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FEATURE ARTICLE

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Cognitive assistance to support individuals with traumatic brain injury using a minimal and personalised approach: A conversion mixed methods study using video analysis

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Abstract

Introduction: Individuals with traumatic brain injury (TBI) frequently need assistance to manage complex everyday activities. However, little is known about the types of cognitive assistance that can be used to facilitate optimal independence. A conversion mixed method study using video analysis was conducted to describe assistance provided by trained occupational therapists during three everyday tasks carried out in the participants' homes and surrounding environments.

Methods: Forty-five people with moderate and severe TBI were tested by three occupational therapists using the Instrumental Activities of Daily Living Profile, an observation-based assessment that documents independence in complex everyday activities and the minimal assistance required to attain task goals. Using video analysis, difficulties experienced by the people with TBI during a meal preparation and grocery shopping task, and the cognitive assistance provided by the occupational therapists in response to these difficulties, were documented. Statistical analyses were also completed to identify the main difficulties and types of cognitive assistance provided during the evaluation, for the whole group and depending on their level of independence.

Results: Nine types of cognitive assistance were used by occupational therapists, including implicit (stimulating thought processes), and more explicit assistance (cueing), to facilitate task performance. When needed, motivational assistance, which consisted of encouraging participants to think for themselves, was also used. Stimulating thought processes was mostly used to support goal formulation and planning, whereas cueing was used in numerous instances. Participants with lower levels of independence received more assistance of almost all types to support them.

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Conclusion: Using these findings, training could be developed for caregivers and occupational therapists to support them in providing minimal and personalised cognitive assistance. Further research is needed to examine the extent to which all types of cognitive assistance are effective in helping various cognitive profiles of people with TBI attain optimal independence.

KEYWORDS
activities of daily living, brain injuries, cognition, cognitive rehabilitation, task performance and analysis

1 | INTRODUCTION

People with moderate to severe traumatic brain injury (TBI) may require the use of canes, crutches, or wheelchairs to enhance their independence and compensate mobility impairments. But do parallel means exist to compensate cognitive deficits? It is well known that people with TBI frequently require assistance or cueing for the completion of complex everyday activities that are impacted by executive function deficits, such as budgeting and meal preparation (Baum et al., 2017; Bottari et al., 2011; Dubuc et al., 2019). Cognitive rehabilitation involves both teaching cognitive strategies to the individuals themselves and training caregivers to provide cues/prompting to facilitate goal-directed activities. However, as many individuals post severe TBI are discharged home and continue to have high support needs even 5 years post-injury (Tate et al., 2020), caregivers are often left to provide necessary cognitive support 24/7, leading to high caregiver burden (Lamontagne et al., 2009). But what knowledge base can be used to help guide these families as they struggle to provide cognitive support to their loved ones while also respecting their need to function on their own despite their deficits and associated risks? Just as therapists would not consider giving a wheelchair to someone who can manage with a cane, understanding how to guide caregivers to provide the right amount and type of cognitive assistance to facilitate independence, without limiting the TBI person's desire for autonomy, remains a priority. Hence, there is an urgent need to initiate research studies designed to provide a greater understanding of the concept of cognitive assistance and how well-designed assistance can help people with TBI regain more control over their lives and optimise their independence.

Cognitive assistance is defined as verbal, visual, auditory, or gestural cues provided to people with cognitive impairments to facilitate greater independence and ensure safety when performing a task (Olivares et al., 2016; Serna et al., 2010; Van Tassel et al., 2011).

Key Points for Occupational Therapy

- Nine types of cognitive assistance were provided, including implicit (stimulating thought processes) and explicit assistance (cueing).
- Motivational assistance was provided to encourage participants to do as much as possible on their own.
- Motivational and implicit assistance were provided to most participants to optimise their independence.

Contrary to physical assistance, cognitive assistance aims to support cognitive processes, similar to 'a form of supported thinking' (Le Dorze et al., 2014, p. 12). Such assistance supports people living with cognitive deficits in their daily activities and can be provided by a person (e.g., informal or formal caregivers and occupational therapists) or through technology (Best et al., 2013; Seelye et al., 2012; Wang et al., 2014).

Chard et al. (2009) and Seelye et al. (2012) previously stated the importance of providing assistance in a progressive manner. This principle of using progressive assistance, first using nonspecific prompts (e.g., *Can you stop and check where you are up to?*) followed by specific cues, was described in various approaches in cognitive rehabilitation, including in the context of error-based learning (Ownsworth et al., 2017), the training of metacognitive strategies such as CO-OP (Dawson et al., 2009), and the multicontext approach (Toglia et al., 2011, 2010). By providing such progressive assistance, therapists can help people with TBI identify and correct errors (i.e., self-discovery), as well as use relevant strategies, thus optimising their self-awareness and ability to generalise learnings.

Serna et al. (2010) further described cognitive assistance provided through technology specifying that assistance should be (1) not more than necessary, (2) provided at the right moment, (3) acceptable to the person,

(4) perceptible and (5) efficient in helping the person attain the goals. Coherent with this description of cognitive assistance, Ylvisaker et al. (2003) highlighted the usefulness of 'supported cognition' as a way of mentoring people with TBI when completing complex everyday activities. This person-centred and interactive approach is embedded in a contextualised paradigm, which emphasises the context, routines, and natural supports of the person with TBI (Ylvisaker et al., 2002). Supports such as modeling and cueing provided within a functional performance context (e.g., meal preparation within the person's home) facilitate engagement and accomplishment of meaningful tasks. Nonetheless, providing such contextualised and progressive assistance when supporting people with TBI in everyday activities (i.e., only how much and only when necessary) requires a solid understanding of the underlying cognitive processes associated with observed difficulties, as well as the types of cognitive assistance that are necessary in multiple contexts.

One means of examining assistance in relation to underlying difficulties is to explore the assistance that is provided within assessment contexts where the assistance needs of individuals with physical or cognitive deficits are determined, such as with the Instrumental Activities of Daily Living (IADL) Profile (Bottari et al., 2010b). The IADL Profile is an ecological evaluation tool that explicitly aims to determine optimal abilities and the degree of independence of individuals with brain injury while providing them with minimal assistance to accomplish complex everyday tasks (Bottari et al., 2010b). Based on the model of Lezak (1982) on executive functioning, the IADL Profile assesses experienced difficulties on the basis of four task-related operations, which are the ability to formulate a goal, plan, carry out the plan, and verify goal attainment. Using this evaluation, occupational therapists can qualify observed difficulties and their impact on performance and test within the assessment process potential interventions and types of cognitive assistance that could then be included in the intervention plan to support the person in relation to these difficulties in everyday activities (Coelho et al., 2005; Gagnon-Roy et al., 2021). In one of the rare studies of cognitive assistance within an evaluation context, Gagnon-Roy et al. (2021) explored the clinical reasoning used by occupational therapists when deciding the amount and types of cognitive assistance to provide to individuals with TBI during the IADL Profile evaluation (Bottari et al., 2010b). In this study, numerous factors were found to explain how therapists progressively provide cognitive assistance, including the 'Presence of safety and/or emotional issues', 'Lack of progress in the task', and 'Requests for help'. In their analysis, the authors emphasised the link between the person's difficulties and behaviours and the amount and type of cognitive assistance provided in response. Using this same context (i.e., during the IADL Profile), Le Dorze et al. (2014) completed a detailed analysis of contextualised cognitive assistance provided verbally to facilitate the performance of two individuals with severe TBI when planning a single task, that is, obtaining an information consisting of a schedule of inter-city bus departures. For both participants, restarting their thinking, which was an implicit assistance aimed at refocusing the person's attention towards pursuing the ongoing task, was frequently used. Direct assistance was often provided later in the evaluation to help participants' progress in the task, when previous more implicit assistance had failed to help them attain the task goal. However, to our knowledge, little is known about how contextualised cognitive assistance should be provided to support individuals with various assistance needs during other complex tasks (e.g., preparing a hot meal) including several task-related components (e.g., formulating goals and carrying out the task).

To further understand cognitive assistance, the present study aimed to explore the assistance provided verbally by trained occupational therapists to individuals with TBI during an ecological evaluation administered in their home and surrounding environment. Specifically, this study aimed to (1) describe difficulties experienced by individuals with TBI during the evaluation of multiple complex everyday tasks and (2) define and identify the types of cognitive assistance provided verbally in relation to identified difficulties. As an exploratory search for the cognitive equivalents of canes, crutches, and wheelchairs, this study also aimed to (3) explore potential associations between the level of independence of these individuals and the amount and types of cognitive assistance provided to support them. Ultimately, this study should provide an initial understanding of difficulties experienced by individuals with TBI in complex everyday activities carried out in a real-world environment and how cognitive assistance can be provided to support them.

2 | METHODS

2.1 | Study design

This study was conducted using a conversion mixed design (Corbière & Larivière, 2014) with video data analysis (Nassauer & Legewie, 2018). This mixed method design was chosen as it allowed us to collect and analyse data using one methodological approach, here qualitative, followed by a conversion or transformation of the data using the other approach, here quantification, to enrich the analysis process (Bazeley, 2017; Teddlie &

Tashakkori, 2006). Moreover, videos were selected as the primary way of collecting data as they provide a unique opportunity to examine experienced difficulties and cognitive assistance embedded within a context, social interactions, and sequence of actions (Nassauer & Legewie, 2018; Pierce, 2005). Such designs are increasingly used in qualitative research (e.g., Lynch and Stanley (2018); Patterson et al. (2021)). First, qualitative data were analysed to identify and describe in an inductive manner difficulties experienced by individuals with TBI during three complex tasks, and various types of cognitive assistance provided by trained occupational therapists. Second, video data were again analysed to quantify the difficulties experienced by the individuals with TBI, and the types of cognitive assistance provided in response. Included videos were part of a database of approximately 100 videos of individuals with moderate to severe TBI tested with the IADL Profile in an earlier study (Bottari et al., 2009b). Each evaluation was completed by one of three occupational therapists previously trained with the IADL Profile, accompanied by an observer. The ethical review board of the Centre for Interdisciplinary Research in Rehabilitation of Greater Montreal (CRIR-1173-0616) approved this study, and all participants consented to being filmed and that their videos be used in studies linked to the IADL Profile tool.

2.2 | Participants

Using purposive sampling, various participants living with a moderate to severe TBI, aged between 16 and 65 years and videotaped during their assessment with the IADL Profile were selected. The severity of the participants' TBI was estimated using the Glasgow Coma Scale score (severe = score of 8 and less; moderate = between 9 and 12) (Teasdale & Jennett, 1974) and the duration of post-traumatic amnesia (moderate = 1–14 days; severe = several weeks). First, potential participants were identified in collaboration with the last author (CB) who was involved in previous studies on the IADL Profile, based on independence scores and difficulties experienced during the IADL Profile, as recorded in their research files from the previous study (Bottari et al., 2009b). Participants were selected if they (1) required cognitive assistance to progress in at least one operation (i.e., formulating a goal, planning, carrying out, and verifying goal attainment) of one of the three tasks, (2) presented a broad variety of difficulties typically observed in this clientele, and (3) provided a range of independence levels and living contexts. Second, videos of potential participants were screened to ensure their compliance with inclusion criteria. Sampling of participants was deemed complete once video analysis of included participants revealed data saturation in terms of the types of cognitive assistance provided verbally by the evaluators. More specifically, data saturation was defined as the point where no new types of cognitive assistance were identified, despite variabilities in terms of participant difficulties, levels of independence, living contexts, and evaluators (Fusch & Ness, 2015).

Participants included in the present study were assessed by three trained occupational therapists working with TBI clients in rehabilitation centres (CB, CL, and MT). They had no previous contact with the participants and had little information (e.g., contraindications) before the evaluation. All three evaluators were previously trained with the IADL Profile, including how to provide minimal and personalised cognitive assistance during the evaluation. Training was provided through a 3-day workshop and observations of 5 to 10 evaluations administered by the tool developer (CB). In addition, to learn how to administer and score the IADL Profile, occupational therapists were made aware of the impact of cognitive assistance on their analysis of the performance of their clients, and the need to provide assistance only when and how much was required. Their level of clinical experience varied greatly: MT had limited clinical experience, whereas CL and CB had respectively 5 and 10 years of experience with the clientele. However, both CL and MT had the opportunity to observe, videotape and discuss evaluations completed by CB to ensure compliance of their evaluations to the tool's guidelines.

2.3 | Data collection and analysis

2.3.1 | Evaluation tool

The IADL Profile, an ecological observation-based tool, was chosen to examine the phenomenon of cognitive assistance as it was designed to determine the difficulties experienced by individuals with TBI within tasks carried out in their home and surrounding environment and explore related assistance needs. This evaluation tool documents independence in eight everyday tasks on the basis of four task-related operations that particularly consider executive functions, defined as the ability to (1) formulate a goal, (2) plan, (3) carry out the plan to reach the goal, and (4) verify goal attainment (Lezak, 1982). More precisely, this psychometrically sound ecological tool (Bottari et al., 2009a, 2009b, 2010a, 2010b) comprises three scenarios carried out in the person's home and surrounding environment, of which three tasks were included in this study: going to the grocery store, shopping for food, and preparing a hot meal. These tasks were

selected as meal preparation is an intervention priority for individuals with severe TBI (Levasseur et al., 2016). Using a minimally directive approach, the IADL Profile promotes the exploration of both goal formulation and planning by allowing individuals to identify their own goals and plans in interaction with their real-world environment. Throughout the administration of the IADL Profile, the therapist must provide only a minimal amount of personalised and progressive cognitive assistance to facilitate the individual's progression towards the goal of the task. Using a non-structured approach, assistance is provided in a dynamic way based on the individual's difficulties and the evaluator's clinical reasoning and growing understanding of their patient's assistance needs (Gagnon-Roy et al., 2021). By providing the least amount of cognitive assistance, and only when necessary, the evaluator can document difficulties experienced by the person and their optimal level of independence (i.e., optimal capacity for independent thinking when performing a task) in their daily activities within their home and surrounding environments. Based on this premise, assistance is only provided in a progressive manner in case of safety and/or emotional issues, and inability to progress in the task (Gagnon-Roy et al., 2021). The time lapse between an observed difficulty and the provision of an assistance is not specified in the IADL Profile guidelines. However, except when safety issues are observed, it far exceeds similar studies that suggest waiting about 15 s prior to providing feedback on an error (e.g., Thomas & Marsiske, 2014).

The IADL Profile is scored on a total of 118, corresponding to the summation of the scores obtained per task-related operations for each task. For each operation, independence is scored using a five-point ordinal rating scale: Independent (4); Independent with difficulty (3); Requiring verbal or physical assistance (2); Requiring verbal and physical assistance (1); and Dependent (0). An average score is then calculated per task and interpreted using the same scale. For example, a person who had a score of 2.75 for meal preparation (3; 2; 3; 3) will be considered independent with difficulty for this task. Inter-rater reliability of the IADL Profile was found to be moderate to almost perfect (Bottari et al., 2010b).

2.3.2 | Video data analysis—Creation of codes

Of the 50 potential participants that were screened, 45 videos from IADL Profile evaluations met inclusion criteria and were included in the study. This number of participants was deemed sufficient to obtain and ensure saturation of potential types of cognitive assistance and difficulties, as no more codes were identified after coding of the first 20 videos. These were analysed using the cycle of coding and analysis described by Jacobs et al. (1999). This cycle was pertinent for this study as it allows the integration of both qualitative and quantitative approaches. Using an evolving extraction grid, three of the authors (MGR, SB and GP) repeatedly watched and discussed the videos to generate preliminary codes about the different difficulties individuals with TBI experienced during the evaluation and the types of cognitive assistance that were provided by the evaluators to facilitate task progression and safety. For each moment of difficulty and assistance, qualitative data such as the content and the context of the difficulty or the assistance, the interactions between the participant with TBI and the occupational therapist, as well as nonverbal information influencing how the assistance was interpreted by the participant with TBI (e.g., question-specific tone, reassurance, and encouragement including nodding) were documented. Experienced difficulties were documented using the IADL Profile operation-based task-analysis guidelines (Bier et al., 2016; Bottari et al., 2009b, 2010b). Based on the model of Lezak (1982), this task analysis allowed us to document observed behaviours in terms of difficulties when formulating goals, planning, carrying out the task, and verifying the attainment of the goal, thus providing a context in which assistance was provided. The types of cognitive assistance provided verbally by the evaluators were coded and defined based on work by Le Dorze et al. (2014). When applicable, we identified and defined new difficulties and types of cognitive assistance observed within the videos, following discussion between the three authors who did the coding (MGR, SB, and GP), and added these to the extraction grid until data saturation. As a final step, the final extraction grid was validated with two senior authors of the study: an expert in adult communication disorders (GLD), the author of the IADL Profile and one of the three evaluators who assessed participants (CB).

2.3.3 | Video data analysis—Quantitative data

Videos lasted between 1.5 and 4 hours. They were carefully viewed and analysed with the final extraction grid by at least two of the co-authors (MGR, SB, and GP) using StudioCode (VOSAIC, 2016). Two sets of three videos were coded by SBR and simultaneously by another member of the research team (MGR or GP) to validate the previously developed extraction grid. All videos were then coded by SBR using the final version of the

extraction grid. Though inter-rater reliability of coding was not assessed, all videos were independently reviewed by a second member of the research team (MGR). When applicable, disagreements were discussed between SBR and MGR to attain consensus. Moreover, when a therapist provided more than one type of assistance related to one instance of participant difficulty, all assistance types were coded.

Following video data analysis, we sought to identify the most prevalent difficulties and related assistance types. Thus, we tallied the number of moments where a type of cognitive assistance and/or a difficulty was coded in all videos and the number of participants who experienced a specified event. More specifically, we sought to describe (1) the main difficulties experienced by the participants, including by task-related operations and by task, and (2) the most frequently provided type of cognitive assistance, overall and in response to specific difficulties. To attain these objectives, we first applied nonparametric statistical analysis using both Friedman's ANOVA and a post hoc Wilcoxon test to identify the main difficulties experienced by participants by task and operations. These tests were selected as the data was not normally distributed and analysis of the difficulties experienced within specific tasks or operations had to be paired since they all pertained to the same sample of participants. Second, to identify only the most prevalent types of assistance in response to a specific difficulty, only the types of cognitive assistance that were provided to at least five participants and 10 times in total were presented in the results. Finally, for objective 3, which was to explore potential associations between the level of independence of the participants and the amount and types of cognitive assistance provided to support them, participants were distributed into three even groups based on their level of independence on the IADL Profile for all eight tasks: the 15 participants with the lowest scores on the IADL Profile (#1); the15 participants with the middle scores (#2); and the 15 participants with the highest scores (#3). Such comparisons between groups based on scores on the IADL Profile had previously found an association between the total score on the IADL Profile, and concomitant variables related to the injury (i.e., post-traumatic amnesia and coma duration) and executive functioning (scores at the Tower of London and WMI of WMSIII) (Bottari et al., 2009a). When applicable, observed differences between groups were validated using the following statistical tests: ANOVA for continuous variables, and Fisher's exact tests for categorical variables and proportions due to the small number of participants. Because the data were not normally distributed, nonparametric statistical analysis using the Kruskal–Wallis H test was then completed to explore differences between groups regarding the total number of assistances and the types of cognitive assistance that were provided. When differences were significant, a post hoc Dunn–Bonferroni test was completed to compare groups. The same analyses were undertaken to explore variations between groups in terms of the proportion of the total number of cognitive assistances, and the types of cognitive assistance provided as a function of level of independence. All statistical analyses were completed using SPSS 25.

3 | RESULTS

Of the 45 individuals with TBI included in the study, 17 required an assistive device to move around inside or outside, either a cane/walker ($n = 12$) or a wheelchair ($n = 2$). According to the IADL Profile results, 28 participants were considered independent (with or without difficulty) for the task of meal preparation, 15 required assistance to progress in the task, and two were judged to be dependent. Of the participants who were independent, 11 required assistance for at least one operation of the meal preparation task. For grocery shopping, 23 were considered independent (with or without difficulty), 15 required assistance, and seven were dependent, whether they completed the task or not. Of the participants who were independent, 18 required assistance for at least one operation of the grocery shopping task. Participant characteristics as a whole group and for each subgroup based on level of independence according to the IADL Profile are presented in Table 1.

3.1 | Objective 1—Difficulties experienced by individuals with TBI during the evaluation of multiple complex everyday tasks

A total of 862 moments of observed task-related difficulties were documented and judged as requiring assistance by the evaluators. With respect to task difficulty, the main difficulties were observed during the meal preparation task ($n = 465$, 37 participants), followed by grocery shopping ($n = 287$, 37 participants) and going to the grocery store ($n = 110$, 25 participants). Results showed that there was a statistically significant difference in the number of difficulties depending on the task ($x^2(2) = 24.307$, $p < 0.001$), including between meal preparation and going to the grocery store ($Z = -4.577$, $p < 0.001$), and between grocery shopping and going to the grocery store ($Z = -3.802$, $p < 0.001$). No statistically significant difference was however noted between grocery shopping and

TABLE 1 Characteristics of the participants who required cognitive assistance during the evaluation as a group and based on their total score on the IADL Profile.

	Total ($n = 45$)	**Group 1—Lowest scores ($n = 15$)**	**Group 2—Middle scores ($n = 15$)**	**Group 3—Highest scores ($n = 15$)**	**Differences between groups (p-value)**
Score at the IADL Profile (/118), mean (range)	80.89 (30–109)	56.60 (30–73)	85.07 (75–95)	101.00 (96–109)	0.000*
Age, mean (range)	36.11 (17–64)	40.13 (18–59)	35.93 (18–64)	32.27 (17–57)	0.315
Sex, *n* (%)					
Male	39 (86.7)	13 (86.7)	13 (86.7)	13 (86.7)	1.000
Level of education, years, mean (range) Missing data: 1	11.18 (5–18)	11.43 (8–14)	9.80 (5–13)	12.33 (8–18)	0.022*
TBI severity, *n* (%)					
Moderate	12 (26.7)	3 (20.0)	5 (33.3)	4 (26.7)	0.912
Severe	33 (73.3)	12 (80.0)	10 (66.7)	11 (73.3)	
Time post-injury, months, mean (range)	14.32 (2–83)	14.80 (3–83)	15.35 (2–53)	12.80 (5–28)	0.884
PTA duration, days, mean (range)	31.65 (0–150)	42.92 (0–150)	30.90 (0–100)	21.71 (0–61)	0.237
Coma duration, *n* (%) Missing data: 8					
None	14 (31.1)	4 (26.7)	5 (33.3)	5 (33.3)	0.311
Less than 7 days	5 (11.1)	0 (0.0)	2 (13.3)	3 (20.0)	
Between 8 and 14 days	6 (13.3)	5 (33.3)	0 (0.0)	1 (6.7)	
More than 14 days	13 (28.09)	4 (26.7)	5 (33.3)	4 (26.7)	
Glasgow score (/15) at emergency, *n* (%) Missing data: 1					
Score of 3 to 8	32 (71.1)	10 (66.7)	11 (73.3)	11 (73.3)	0.052
Score of 9 to 12	5 (11.1)	4 (26.7)	1 (6.7)	0 (0.0)	
Score of 13 to 15	7 (15.6)	0 (0.0)	3 (20.0)	4 (26.7)	
Living context, *n* (%)					
Alone	9 (20.0)	2 (13.3)	4 (26.7)	3 (20.0)	0.974
With family	33 (73.3)	12 (80.0)	10 (66.7)	11 (73.3)	
In a supported-living residence	3 (6.7)	1 (6.7)	1 (6.7)	1 (6.7)	
Employment status, *n* (%)					
Returned full time	2 (4.4)	0 (0.0)	1 (6.7)	1 (6.7)	0.487)
Returned part-time	2 (4.4)	1 (6.7)	0 (0.0)	1 (6.7)	
Unfit to work	9 (20.0)	3 (20.0)	3 (20.0)	3 (20.0)	
Sick leave or in rehab	29 (64.4)	8 (53.3)	11 (73.3)	10 (66.7)	
Retired	3 (6.7)	3 (20.0)	0 (0.0)	0 (0.0)	
Driving licence, *n* (%)					
Revoked	28 (62.2)	12 (80.0)	12 (80.0)	4 (26.7)	0.003*
Not revoked	15 (33.3)	2 (13.3)	3 (20.0)	10 (66.7)	
N/A	2 (4.4)	1 (6.7)	0 (0.0)	1 (6.7)	

*Statistically significant ($p < 0.05$) differences between groups.
Abbreviations: N, number; N/A, not applicable; PTA, post-traumatic amnesia; TBI, traumatic brain injury.

meal preparation, suggesting that both tasks were more difficult for participants than going to the grocery store.

With respect to task-related components, all of them, except for verifying goal attainment ($n = 8$, 3 participants), gave rise to many assistances, especially carrying out the tasks ($n = 378$, 32 participants). Participants also experienced difficulties when formulating a goal ($n = 245$, 34 participants) and planning ($n = 231$, 37 participants). This was confirmed by a statistically significant difference in the number of difficulties depending on the task-related components ($x^2(2) = 51.327$, $p < 0.001$). The number of difficulties encountered by the participants when verifying goal attainment was statistically significantly less than the difficulties encountered during all other operations (goal formulation: $Z = -4.882$, $p < 0.001$; planning: $Z = -5.312$, $p < 0.001$; carrying out the task: $Z = -4.821$, $p < 0.001$), suggesting that goal formulation, planning and carrying out a task were significantly more difficult for participants than verifying goal attainment.

To further understand the difficulties of the participants with TBI, observed moments of task-related difficulties were detailed in terms of issues experienced by the person using the IADL Profile task-analysis guidelines (see Table 2). Pertaining to goal formulation, 34 participants required at least one assistance to help them find a solution appropriate to the evaluation scenario specified by the evaluator, for a total of 235 moments of assistance. With respect to planning, difficulties mainly arose when identifying alternatives ($n = 110$; 25 participants) and making a choice ($n = 66$; 19 participants). In terms of carrying out the task, the main difficulties included difficulty finding items in the environment such as in the grocery store ($n = 104$; 16 participants) and modifying plans as needed ($n = 102$; 17 participants). Finally, participants with TBI frequently required

TABLE 2 Participants' difficulties by task-related component, in terms of the overall frequency of difficulty and the number of participants who experienced each difficulty.

Task-related component	Difficulties	Example of difficulties
Goal formulation	• Difficulty finding an appropriate solution ($n = 235$; 34 participants)	• Difficulty identifying the goal of going to the grocery store since it is implicitly alluded to at the outset of the evaluation as the participant was provided $20 to prepare to receive unexpected guests
Planning	• Difficulty considering conditions ($n = 8$; 5 participants) • Difficulty identifying alternatives ($n = 110$; 25 participants) • Difficulty choosing an alternative ($n = 66$; 19 participants) • Difficulty developing a plan ($n = 24$; 11 participants)	• Difficulty considering their own physical and cognitive abilities when choosing a recipe • Difficulty finding means to go to the grocery store (i.e., difficulty identifying alternatives such as walking, using public transportation, or driving) • Difficulty choosing a recipe between various options • Difficulty identifying the steps to prepare a specific recipe
Carrying out	• Difficulty initiating the task ($n = 45$; 17 participants) • Difficulty identifying errors/problems ($n = 65$; 11 participants) • Difficulty modifying a plan while carrying out the task ($n = 102$; 17 participants) • Difficulty finding items ($n = 104$; 16 participants) • Difficulty making a decision ($n = 48$; 22 participants)	• Difficulty initiating cooking after coming back from the grocery store • Difficulty identifying safety issues such as forgetting a hot burner on the stove • Difficulty adapting the cooking when confronted with unexpected problems (e.g., the food is not cooked) • Difficulty finding items in the kitchen or the grocery store • Difficulty choosing between two items when grocery shopping
Verification	• Difficulty accepting or rejecting the result ($n = 8$; 3 participants)	• Difficulty identifying a meal as acceptable or unacceptable, and resuming the task if it is the latter
Other	• Difficulty staying focused on the task ($n = 47$; 11 participants)	• Frequently talks about off-task subjects

TABLE 3 Definitions of the types of cognitive and motivational assistance provided during the IADL Profile evaluation.

Type of assistance	Definition	Example
Cognitive assistance		
Repeating the instructions	Repeat the initial instructions to help the person start thinking about the task. Mainly used at the beginning of the evaluation.	The person with TBI says that they do not remember the initial instructions. *'Without knowing it, you invited my assistant and me to have lunch with you. Please get ready to receive us. We will assume any incurred expenses for a maximum of $20. Can you tell me in your own words what I have just explained to you?'*
Stimulating thought processes	Encourage the person to verbalise the plan they appear to be thinking about, or to begin planning, or to think about other ideas/alternatives.	The person with TBI asks the evaluator how they could go to the grocery store. *'What are your options? How can we go to the grocery store?'* The person with TBI has difficulty formulating the goal of grocery shopping. *'If you want to get some [broccoli and rice], what could you do?'*
Reactivating a memory/ knowledge	Have the person recall a memory or previous knowledge about something that can help them progress in the task. This gives the person the opportunity to consider a different context.	Despite previous assistance, the person with TBI remains inactive and is unable to find an idea of a meal they could prepare. *'What are the meals that you were preparing [before TBI]?'*
Recalling an element	Repeat a statement that was previously said by the person.	The person with TBI offers to prepare a meal with ingredients that they have at home. *'You have $20. What is it for?'*
Scaffolding	Bring the person's attention to an element of a previous valid response.	Because they do not have certain ingredients at home, the person with TBI suggests a new menu, just rice without vegetables. *'Would you like to buy something at the grocery store [...] to complement your rice?'*
Restarting thought processes	Revive the person's thinking and/or planning when they appear to have stopped. This type of assistance was coded only when there was evidence that the person had previously begun the process of planning the task.	The person with TBI remains inactive and silent after receiving implicit assistance from the evaluator about the task to complete. *'What are we going to do?'*
Action priming	Invite the person to start putting their plan into action. The goal is to help the person transition from planning the task to carrying it out.	After explaining that they would like to cook some macaroni, the person with TBI remains seated and discusses unrelated subjects. *'So, shall we go?'*
Challenging	Bring certain errors made by the person to their attention, either an error affecting the success of the task at hand or an error leading to a potentially dangerous situation.	The person with TBI forgets their meat on the counter. *'Do you usually leave your meat on the counter?'*
Cueing	Provide a new element or additional information to the person to help them progress in the task.	At the grocery store, the person with TBI is searching for an item. *'It will be in the cake aisle.'* The person with TBI has difficulty finding a way to go to the grocery store. '*Could we go [to the grocery store] by car?*' The person with TBI has difficulty following the recipe as he chose a recipe that was too difficult for him *'I think you have put enough oil.'*

(Continues)

TABLE 3 (Continued)

Type of assistance	Definition	Example
Motivational assistance, which is not considered as cognitive assistance when scoring task performance in the context of the IADL Profile		
Encouraging independence	Remind and encourage the person to do as much as possible by themselves. This also aims to ensure that the person feels personally engaged in the task. Contrary to cognitive assistance, encouraging independence does not aim to support task-related operations (e.g., formulating goals, planning, carrying out, and verifying the attainment of the goal) and is thus not coined as assistance.	The person with TBI asks if they should go to the grocery store with a walker or in a wheelchair. *'That's up to you to decide.'* *'I'll let you decide'* *'Do as you wish'*

assistance to stay focused on the task at hand, whether during goal formulation, planning, or carrying out the task ($n = 47$; 11 participants). In summary, participants with TBI mainly experienced difficulties when formulating the goal of grocery shopping, identifying a choice of meal, planning it accordingly, and carrying it out safely while adapting themselves when confronted with difficulties, thus requiring cognitive assistance to help them progress in the tasks.

3.2 | Objective 2—Cognitive assistance provided to individuals with TBI during an ecological evaluation administered in their home and surrounding environment

As presented in Table 3, nine types of cognitive assistance were identified throughout the coding process. Cognitive assistance varied in level of implicitness, including implicit assistance such as stimulating and restarting thought processes, as well as more explicit assistance like cueing. Overall, cueing ($n = 295$; 40 participants) and stimulating thought processes ($n = 86$; 22 participants), which was frequently one of the first provided cognitive assistance, were the two most frequently used types of cognitive assistance.

Moreover, throughout the coding process, the evaluators often had to encourage participants to engage in the task and be as independent as possible ($n = 187$; 40 participants). This was coded as 'encouraging independence', under a separate category, called motivational assistance. These results were coded and reported separately, as (a) this type of stimulation does not impact overall scoring of independence within the context of the IADL Profile, that is, a person will not be scored as having required cognitive assistance, (b) but was largely used by the evaluators and was often provided when participants experienced difficulties.

Table 4 presents the main types of cognitive and motivational assistance that were provided by the evaluators in response to the participants' difficulties. Numerous types of cognitive assistance were widely provided to help participants formulate a goal, including cueing ($n = 63$; 25 participants), stimulating thought processes ($n = 33$; 14 participants), recalling a task element ($n = 28$; 15 participants) and reactivating a memory/knowledge ($n = 22$; 13 participants). Motivational assistance was also frequently used to help participants formulate their goals ($n = 30$; 16 participants). These results suggest that evaluators used a broad variety of types of assistance to support goal formulation in individuals with TBI. With respect to planning, cueing was overall the most often employed type of cognitive assistance, though stimulating thought processes was also frequently used to help participants identify alternatives ($n = 24$; 13 participants). With regards to carrying out the task, cueing was the major type of cognitive assistance provided by the evaluators. More specifically, they frequently provided cueing when the person experienced difficulty identifying errors/problems and modifying the plan accordingly (respectively $n = 40$; 9 participants and $n = 58$; 14 participants), and finding items either in the grocery store or in the kitchen ($n = 64$; 13 participants). Alternatively, motivational assistance such as encouraging independence was frequently used when the person had difficulty making a choice ($n = 35$; 9 participants). As many participants had difficulty staying focused on the evaluation, assistance was often provided to restart their thought processes and bring them back to the task at hand ($n = 20$; 8 participants).

3.3 | Objective 3—Potential associations between the level of independence of the participants and the amount and types of cognitive assistance provided to support them

Finally, associations between the assistance needs of the participants and their level of independence on the IADL

TABLE 4 Main types of cognitive and motivational assistance provided in total in response to the participants' difficulties and in terms of the number of participants for which it was used.

		Types of assistance most frequently provided in response to an underlying difficulty[a]	
Difficulty by task-related operation		**Cognitive assistance**	**Motivational assistance**
Goal formulation	Difficulty finding an appropriate solution	• Cueing ($n = 63$; 25 participants) • Stimulating thought processes • ($n = 33$; 14 participants) • Recalling an element ($n = 28$; 15 participants) • Reactivating a memory/ knowledge ($n = 22$; 13 participants) • Challenging ($n = 18$; 13 participants) • Scaffolding ($n = 17$; 10 participants) • Restarting ($n = 14$; 7 participants) • Repeating the instructions ($n =$ 10; 8 participants)	Encouraging independence ($n = 30$; 16 participants)
Planning	Difficulty identifying alternatives	• Stimulating thought processes ($n = 24$; 13 participants) • Cueing ($n = 24$; 11 participants) • Reactivating a memory/ knowledge ($n = 10$; 6 participants)	Encouraging independence ($n = 25$; 17 participants)
	Difficulty choosing an alternative	• Cueing ($n = 13$; 9 participants)	Encouraging independence ($n = 29$; 14 participants)
	Difficulty developing a plan		Encouraging independence ($n = 10$; 8 participants)
Carrying out	Difficulty initiating the task	• Action priming ($n = 16$; 7 participants)	Encouraging independence ($n = 19$; 13 participants)
	Difficulty identifying errors/ problems	• Cueing ($n = 40$; 9 participants) • Challenging ($n = 21$; 6 participants)	
	Difficulty modifying a plan while carrying out the task	• Cueing ($n = 58$; 14 participants) • Stimulating thought processes ($n = 10$; 5 participants)	Encouraging independence ($n = 15$; 8 participants)
	Difficulty finding items	• Cueing ($n = 64$; 13 participants)	Encouraging independence ($n = 11$; 18 participants)
	Difficulty making a decision		Encouraging independence ($n = 35$; 9 participants)
Other	Difficulty staying focused on the task	• Restarting ($n = 20$; 8 participants)	

[a]Only types of cognitive and motivational assistance provided to at least 5 participants and 10 times in total for a specific difficulty are presented in the table.

Profile were explored. Overall, the group with the lowest level of independence (#1) received a larger number of assistances in total and of almost all types of assistance compared to the group with the highest level of independence (#3), whether it was implicit or explicit assistance. In fact, there was a statistically significant difference in the total number of cognitive assistances received by each of the three groups ($x^2(2) = 10.784$, $p = 0.005$) with a significant difference between the groups #1 and #3 ($p = 0.003$). Regarding the types of assistance that were provided, statistically significant differences between groups emerged for five types of cognitive and

motivational: reactivating a memory/knowledge ($x^2(2) = 7.289$, $p = 0.026$), recalling an element ($x^2(2) = 8.797$, $p = 0.012$), restarting thought processes ($x^2(2) = 8.394$, $p = 0.015$), cueing ($x^2(2) = 7.604$, $p = 0.022$) and encouraging independence ($x^2(2) = 8.886$, $p = 0.012$). For each of these types of assistance, a post hoc comparison showed that the group with the lowest level of independence (#1) received a significantly higher number of assistances than the group with the highest one (#3), with all $ps < 0.05$.

Nonetheless, when focusing on the proportion of times each type of assistance was provided to the groups (calculated by considering the amount of one specific type of assistance divided by the overall total number of assistances, see Figure 1), only one type of assistance emerged as statistically different between groups, which was recalling an element ($x^2(2) = 6.500$, $p = 0.039$), and another as almost significant, being reactivating a memory/knowledge ($x^2(2) = 5.962$, $p = 0.051$). No differences between groups were noted for recalling an element following the post hoc analysis ($p > 0.075$). Nonetheless, occupational therapists seemed to be more likely to reactivate a memory/knowledge and recall an element when supporting participants with middle level of independence (#2) compared with the other two groups. Furthermore, a large portion of the assistance provided to participants with the highest level of independence (#3) aimed to encourage them to do as much as they could on their own (i.e., motivational assistance, around 47% of the total assistance they received). Consequently, though participants from group #1 received a higher number of almost all types of assistance, these results suggest that assistance such as recalling an element and reactivating a memory/knowledge could be a pertinent tool to support participants with middle level of independence according to the IADL Profile, as well as encouraging independence for those with a higher level of independence.

4 | DISCUSSION

As an exploration of minimal and progressive cognitive assistance, this mixed methods study analysed how cognitive assistance was offered by occupational therapists specialised in cognitive rehabilitation in response to difficulties experienced by individuals with TBI and the impact of the latter difficulties in meal preparation and grocery shopping tasks. Overall, 12 underlying difficulties pertaining to the four task-related operations were identified in this study. Of those, nine were from the IADL Profile operation-based task-analysis guidelines (Bier et al., 2016; Bottari et al., 2009b, 2010b), which are based

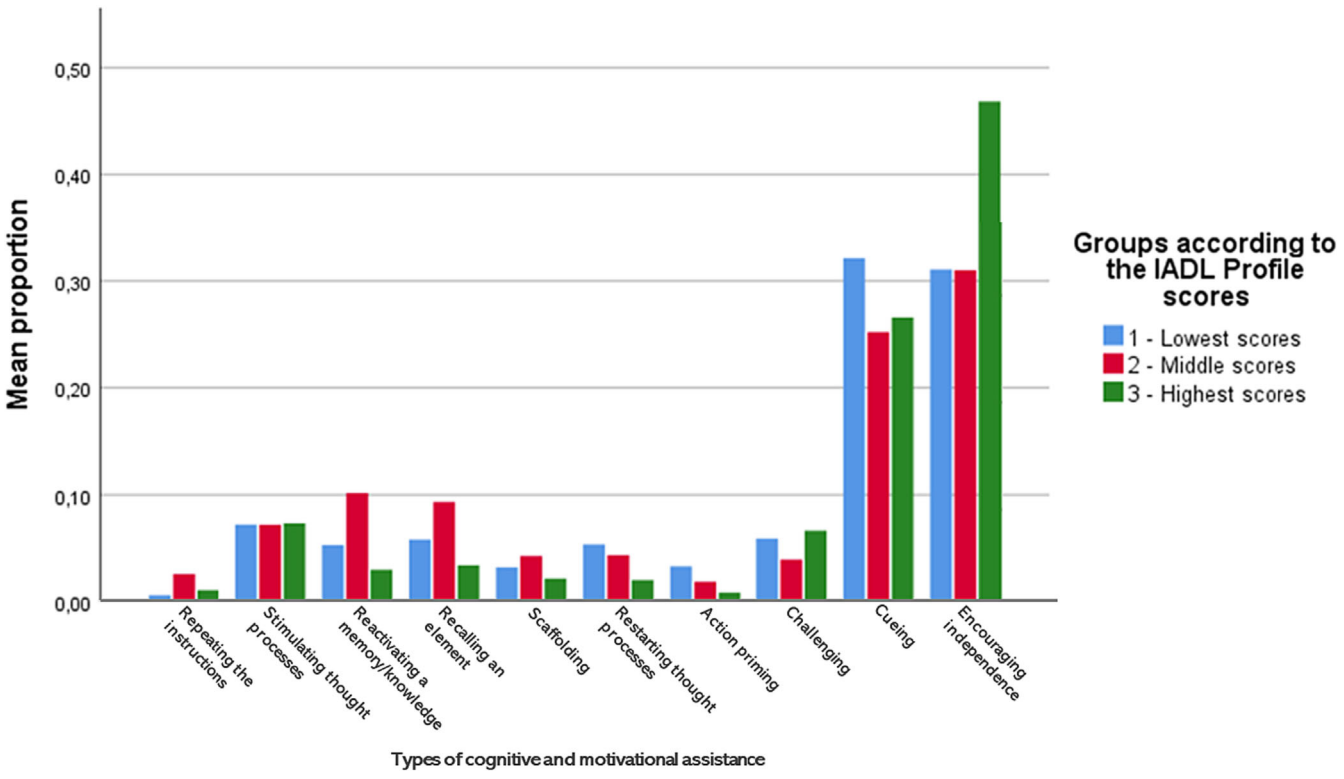

FIGURE 1 Mean proportion of the total number of assistances provided to the participants based on their IADL Profile scores, by type of cognitive and motivational assistance.

on the model of Lezak (1982), and three were added to capture other underlying difficulties observed in people with TBI, such as attention (Cicerone et al., 2022; Godefroy et al., 2010; Tate et al., 2014) and visual search deficits (Merezhinskaya et al., 2019; Schmitter-Edgecombe & Robertson, 2015). Formulating the goal of grocery shopping, as well as planning and carrying out the meal preparation task, was identified as problematic for most participants, including difficulties in identifying the need to buy items at the grocery store, finding and choosing adequate alternatives of what meal to cook, finding items in the kitchen, and adapting their plan while carrying out the tasks. Nine types of cognitive assistance, as well as one type of motivational assistance, were provided to the participants to support them to attain task goals. Although difficulties and assistance needs varied between participants, cueing and implicit assistance such as stimulating thought processes were the main types of cognitive assistance provided during the evaluation. Occupational therapists also frequently encouraged independence in the ongoing task before providing cognitive assistance. Moreover, though participants with the lowest level of independence received a higher number of almost all types of assistances, a larger portion of the assistance provided to participants with higher levels of independence aimed to help them recall an element of the task at hand, reactivate a memory or knowledge, and encourage them to do as much as they could on their own.

4.1 | Clinical implications

Stimulating thought processes was frequently used to help participants progress in the task. This type of assistance was often one of the first provided after encouraging independence when participants were confronted with a difficulty, even later on in the evaluation. Although implicit assistance such as stimulating thought processes was rarely sufficient to help participants progress in the task, it has been found to be helpful in other contexts (Boyd & Sautter, 1993) and could thus be helpful in supporting people with TBI who have a higher level of independence. Moreover, we expect that these assistances, in addition to motivational assistance, may have positively influenced most participants' readiness to pursue the evaluation despite the difficulties they experienced and provided them an opportunity to use their cognitive abilities and strengths. Motivational assistance and implicit cognitive assistance such as stimulating thought processes could therefore be a pertinent first step when helping people with TBI progress in a complex task.

Many participants required cueing later in the evaluation to help them progress in the tasks, especially those with lower levels of independence. This is consistent with other studies that have described cues as a way of optimising the independence and safety of individuals with cognitive deficits (Chard et al., 2009; Serna et al., 2010; Thomas & Marsiske, 2014; Van Tassel et al., 2011). Considering the opportunities motivational and implicit assistance provides for the person to use their abilities and strengths, we suggest however that cueing should be used sparingly, only after the person has been encouraged and given opportunities to think through the task as independently as possible when confronted with a specific difficulty. Recalling an element and reactivating a memory/knowledge, which were more likely to be provided to the participants with middle scores on the IADL Profile compared with the two other groups, are types of cognitive assistance that may be provided as a middle ground when implicit assistance is not enough, before progressing to more explicit cues. Furthermore, by reminding the person to use their own abilities using motivational assistance while providing just enough cognitive assistance in the process to help attain their goals, occupational therapists may empower the person to complete complex everyday tasks that may have been abandoned otherwise and highlight their strengths and successes throughout the evaluation. Interventions guided by the results of an evaluation such as the IADL Profile could then build on the person's strengths, such as in other strengths-based approaches, and further empower individuals with TBI (Hammell, 2016; Ylvisaker et al., 2003).

Recommendations for providing progressive assistance, first through encouragements and implicit assistance to help the person use their own abilities and then by providing cueing, should be used when intervening and supporting people with TBI in their home and surrounding environments. Cognitive assistance is known to be a key ingredient in numerous cognitive rehabilitation interventions with people with TBI, including error-based learning (Ownsworth et al., 2017) and metacognitive strategies such as the guided discovery component of the CO-OP intervention (Dawson et al., 2013) and the multicontext approach (Toglia et al., 2011, 2010). In these instances, occupational therapists support problem solving as well as self-awareness by asking questions and progressively providing cues to support self-discovery. Second, most people with TBI continue to require human support for meal preparation and nutrition (Lamontagne et al., 2009). A better understanding of how caregivers can provide assistance and the types that could be used to support the performance of their loved ones in complex everyday activities (including help with using adaptations and assistive technologies) without doing the task

for them thus remains important. Finally, technological avenues, such as assistive technology for cognition, smart technologies and machine learning (Seelye et al., 2012), are a promising way of providing assistance according to the person's actions and context in a manner that empowers them and supports their cognition (Tekemetieu et al., 2021, 2022). Findings from the current study could support further personalization of the assistance provided by these technologies by identifying the types of assistance to provide according to the person's difficulties.

4.2 | Limitations

Although a total of 45 participants with TBI were included in this study, we were able to document cognitive assistance provided by only three occupational therapists, that is, all the occupational therapists involved in a previous study with the IADL Profile (Bottari et al., 2009b). Further studies including more trained occupational therapists, as well as less experienced ones, will be necessary to improve the generalizability of our results. In terms of coding, inter-rater reliability was not formally assessed. However, all videos were reviewed by at least two members of the research team. Moreover, the extent to which each unique moment of assistance successfully helped participants could not be formally assessed as the latter were generally provided in a successive manner with any one person, each building on the previous one. Consequently, we were not able to identify which types of cognitive and motivational assistances were effective to support each observed difficulty. Nonetheless, by documenting the types of assistance naturally provided by occupational therapists in response to specific difficulties, we were able to describe potential tools to support individuals with TBI when confronted with difficulties, while assessing their full potential. Further studies are required to better understand how each unique moment of assistance may help a person progress in tasks, as well as their gradation over time. Finally, self-awareness of the individuals with TBI was not assessed, despite its impact on functional outcomes (Toglia & Goverover, 2022). Further studies focusing on cognitive assistance should assess this ability and explore how it could influence how assistance is provided.

4.3 | Conclusion

Expanding on previous findings on cognitive assistance, the current study described in detail the cognitive and motivational assistance provided by occupational therapists in relation to the difficulties experienced by individuals living with moderate to severe TBI during meal preparation and grocery shopping tasks. Just as a wheelchair is not provided right away for physical limitations if not necessary, participants were not given explicit cueing before being first provided the opportunity to think through the task and find a solution by themselves, albeit requiring improvement. Furthermore, various ways of supporting cognitive deficits, such as challenging, restarting, and scaffolding, were described and illustrated. This detailed description of cognitive and motivational assistance is a first step towards developing a framework to better understand cognitive deficits and how to support them in a manner that supports the cognition of individuals with TBI and empowers them (Tekemetieu et al., 2021, 2022). Using this knowledge, training could be developed for caregivers and occupational therapists to support them in providing the optimal level of assistance in everyday activities according to the person's abilities and needs, including their ability to understand and interact with others (Togher et al., 2014).

AUTHOR CONTRIBUTIONS

The authors declare that they all have contributed significantly and that they are all in agreement with the content of the manuscript. Mireille Gagnon-Roy led the project under the supervision of Carolina Bottari and Nathalie Bier, conceptualized the findings, and wrote the manuscript. Stéphanie Boulé-Riley and Guillaume Paquette completed the formal analysis. Nathalie Bier, Guylaine Le Dorze, Mélanie Couture, and Carolina Bottari validated the methodology and results. All authors reviewed the manuscript.

CONFLICT OF INTEREST STATEMENT

The authors had no financial or personal interest in the research.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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