement indicate that the CFCS-TH is a sufficiently robust classification tool for evaluating communication functions across diverse evaluator types.

Multiple factors may contribute to the observed variation in inter-rater reliability between the CFCS-TH and other language versions. One such factor is participant age, as previous studies have reported increased inter-rater reliability in individuals with CP aged five years and older. For instance, Hidecker *et al.*,[10] observed higher reliability among older individuals with CP, while Wang *et al.*,[13] found that inter-rater agreement was greater in individuals aged 4-16 years compared to those aged 2-4 years. Studies of the CFCS Korean version[14] and CFCS Turkish version[15] similarly noted higher reliability when participants were at least four years old. Given that the majority of participants in this study were older than seven years, it is likely that participant age contributed to the observed level of inter-rater reliability.

Parental education level was another influential factor. In this study, 80% of parents had at least a lower secondary education, which may have contributed to the good agreement between SLPs and parents. This aligns with findings by Mutlu *et al.*,[15] who reported higher inter-rater reliability when parents had higher education levels. More educated parents were better able to comprehend the definitions and criteria underlying the communication classifications, thereby producing more consistent assessments.[14,26] However, highly educated parents may also have elevated expectations of their children, which could influence their rating decisions and, consequently, impact inter-rater reliability.[26]

The lower agreement between PTs and parents in this study may have been influenced by limited prior exposure to the CFCS-TH among raters. [27,28] Neither the PTs nor parents had prior experience using the CFCS-TH, which may have contributed to variability in their interpretation of communication function levels. Previous studies, such as those by Choi *et al.*,[14] have found that experienced raters demonstrated higher inter-rater reliability. Similarly, Soleymani *et al.*,[12] reported improved reliability after providing additional

orientation and training with the CFCS-FS. These findings suggest that future applications of the CFCS-TH could benefit from structured training sessions or familiarity-building activities before use.[28]

To provide a more detailed perspective, the present study conducted an additional analysis by separating inter-rater reliability data based on the first and second assessment sessions. The resulting weighted kappa values offered further insight into the stability of agreement patterns over time. Agreement between the SLP and PT remained substantial across both sessions (κ=0.73 and κ=0.69, respectively), indicating stable interpretability of the CFCS-TH among professional raters.

The SLP-parent pairing demonstrated moderate agreement in both rounds (κ=0.61 and κ=0.66), suggesting that minimal exposure to the instrument may have enhanced parents' ability to apply the classification criteria in a manner more aligned with professional judgment. A similar pattern was observed between PTs and parents, whose agreement improved from fair (κ=0.48) in the first round to moderate (κ=0.62) in the second. This improvement may reflect a familiarity effect, wherein lay raters became more adept at applying CFCS-TH categories with repeated use.

Taken together, these results suggest that, although professional raters initially exhibit more consistent agreement, parents can achieve comparable reliability with increased exposure and appropriate orientation. These findings are consistent with prior evidence indicating that factors such as rater experience, participant age, and parental education level play a significant role in inter-rater agreement. As noted previously, the majority of individuals with CP participating in this study were older than seven years, and most parents had at least a lower-secondary level of education, both of which are factors known to contribute positively to reliability outcomes.

In conclusion, this study found that the CFCS-TH produced moderate to good inter-rater reliability across diverse rater groups, including both professionals and parents. These results are consistent with previous validations of the original and adapted CFCS versions, supporting the cross-cultural robustness of the instrument. Furthermore, the additional session-based analysis confirmed the temporal consistency of classification outcomes and revealed a potential familiarity effect among layperson raters. Collectively, these results affirm the CFCS-TH as a reliable and practical tool for assessing communication function in individuals with CP. With appropriate training or orientation, it holds promise for widespread use across clinical, educational, and community-based contexts.

Intra-rater reliability

The intra-rater reliability of the CFCS-TH was found to be very good and excellent, consistent with previous studies on the original CFCS and its various language adaptations (e.g., Dutch, Farsi, Korean, and Turkish), which also reported high levels of intra-rater reliability.[10-15] The methodologies employed in previous studies on translated versions of the CFCS exhibited certain variations, including differences in the types of raters involved, the number of raters per study, and the time intervals between assessments. The typical rater groups across these studies have included SLPs,[11,12,14] PTs,[14] Ots,[12] multidisciplinary professionals,[10] and parents.[12,14] The number of raters per group has varied significantly, with some studies involving a single rater per classification group,[14] while others have included between two and four raters,[11,12] and some studies have involved as many as 48 raters.[10] The time interval between the first and second classification assessments has also differed, ranging from retesting within two weeks,[14] to a minimum of two weeks,[10,12] and at least seven weeks apart in some cases.[11] Despite these methodological differences, the high consistency in results across studies confirms that both the CFCS-TH and other translated versions are robust tools with strong intra-rater reliability.

Additionally, a common finding in all studies,[10-12,14] is that intra-rater reliability among parents tends to be lower than that of professional raters, which is likely due to the same influencing factors previously identified in the inter-rater reliability analysis, including participant age, parental education level, and prior familiarity with the CFCS-TH.

Limitations

A key limitation of this study was the absence of a standardized Thai-language assessment tool for criterion validity testing, which is commonly used in the evaluation of CFCS adaptations in other languages. Additionally, the study was conducted during the COVID-19 pandemic, which hindered access to the target sample and led to a smaller sample size as a result of adjustments in statistical analysis. Some individuals with CP were students residing at Srisangwan Chiangmai School, meaning their communication functions were necessarily classified by their homeroom teachers rather than their parents or guardians. The sample was also imbalanced, particularly in the 2–4 years age group, which may have impacted inter-rater reliability and limited the generalizability of the findings to younger individuals. For individuals with CP in this age group, a collaborative evaluation involving clinicians and parents may be necessary, or additional factors should be considered to improve inter-rater reliability.

Conclusion

The Communication Function Classification System for Individuals with Cerebral Palsy-Thai Version (CFCS-TH) was demonstrated to be a valid and reliable medical classification tool for assessing the communication performance levels of individuals with CP in their daily lives in Thailand. The findings

of this study support its application in both clinical and research settings by providing a standardized framework for evaluating communication functions and facilitating effective intervention planning.

Ethical approval

This study received ethical approval from the Research Ethics Committee of the Faculty of Associated Medical Sciences, Chiang Mai University (AMSEC-65FB-003), as well as from the Suan Prung Psychiatric Hospital, Chiang Mai (SPH.IRB005/2565SCs_ful) for research involving human participants. Prior to enrollment in this study, all participants and caregivers were provided with all pertinent research information, and written informed consent was obtained.

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Conflicts of interest

The authors declare no conflicts of interest.

CRediT authorship contribution statement

Pim Chaisook: conceptualization, methodology, project administration, formal analysis, investigation, data curation, writing: original draft, visualization; **Phuanjai Rattakorn**: supervision, project administration, data curation, writing: review and edit, funding acquisition; **Supaporn Chinchai**: supervision, project administration, writing: review and edit, funding acquisition; **Wannipa Bunrayong**: supervision, project administration, funding acquisition.

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