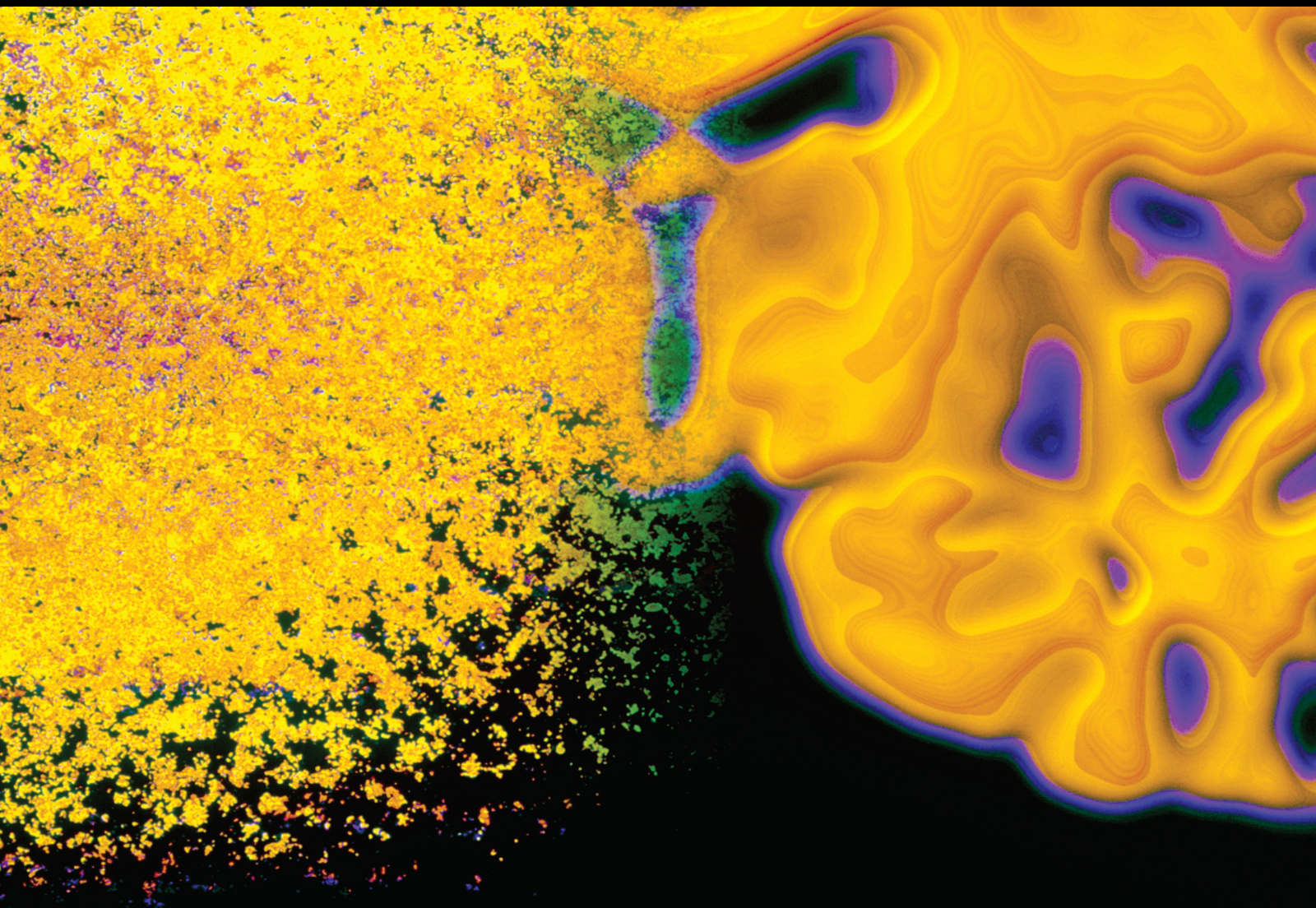


# Impact of Stroke-related Neuropsychological Deficits on Everyday Functioning and Rehabilitation Outcomes

Lead Guest Editor: Simona Spaccavento

Guest Editors: Robert L. Glueckauf and Laura Piccardi





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## Research Article

# Apathy, Cognitive Impairment, and Social Support Contribute to Participation in Cognitively Demanding Activities Poststroke

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**Importance.** Individuals with chronic stroke experience decreased participation in activities with cognitive demands across all areas of occupation. **Objective.** To understand the extent to which apathy, cognition, and social support predict participation in activities with cognitive demands. **Design.** Prospective, quantitative correlational, cross-sectional study. **Setting.** Outpatient treatment centers and community stroke support groups located in St. Louis, MO, and Boston, MA. **Participants.** 81 community-dwelling individuals  $\geq 6$ -month poststroke with and without aphasia. **Measures.** Participants completed the Activity Card Sort (ACS), Apathy Evaluation Scale (AES), Medical Outcomes Study Social Support Survey (MOS-SSS), and Delis-Kaplan Executive Function System (DKEFS) Design Fluency and Trail-Making subtests. **Results.** Cognitive deficits limit participation in activities with high cognitive demands. Apathy and positive social interaction influence participation, regardless of high or low cognitive demands. Poststroke aphasia did not impact return to participation in activities with high and low cognitive demands. **Conclusions and Relevance.** Cognitive deficits seen poststroke contribute to participation only for activities with high cognitive demands. Apathy has a significant and negative influence on participation overall. Social support is a modifiable contextual factor that can facilitate participation. Poststroke apathy can be detrimental to participation but is not well recognized. The availability of companionship from others to enjoy time with can facilitate participation.

## 1. Introduction

Stroke is the leading cause of complex disability in the United States with an additional 3.4 million US adults projected to have a stroke by 2030 [1]. Stroke leads to lasting impairments in physical, emotional, cognitive, and language domains [2–4] that can negatively impact long-term participation, resumption of meaningful occupations, and quality of life (e.g., [5, 6]). To individuals, stroke recovery is synonymous with resuming participation in meaningful prestroke activities and reintegrating into normal living [7]. Over 65% of stroke survivors, however, report participation restrictions in reintegrating into normal living six months into their recovery. Additionally, three-quarters of individuals poststroke do not occupy their day with any meaningful social,

leisure, or occupational activities [8]. Moreover, participation limitations persist for years after stroke [9, 10].

Postacute stroke rehabilitation is aimed primarily at improving functional independence in self-care activities, placing a major focus on physical and functional recovery. However, the emphasis on physical sequela often overshadows other areas of deficit that have a negative impact on long-term participation outcomes such as cognitive and motivational consequences of stroke. For instance, over the course of three years, Kapoor et al. [11] followed individuals who had physically recovered poststroke and were independently performing their basic ADLs. Despite having physically recovered, one-third of their participants endorsed depressive symptoms and over half experienced cognitive impairments and participation restrictions. While physical

function and self-care are important components of participation, addressing stroke recovery with the goal of enabling long-term participation outcomes is imperative and extends beyond functional independence for physical activities.

Although restoration of independent performance in ADLs may be realized, participation in instrumental activities of daily living (IADLs) and other complex recreational, occupational, and social activities often lags behind [8]. More specifically, stroke survivors report limitations with their ability to prepare meals, manage their finances, shop, drive, and fully participate in education, vocational activities, and indoor and outdoor leisure activities [8–10, 12]. This discrepancy between ADL and IADL performance poststroke may be explained by greater activity requirements of IADLs, specifically dependence on higher-order cognitive skills such as executive abilities.

Individuals poststroke report dissatisfaction in their participation with activities requiring cognition [12]. Rudimentary activities are primarily physically demanding, relying on habitual, motoric performance. Complex activities are much more cognitively demanding, requiring active problem-solving and organized planning [13, 14]. Complex activities are not limited to the home; they also include activities in the community. Community activities may require cognitive skills supporting awareness of the dynamic environmental context and adaptation to new situations. The ability to participate in complex activities is necessary for independent living in the home and community [9, 13], warranting a closer investigation into cognitive demands involved in complex tasks. Yet, there is a paucity of stroke studies that examine activity demands to understand the role they may play in restricting participation.

In addition to examining demands of activities themselves, it is important to consider the cognitive and motivational capabilities of the individual that are required to participate in complex activities. Understanding goal-directed behavior that precedes performing complex activities is necessary to understand how cognitive and motivational limitations may impact participation in activities with high cognitive demands. The ICF [15] identifies motivation and executive function as essential for goal-driven behavior. Higher-level cognitive functions such as executive abilities are thought to be foundational prerequisites to successfully complete daily complex tasks, vocational responsibilities, leisure activities, and social participation (e.g., [16]). Stroke survivors who experience executive function deficits are less likely to resume participation in complex IADLs, social roles, leisure activities [17, 18], and work [19].

Apathy is a neuropsychiatric consequence of a stroke presenting as decreased motivation, emotional detachment, and decreased engagement in previously preferred activities, thereby resulting in reduced goal-directed behavior [20, 21]. An estimated 39% of stroke survivors experience cognitive impairments [22] and 34% experience apathy [23]. However, a scarcity of stroke studies examines both higher-level cognitive abilities and apathy with respect to participation in complex tasks among stroke survivors.

The reduction of goal-oriented activity in people with apathy is thought to have affective, behavioral, and cognitive components [20, 24]. The motivational and emotional disturbances

brought on by apathy may be amplified by deficits in cognitive performance [25]. Furthermore, apathy impedes rehabilitation participation [23], resulting in reduced engagement in intense early rehabilitation programs and consequently worse functional and cognitive performance outcomes [21, 24, 26]. These collective cognitive and motivational problems and the participation limitations in meaningful activities that result negatively impact stroke survivors' quality of life [6].

Roughly one-third of strokes result in aphasia, an impairment impacting language comprehension, expression, or both [27]. The prevalence of apathy is twice as high in stroke survivors with aphasia as those without [3]. Stroke survivors with aphasia are inconsistently reported to experience more severe cognitive deficits in executive function, memory, and attention, than those without aphasia [4, 28]. The uncertainty regarding concomitant cognitive deficits may be due to difficulty in disentangling the contributions of language deficits and nonlinguistic cognitive deficits [29]. This complexity, along with the difficulty of managing the communication impairment, often results in people with aphasia (PWA) being excluded from stroke studies (e.g., [30]). However, with the proper adaptations of assessment materials and communication accommodations, PWA can participate in stroke studies [31, 32]. Given these findings that individuals with aphasia may be disproportionately affected by apathy and inconsistently by cognitive deficits, further investigation regarding the retention of prestroke cognitively demanding activities is warranted.

Environmental contextual factors, such as availability of social support, can facilitate meaningful participation, despite deficits in cognitive, motivational, and communication skills. Social support is typically conceptualized by structural or functional social support [33]. Structural social support objectively measures the quantifiable breadth of existing social connections, whereas functional social support subjectively measures the robust interpersonal relationships that are readily available to meet one's needs and serve a supportive purpose. In mitigating stroke-related stressors, social support has been shown to positively predict social and community participation [34, 35]. Three recent systematic reviews examining the determinants of poststroke participation found that social support was a common contextual facilitator for participation [36–38]. Moreover, in population-level studies focusing on healthy aging adults, social support was found to help preserve cognitive functioning, such as executive functioning and memory [39–41]. Empirical evidence suggests social support is a modifiable contextual factor that may preserve cognitive functioning of healthy aging adults and serves as a facilitator for participation after a stroke event; however, limited studies have investigated the generalizability of these benefits to poststroke participation in activities with cognitive demands.

Studies support the unique participation restrictions that stroke survivors experience [2, 7, 42]. Gadidi et al. [10] found that functional ability predicts activity limitations, which in turn predict participation restrictions in chronic stroke survivors. To better understand participation restriction, we must critically assess the demands of the activities themselves and the cognitive, motivational, and language capabilities that the person with stroke has to determine whether participation



can be explained by the match between person-specific factors and the demands of particular activities and whether social support can help to mitigate participation restrictions.

Evidence suggests poststroke cognitive dysfunction, apathy, and aphasia limit participation and that the cognitive task demands of complex activities can pose as barriers to participation. Furthermore, social support may facilitate participation despite these health consequences. The aim of this study is to understand the extent to which apathy, cognition, and social support facilitate or hinder participation in activities with high and low cognitive demands among community-dwelling stroke survivors with and without aphasia.

## 2. Method

This research was approved by the Partners Healthcare Institutional Review Board and the Washington University Human Research Protection Office with participants providing written informed consent. The human study processes and the consent procedures conformed to the Declaration of Helsinki, 1964.

**2.1. Participants.** Participants were recruited from the Cognitive Rehabilitation Research Group Stroke Registry at Washington University in St. Louis, the IMPACT Practice Center at MGH Institute of Health Professions in Boston, and local stroke support groups in the Greater Boston metropolitan area. The study recruited stroke survivors, with and without aphasia, who were living in the community and met the following inclusion criteria: at least 18 years old, first stroke, at least six-month poststroke, able to commute to the testing location, and able to withstand two testing sessions that lasted two to three hours each by self-report. Individuals with aphasia needed to have a diagnosis of aphasia and the ability to reliably answer aphasia-adapted questions requiring a yes or no response. Yes/no responses were assessed with questions regarding key elements of the consent form. Aphasia-adapted questions about key components of the study were presented in written form and were read to participants for a response. For example, “Are we doing this study to learn about a new drug?” We expected the participant to answer the 7 questions correctly after no more than one opportunity for explanation in order to be enrolled in the study. Exclusion criteria consisted of a history of additional strokes or a history of nonstroke-related physical, cognitive, neurological, or psychological disorders including an ongoing seizure disorder. Demographic information of the 81 enrolled participants is displayed in Table 1.

**2.2. Data Collection and Outcome Measures.** Measures were adapted to facilitate communication for all participants while preserving the psychometric integrity of various assessments [32]. Using a multimodal approach, the administration, presentation, and response format of the assessments were adapted to support reading and auditory comprehension, though the wording of the items was not altered. Applying the principle of supported communication ramps [31], a systematic hierarchy of examiner supports was utilized when indicated. Participants were administered a battery of assess-

TABLE 1: Demographic characteristics of participations.

Demographic variables	Participants (N = 81)
Gender	
Female	42
Male	39
Self-reported race and ethnicity	
Caucasian	43
African American	34
Hispanic/Latino	1
Asian	2
Native American	1
Mean age in years	60
Age range	33-81
Mean time poststroke in months (SD)	57 (78)
Time poststroke range in months	6-360
Education in years (SD)	15 (2.6)
NIH Stroke Scale mean (SD)	2.9 (2.5)
NIH Stroke Scale range	0-10
NIH Stroke Scale Total of Motor Items*	1.0 (1.7)
NIH Stroke Scale Motor Item range	0-8

\*NIH Stroke Scale Total Motor Items are the sum of the scores of items 5a and b and 6a and b that grade the extent of motor impairment in the upper extremities and lower extremities on a scale of 0, indicating no impairment, to 4, indicating no movement; total possible score is 16.

ments during two sessions requiring approximately 5 to 6 hours to complete. The assessments included in this investigation are a subset of the total assessment battery.

**2.2.1. Participation.** The Activity Card Sort (ACS) measures participation retention among 89 activities, which comprise 20 instrumental, 35 social, 17 high physically demanding, and 17 low physically demanding leisure activities [43]. Each activity is represented on an individual card by a corresponding photograph and caption. Participants placed the individual cards into structured categories that represent previous and current participation. Scores were then calculated to indicate the percentage of prestroke activities retained. The ACS has been demonstrated to have high internal consistency, high test-retest reliability, and content, construct, and predictive validity (e.g., [44]).

To categorize ACS activities along a cognitive continuum, data from an unpublished normative study was used. Healthy adults ( $N = 43$ ) rated the extent (none = 0, some = 1, fair = 2, a lot = 3) to which each activity required 9 different demands to participate, including cognitive demands, the dimension of interest to the current study. The calculated average ratings (little = 0-0.99, fair = 1.0-1.99, a lot = 2.0-3.0) for each activity were used to group them into the respective activity demand categories. For the specific dimension of activities requiring cognitive skills, 27 activities were identified as requiring a lot of cognitive skill (high CS), that is, activities with an average rating  $\geq 2.0$ , and 14 activities were identified as requiring little to no cognitive skill (low CS), that is, activities with an average rating  $< 1$ . Notably,

each of these subsets that differed in cognitive demand had about the same number of items from the low demand leisure and the high demand leisure categories from the ACS. The high CS subset did have more IADL items than the low CS subset (see Tables 2 and 3 for specific items), but percent retained was the outcome measure used, not number of items retained. There were 48 activities with middle-range cognitive scores not considered in this analysis.

**2.2.2. Apathy.** The Apathy Evaluation Scale (AES) measures self-reported apathy symptoms within the last four weeks on a 4-point Likert scale [20]. Total summed scores range from 18 to 72 with higher scores indicating more apathy symptoms. For the post hoc analysis, an AES cutoff score of  $\geq 37$  was selected to indicate apathy [24, 45]. The psychometric properties of the AES indicate excellent internal consistency, high internal reliability, excellent interrater reliability, and a test-retest reliability of 0.76-0.94 [20].

**2.2.3. Cognition.** The Delis-Kaplan Executive Function System (D-KEFS) is a neuropsychological assessment that measures executive function [46]. Two of the nine subtests were utilized, the Trail Making (TM) Test and Design Fluency (DF) Test. The composite D-KEFS score used in the analysis was the average of the scaled scores from the Trail Making subtest, condition 4—number-letter switching, and the Design Fluency subtest, condition 3—switching. The D-KEFS has high internal consistency and moderate test-retest reliability [46].

**2.2.4. Social Support.** The Medical Outcomes Study Social Support Survey (MOS-SSS: [47]) is a self-reported measure of functional social support in four domains: tangible, affectionate, emotional-informational, and positive social interaction, using a 5-point Likert scale with higher scores indicating more social support. The MOS-SSS has high internal consistency and good validity and reliability [48]. Based on prior work from our laboratory, the MOS-SSS positive social interaction score was included as a potential predictor [35].

**2.3. Data Analysis.** Data analysis was conducted with SPSS Statistics 24.0 [49]. First, an independent samples *t*-test was utilized to identify whether there was a significant difference between persons with aphasia (PWA) and persons without aphasia (PWOA) on the primary outcome variables—the percent retained low-CS activities and percent retained high-CS activities as measured by the ACS. If significantly different, aphasia status would be included as a variable in the regression models. Second, bivariate Pearson correlations were calculated to inform which variables to include into the hierarchical regression analysis. Variables that significantly correlated ( $p < 0.05$ ) with either of the two outcome measures were included in the regression model. Third, two hierarchical regression analyses were conducted to determine how much of the variance in percent retained low-CS and high-CS activity scores was accounted for by the predictor variables. Last, a post hoc analysis compared differences in participation scores and predictor variables in those with and without apathy.

TABLE 2: High-cognitive skill activities ( $n = 27$ ).

ACS (number) and activity	ACS domain
(1) Shopping in a store	IADL
(2) Shopping for groceries	IADL
(7) Cooking dinner	IADL
(8) Household maintenance	IADL
(9) Fixing things around the house	IADL
(10) Driving	IADL
(12) Car maintenance	IADL
(15) Paying bills	IADL
(16) Managing investment	IADL
(19) Child care	IADL
(20) Work (paid)	IADL
(28) Computer (email, paying bills, shopping)	LD leisure
(31) Playing cards (solitaire, poker, bridge)	LD leisure
(32) Putting together puzzles	LD leisure
(33) Crossword or Sudoku puzzle	LD leisure
(37) Playing a musical instrument	LD leisure
(38) Reading magazines/books	LD leisure
(39) Reading newspaper	LD leisure
(40) Reading the bible/religious materials	LD leisure
(42) Creative writing/journal	LD leisure
(43) Letter writing	LD leisure
(57) Playing team sports	HD leisure
(58) Woodworking	HD leisure
(73) Studying for personal advancement	Social
(74) Traveling local/regional	Social
(75) Traveling national/international	Social
(86) Storytelling with children	Social

IADL: instrumental activities of daily living; LD: low demand (physically); HD: high demand (physically).

TABLE 3: Low-cognitive skill activities ( $n = 14$ ).

ACS (number) and activity	Domain
(17) Resting	IADL
(18) Beauty/barbershop	IADL
(21) Spectator sport	LD leisure
(44) Birdwatching	LD leisure
(46) Going to garden or park	LD leisure
(47) Attending concerts	LD leisure
(51) Watching movies	LD leisure
(52) Watching television	LD leisure
(53) Listening to music	LD leisure
(54) Listening to radio	LD leisure
(55) Sitting and thinking	LD leisure
(61) Walking	HD leisure
(62) Running	HD leisure
(83) Going to a place of worship	Social

IADL: instrumental activities of daily living; LD: low demand (physically); HD: high demand (physically).

### 3. Results

Of the 81 participants, 43 were PWA and 38 were PWOA. The average age of the entire sample was 60 years old with participants averaging 5-year post stroke with mild stroke severity scores at the chronic stage. The results of the independent samples *t*-test showed no significant differences between the two groups in retention percentages for low- ( $t(79) = -0.465$ ,  $p = 0.644$ ) and high-CS activities ( $t(79) = 0.923$ ,  $p = 0.359$ ),

TABLE 4: Percent retained participation by aphasia status.

Outcome variables	PWA mean (SD) <i>N</i> = 43	PWOA mean (SD) <i>N</i> = 38	All (SD) <i>N</i> = 81
% retained high-CS activities	67.9 (23)	63.4 (21)	65.8 (22)
% retained low-CS activities	79.4 (20)	81.3 (17)	80.3 (19)

PWA: persons with aphasia; PWOA: persons without aphasia.

displayed in Table 4. Therefore, aphasia status was not retained as a variable in the regression analyses.

The potential predictor variables and their correlations with percent retained participation in activities with low and high cognitive demands are shown in Table 5. There was a positive correlation between cognition scores and percent retained low-CS activities and between MOS-SSS positive social interaction scores and percent retained low-CS activities, such that higher cognitive ability and greater social support were associated with higher percent retained low-CS activities. Similarly, there were significant positive correlations between cognitive skill and social support and percent retained for high-CS activities. Apathy scores were significantly and negatively correlated with both categories of CS activities, such that the greater the apathy score, the lower the percent retained for both high-CS and low-CS activities.

The top half of Table 6 represents the results of the multiple linear regression analysis examining predictors of retained participation in low-CS activities. A significant regression model was obtained ( $F(3, 77) = 12.9$ ,  $p < 0.0001$ ) with predictor variables accounting for 33.4 percent of the variance in low-CS activities. As expected, the cognition composite score was not a significant independent predictor of low-CS activity retention. Both MOS-SSS positive social interaction and AES were statistically significant independent predictors of percent retained low-CS activities.

The bottom half of Table 6 represents the results of the multiple linear regression analysis examining predictors of retained participation in high-CS activities. A significant regression model was obtained ( $F(3, 77) = 16.7$ ,  $p < 0.0001$ ) with predictor variables accounting for 39.4 percent of the variance in high-CS activities. Cognition, as predicted, was an independent predictor of high-CS activity retention, in contrast to the results for the low-CS activity retention model. Positive social interaction and apathy were also statistically significant predictors of percent retained high-CS activities.

Apathy was a significant predictor in both models for retained participation in activities with low-CS and high-CS activities. To investigate the extent to which individuals with and without clinically significant apathy differed in their cognitive, social support, and participation level, a post hoc analysis of apathy was implemented (see Table 7). Participants with AES scores  $< 37$  or  $\geq 37$  were identified as nonapathetic and apathetic, respectively [24, 45]. The results of the independent samples *t*-tests showed there were significant differences between the groups in retained low-CS ( $t(79) = -3.68$ ,  $p < 0.0001$ ,  $d = -0.890$ ) and high-CS activities ( $t(79) = 3.612$ ,

TABLE 5: Pearson correlations of potential predictors with Activity Card Sort outcomes for high-cognitive skill and low-cognitive skill activities.

Predictor variables	% retained low-CS activities	% retained high-CS activities
DKEFS cognition composite	0.273*	0.410**
Apathy Evaluation Scale	-0.487**	-0.490**
MOS-SSS: positive social interaction	0.501**	0.498**

DKEFS: Delis-Kaplan Executive Function Scales; MOS-SSS: Medical Outcome Study-Social Support Scale; \* $p < 0.05$ ; \*\* $p < 0.01$ .

TABLE 6: Multiple regression results for percent retained participation in low-cognitive skill and high-cognitive skill activities.

Predictor variable	$\beta$ -Weight	<i>p</i> value
Low-cognitive skill activities		
DKEFS cognition composite	0.146	0.131
Apathy Evaluation Scale*	-0.279	0.016
MOS-SSS: positive social interaction*	0.316	0.006
$R^2$	0.334	
High-cognitive skill activities		
DKEFS cognition composite*	0.292	0.002
Apathy Evaluation Scale*	-0.264	0.016
MOS-SSS: positive social interaction*	0.291	0.008
$R^2$	0.394	

DKEFS: Delis-Kaplan Executive Function System; MOS-SSS: Medical Outcome Study-Social Support Scale; \*statistically significant independent predictor.

TABLE 7: Mean scores and standard deviations (in parentheses) for those with and without clinically significant apathy.

Variables	No apathy (SD) <i>N</i> = 58	Apathy (SD) <i>N</i> = 23
% retained low CS activities**	85.6 (14)	69.0 (22)
% retained high CS activities**	71.9 (20)	52.9 (21)
MOS-SSS: positive social interaction**	85.5 (24)	60.1 (30)

Apathy: Apathy Evaluation Scale score of 37 or greater; \*\* $p < 0.01$ .

$p = 0.001$ ,  $d = 0.907$ ) and overall perceived social support ( $t(79) = -4.037$ ,  $p < 0.0001$ ,  $d = -0.995$ ) such that people who met the clinical cutoff for apathy had lower activity retention for high-CS and low-CS activities and fewer positive social interactions.

A post hoc analysis was conducted to determine if motor impairment, as measured by the NIHSS Total Motor Items, could account for differences in those with and without apathy. There was, however, no significant correlation of NIHSS Total Motor Items with the AES ( $r(71) = .107$ ,  $p = 0.367$ ), nor did those with significant apathy differ from those



without significant apathy with regard to their NIHSS Total More Item score ( $t(71) = 0.885$ ,  $p = 0.379$ ,  $d = 0.236$ ).

#### 4. Discussion

Our study sought to understand the extent to which apathy, cognition, and social support predict participation in activities with high versus low cognitive demands as measured by the ACS. Nearly 40% of the variance in percent retained high-CS activities was explained by apathy, cognitive abilities, and positive social interaction. For percent retained low-CS activities, the same predictive variables explained 33% of the variance. Although there is a considerable proportion of variance that is unaccounted for in these activities, the findings point out that apathy, cognition, and social support all play a role in the retention of prestroke activities. These factors may provide avenues for intervention to increase participation via remediation, compensatory strategies, modifying the activities themselves, or modifying the environment in which the activities are done.

Notably, participants who were nearly 5-year postmild stroke living in the community gave up, on average, 33% of their high-CS prestroke activities and 20% of their low-CS prestroke activities. That translates to a loss of approximately 9 activities in the high-CS domain and approximately 3 activities in the low-CS domain. This degree of restriction appears remarkable in a group of people who experienced only a “mild” neurological event. This pattern of a greater number of activities given up in the high-CS domain provides beginning support for the hypothesis that individuals who experience stroke may have cognitive deficits that have an impact on participation in cognitively demanding activities. We did not, however, detect a difference in the percentage retained of high- and low-CS activities between PWA and PWOA. Thus, the presence of mild aphasia did not differentially impact retained participation in activities with low or high cognitive demands, suggesting that participation in activities with cognitive demands can be explained by factors other than language ability. It is possible that a sample with more severe aphasia might have shown different effects on retention of participation in cognitively demanding activities.

Perceived positive social interaction correlated with participation in low-CS and high-CS activities. Moreover, positive social interaction was a significant independent predictor of participation in both low CS and high CS. This suggests that having the companionship of a supportive individual to enjoy activities with facilitates participation in activities with or without cognitive demands. Perhaps, the perceived support of having someone to engage in activities with is cognitively stimulating [41] and encourages participation in a variety of activities, regardless of cognitive demands. The findings in this study are consistent with previous work from our lab [35] showing that positive social interaction is an independent predictor of social participation. Addressing modifiable contextual factors, such as social support, may be an effective way to augment participation outcomes.

Objectively derived estimates of cognitive skills have differential predictive power depending on the cognitive complexity of activities. This finding supports the assertion in

the literature that executive functions and higher-order cognitive functions are necessary for participating in complex activities (e.g., [16]; WHO, 2011). Similarly, Reppermund et al. [14] found that among individuals with mild cognitive impairments, better cognitive ability outcomes related to more involvement in daily activities with high cognitive demands. Cognitive skills underlie a range of activities, including IADLs, social participation, and leisure activities (see Tables 2 and 3). Thus, by addressing participation in activities with high cognitive demands, the goal would be achieved to target participation in activities beyond self-care that are meaningful to clients.

Apathy was found to be both significantly correlated with and independently predictive of both low-CS and high-CS activity retention. Apathy is a mood and motivation disruption that inhibits goal-oriented behaviors, affecting the initiation and execution of once meaningful activities. The association of apathy with restriction in participation of activities in people with chronic stroke is similar to the finding of Babulal et al. [25], namely, that apathy was predictive of the need for increased cognitive support with initiation, organization, sequencing, safety and judgement, and ability to execute to completion complex daily tasks in individuals within the first 3 months poststroke.

In our post hoc analysis focused on clinically significant levels of apathy, apathy was a significant barrier for return to prestroke baseline. Individuals with apathy experienced decreased participation in activities, regardless of cognitive demands and felt less supported by their social network compared to individuals without apathy. Nearly one-third of our sample reported clinically significant apathy, which is in line with the estimated prevalence of 34% found in other stroke studies [23]. Yet, poststroke apathy remains underrecognized. The annual statistical update on stroke from the American Heart Association does not include apathy in their report [1], despite its ubiquity and disruptive impact on rehabilitation outcomes and participation. The impact and persistent nature of apathy significantly inhibit engagement in meaningful and daily activities. Participation is thought to be involved in intrinsically motivating occupations that are meaningful, provide individuals a sense of purpose [50], and contribute to their quality of life [6]. Clearly, the key symptom of apathy, that is, diminished motivation [20], negatively affects recovery from stroke and participation in everyday life. More work needs to be done to recognize the presence of apathy in the stroke population, to understand how it may be intertwined with cognitive deficits, and to develop intervention techniques to address both these areas.

#### 5. Study Limitations and Recommendations

There were several limitations in this study that warrant the need for future research. First, our outcome measure of participation is a quantitative measure of the retention of prestroke activities. Measuring participation in this manner allows participants to individualize the report of their current participation to their own prior level. However, this measure does not probe their satisfaction in these activities and whether these activities are meaningful for them to resume.

Future studies may want to consider supplemental information about satisfaction with participation. Second, our assessment battery largely consisted of questionnaires and pencil-and-paper performance measures. Future studies should consider implementing performance-based functional measures in addition to our paper-and-pencil-based quantitative methods. Third, the mean NIHSS score of our sample was 2.9, indicating mild stroke severity. Our study does not generalize to people who may be living in the community after moderate stroke. Lastly, our cross-sectional design provides information regarding correlations among variables all measured at one time point. Therefore, we are unable to provide a model that predicts which factors measured early in recovery will affect participation later in recovery. Future studies should consider a longitudinal design.

Based on the findings, community-dwelling individuals with milder stroke severity are experiencing decreased participation retention in activities with both low and high cognitive demands. There are barriers and facilitators to poststroke participation in cognitively demanding tasks. Clinicians ought to measure and explain to clients and their caregivers the negative impact of apathy on participation outcomes. For high-CS activities in particular, diminished cognitive abilities will have an impact on participation and may require modifications of the environment or the activities themselves to promote participation. Clinicians should educate clients, family, and friends about the value of social support in poststroke recovery. Loved ones and other persons in the community can provide meaningful influence on poststroke participation by showing up, being present, and available to enjoy activities. Finally, rehabilitation professionals need to recognize that efforts to promote stroke recovery should not stop at recovering independence in activities of daily living and self-care routines but should extend into promoting participation in meaningful activities in the daily life of their clients.

## Data Availability

Data are available by request to the corresponding author.

## Conflicts of Interest

The authors declare that they have no conflicts of interest.

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## Research Article

# Behavioral Assessment of Unilateral Spatial Neglect with the Catherine Bergego Scale (CBS) Using the Kessler Foundation Neglect Assessment Process (KF-NAP) in Patients with Subacute Stroke during Rehabilitation in Japan

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The Kessler Foundation Neglect Assessment Process (KF-NAP) is an assessment tool for unilateral spatial neglect (USN), which is the scoring method for the Catherine Bergego Scale (CBS) based on detailed instructions. This study is aimed at determining the reliability and validity of the Japanese version of the KF-NAP (KF-NAP-J), evaluating the improvement of neglect assessment with KF-NAP-J, and comparing it with the original CBS for subacute stroke patients. We assessed subacute stroke patients admitted to our intensive rehabilitation hospital. Two KF-NAP-trained occupational therapists (OTs) assessed 22 patients. Before implementing the KF-NAP at the hospital, two other OTs assessed the other 23 patients using the CBS. We evaluated the interrater reliability of the KF-NAP and CBS using intraclass correlation coefficients (ICC) for the total scores, weighted kappa statistics for each subscale, and internal consistency using Cronbach's alpha. We assessed the validity of the KF-NAP against the Behavioral Inattention Test (BIT) and Functional Independence Measure (FIM) using Spearman's correlation coefficient. The reliability of both the KF-NAP and CBS was excellent. The weighted kappa results demonstrated that each subscale was in better agreement with the KF-NAP than with the CBS. In the KF-NAP, all eight subscales in which weighted kappa could be calculated were in significant agreement, and two were almost in perfect agreement. The KF-NAP moderately correlated with the subscales of BIT and FIM representing USN and activities of daily living. The USN detection rates of KF-NAP and BIT in the KF-NAP group were 63.6% and 22.7%, respectively. These results suggest that the KF-NAP, as well as the CBS, is useful to assess USN, which strongly impacts the rehabilitation outcomes in subacute stroke patients.

## 1. Introduction

Unilateral spatial neglect (USN) is defined as a failure to report, respond, or orient to novel or meaningful stimuli presented to the side opposite a brain lesion, when this failure cannot be attributed to either sensory or motor defects [1]. This disorder can be challenging for recovery and affect reha-

bilitation outcomes with respect to the activities of daily living (ADLs) [2, 3, 4, 5, 6]. Paper-and-pencil tests, such as the Albert test, Bells test, and Behavioral Inattention Test (BIT) [7], are widely used in clinical practice for the screening of USN. However, they have limitations in evaluating the effects of spatial neglect on the ADLs and may underdiagnose auditory and/or proprioceptive spatial neglect [8]. The

Catherine Bergego Scale (CBS) [9] was developed by Bergego and Azouvi as an assessment tool to identify ADL challenges caused by USN. The reliability and validity of the CBS were excellent, and the sensitivity of the test was superior to that of the paper-and-pencil tests [10]. Right-sided USN in patients with left hemisphere damage was often underdiagnosed because of difficulty assessing USN using paper-and-pencil tests in patients with left hemisphere damage, particularly if they have aphasia and/or severe paresis of the dominant hand. However, the CBS can be used in patients with aphasia and severe dominant hand paresis because it is based on behavioral observations [3, 4]. Using the CBS, Azouvi reported that 77.3% of patients with left hemisphere damage had USN [11]. Recent studies reported that right-sided USN was not rare and was a strong negative predictor of poor rehabilitation outcomes [3, 4]. Furthermore, the scores of paper-and-pencil tests have a tendency to improve when the tests are repeated regardless of the improvement of USN owing to the learning effect [12]. For this reason, CBS is often used to more accurately evaluate the treatment effect of rehabilitation methods for USN [11]. Therefore, behavioral assessments, including CBS, are more appropriate than paper-and-pencil tests to evaluate bilateral USN during the subacute rehabilitation phase.

Chen et al. proposed the Kessler Foundation Neglect Assessment Process (KF-NAP) [13, 14], which is a new scoring method for the CBS based on detailed instructions for observation and scoring. The KF-NAP assessed the perception of left and right space and asymmetrical behaviors by directly observing patients when they explore space with eye and head movements during their daily living activities. Therefore, it can be useful to precisely score CBS even for medical staff unfamiliar with the method of assessment. In addition, it is possible to accurately detect changes in USN in subacute stroke patients during rehabilitation using the KF-NAP.

Our hospital is a rehabilitation hospital in Japan that provides intensive rehabilitation for subacute stroke patients hospitalized within 2 months after onset. In this phase, most patients are in the process of functional recovery, and improvement of USN strongly affects rehabilitation outcomes [4]. Therefore, a precise evaluation of USN is important for proper planning of rehabilitation treatment in patients during this phase. We assessed USN using the CBS since our hospital opened in 2018. We translated the KF-NAP into Japanese and implemented its use in 2019 to score CBS more precisely. The purpose of this study is to evaluate the reliability and validity of our Japanese version of KF-NAP (KF-NAP-J) and to determine whether the introduction of KF-NAP-J has improved the accuracy of neglect assessment in subacute stroke patients during rehabilitation.

## 2. Materials and Methods

**2.1. Participants and Ethical Considerations.** We recruited participants from patients with cerebral stroke who were admitted to Saiseikai Higashi-Kanagawa Rehabilitation Hospital from July 2018 to June 2019, before implementing KF-NAP-J at our hospital, for the CBS group, and from July

2019 to August 2020 for the KF-NAP group. A chief occupational therapist, who did not participate in this study, randomly assigned patients for screening. We included participants admitted within 2 months after the onset of stroke and who could follow the examiner's instructions. We excluded participants whose behavior could not be assessed with the CBS or the KF-NAP-J due to severe aphasia, severe cognitive impairment, severe deafness, or blindness. For the CBS group, we screened 25 stroke patients, and 23 patients fulfilled the inclusion criteria. For the KF-NAP group, of the 39 patients who were screened, 26 fulfilled the inclusion criteria. Four patients were excluded: three had severe aphasia, and one was severely deaf. Therefore, we eventually recruited 23 participants in the CBS group and 22 in the KF-NAP group. We calculated the sample size according to the study by Doros [15]. We assumed the ICC estimate to be 0.8 from previous studies [16, 17], two raters ( $k = 2$ ) assessment, 95% confidence interval (CI), and CI width 0.4; we calculated the minimum sample size as  $n = 20$ . We determined that 20 or more participants were required.

Experiments were performed according to the Declaration of Helsinki and were approved by the Saiseikai Higashi-Kanawa Rehabilitation Hospital Research Ethics Committee (approval number: HKR0001 and HKR0023). All participants provided written informed consent.

**2.2. Instrument Translation Process.** The KF-NAP was translated into Japanese (forward translation) by a professional life science translator. The comparison and panel discussion led to the primary Japanese version. The translators translated the Japanese form back to English (backward translation), and this was checked and verified by members of the Kessler Foundation who developed the KF-NAP. Finally, the committee comprised two psychiatrists and two occupational therapists, who compared the original English form and the obtained form to produce the final Japanese version (KF-NAP-J).

**2.3. Measurements.** The CBS [9] was based on direct observation of the patient's functioning in 10 real-life situations. For each subscale, a 4-point scale was used, ranging from 0 (no neglect) to 3 (severe neglect). The total score was calculated (range: 0–30). The CBS also included self-assessment to measure patients' awareness of the neglect-related activity of daily life. A parallel form of the CBS was used as a questionnaire with the same 10 subscales mentioned above. For the subscales that could not be measured, the average score of the measured items was entered. In this study, we used the observer's assessment as a neglect assessment.

The KF-NAP [13, 14] was a new scoring method for the CBS based on detailed instructions for observation and scoring. It could more precisely assess the perception of both space and asymmetrical behaviors by directly observing patients when they explored space with eye and head movements during their daily living activities. It included the 10 criteria of the KF-NAP: limb awareness, personal belongings, dressing, grooming, gaze orientation, auditory attention, navigation, collisions, meals, and cleaning after meals.

For each item, a 4-point scale was used, ranging from 0 (no neglect) to 3 (severe neglect), the same as the CBS.

The BIT is a standard test used to assess USN and consists of conventional and behavioral tests. The conventional test consists of six subscales (line crossing, letter cancellation, star cancellation, figure and shape copying, line bisection, and representational drawing), with a score ranging between 0 and 146; a higher score indicates a better spatial awareness. In the original version, the cut-off score is 129 [7], whereas it is 131 in the Japanese version [18]. We defined participants whose score was  $\leq 131$  as having USN. In this study, we used the conventional BIT for the participants in the KF-NAP group.

The functional independence measure (FIM), which was developed to ensure uniformity in assessing the ADLs, includes motor and cognitive subscales and is subdivided into 18 items [19]. For each subscale, a 7-point scale was used, ranging from 1 (total assistance) to 7 (complete independence), and the total score ranged from 18 to 126; higher scores indicate greater independence in the ADLs. FIM included the motor subscales (13 items: eating, grooming, bathing, dressing the upper body, dressing the lower body, toileting, bladder control, bowel control, transfer to bed/chair/wheelchair, toilet transfer, transfer to tub/shower, walking or wheelchair use, and stairs) and the cognitive subscales (5 items: comprehension, expression, social interaction, problem-solving, and memory). This score is assessed by a physiatrist or a nurse who treated the participants and was trained in FIM scoring.

The Mini-Mental State Examination (MMSE) is a simple examination used to evaluate the decline in cognitive function (faculty of orientation, memory, calculating ability, language ability, and constructional ability) and is conducted using a verbal questionnaire [20]. It is composed of 11 items, with the score ranging between 0 and 30. In this study, we used the Japanese version of the MMSE (MMSE-J) that is officially licensed by Psychological Assessment Resources Inc. (PAR) [21, 22]. The validity and reliability of the MMSE-J were well documented [22].

**2.4. Procedure.** Two OTs (who had not participated in translating the KF-NAP) assessed participants using the CBS (CBS group). Two other OTs who were members of the KF-NAP-J translation team and trained in KF-NAP assessment assessed participants using the KF-NAP-J (KF-NAP group). The raters of both the CBS and the KF-NAP-J possessed similar clinical experience and skills. The ADLs in both groups were assessed using the FIM. The USN of the KF-NAP group was assessed using the conventional BIT.

## 2.5. Analysis

**2.5.1. Baseline Characteristics.** The two groups were compared by performing the unpaired *t*-test (age, disease duration, Mini-Mental State Examination (MMSE), and FIM) and chi-squared test (sex, lesion, and stroke subtype). The level of statistical significance for the variables was set at 0.05.

**2.5.2. Reliability.** Interrater reliability was calculated employing intraclass correlation coefficients (ICC) for total scores

and weighted kappa coefficients for each subscale. Internal consistency was calculated using Cronbach's alpha. The level of statistical significance for the variables was set at 0.05.

**2.5.3. Validity.** The KF-NAP was evaluated for convergence and discriminative validity of Rater 1. Convergence validity was obtained using the Spearman correlation coefficient of the KF-NAP against conventional BIT and FIM. The level of statistical significance for the variables was set at 0.05.

**2.5.4. USN Detection Rate.** In the KF-NAP group, we calculated and compared the percentage of patients detected with USN symptoms by KF-NAP and the percentage of patients who were below the cut-off point with the BIT conventional test by Rater 1. In addition, we calculated the detection rates of the injured side in the participants assessed using the KF-NAP and BIT.

Data analysis was performed using IBM SPSS Statistics for Mac, Version 23 (Armonk, NY, USA).

## 3. Results

**3.1. Participants.** The demographic data of all participants are presented in Table 1. There was no significant difference between the two groups with respect to age, sex, type of stroke, disease duration, and FIM ( $P > 0.05$ ). The CBS group had more patients with left hemisphere damage and lower MMSE scores than the KF-NAP group. Four participants in the CBS group could not participate in MMSE assessment due to motor aphasia. However, CBS assessment in these participants could be performed because they could understand and follow the instructions.

**3.2. Reliability.** The ICC and Cronbach's alpha of the two groups are shown in Table 2. Both the CBS and KF-NAP exhibited excellent interrater reliability and internal consistency. However, it appears that the KF-NAP exhibited slightly better reliability than the CBS.

The weighted kappa coefficients of each subscale of the KF-NAP and CBS are shown in Table 3. In the CBS, 3 of 10 subscales (limb awareness, dressing, and meals) did not exhibit significant agreement between the two raters, whereas the other subscales were in fair to substantial agreement. In the KF-NAP, weighted kappa coefficients could not be calculated for auditory attention and navigation because one rater assigned the same score (zero) on the subscales for all the participants. In such a case, the weighted kappa cannot be calculated due to the calculation methods used [23]. However, the weighted kappa for all eight subscales was in significant agreement, and two subscales (gaze orientation and cleaning after meals) were almost in perfect agreement.

The order of the CBS was changed to correspond with that of KF-NAP.

**3.3. Validity.** The correlation between the KF-NAP and conventional BIT is shown in Table 4. Four of six subscales of BIT were significantly correlated with KF-NAP, and the total score also tended to be correlated with KF-NAP.

The correlation between the KF-NAP and FIM is shown in Table 4 and Figures 1–3. Total FIM and motor FIM were

TABLE 1: Characteristics of the participants.

	KF-NAP group ( $n = 22$ )	CBS group ( $n = 23$ )	$P$
Age	$65.4 \pm 13.5$	$64.4 \pm 12.2$	0.941
Sex (male/female)	17/5	17/6	0.66
Disease duration (day)	$80.7 \pm 64.5$	$99.6 \pm 36.9$	0.405
Lesion (right/left/bilateral)	16/5/1	9/14/0	0.045*
Stroke subtype			
Ischemic stroke/hemorrhagic stroke	11/11	15/8	0.378
MMSE	$26.1 \pm 3.7$	$21.8 \pm 7.2^{**}$	0.026*
FIM total	$84.8 \pm 26.3$	$89.9 \pm 23.8$	0.310
Motor	$56.0 \pm 22.2$	$62.9 \pm 19.4$	0.158
Cognitive	$28.8 \pm 5.6$	$27.0 \pm 6.3$	0.381
BIT total	$131.8 \pm 26.6$		
Line cancellation	$34.8 \pm 4.8$		
Letter cancellation	$34.7 \pm 8.6$		
Star cancellation	$49.5 \pm 10.9$		
Figure and shape copying	$2.5 \pm 1.4$		
Line bisection	$7.9 \pm 2.5$		
Representational drawing	$2.3 \pm 1.1$		
KF-NAP total score	(Rater 1)		
	(Rater 2)		
CBS total score	(Rater 3)	$2.39 \pm 4.00$	
	(Rater 4)	$2.39 \pm 4.52$	

\*\*MMSE could not be assessed in 4 CBS participants due to motor aphasia. Comparison between the two groups was performed using the unpaired  $t$ -test (age, disease duration, MMSE, FIM) and chi-squared test (sex, lesion, stroke subtype). The level of statistical significance for the variables was set at  $P < 0.05$ .

TABLE 2: Interrater reliability of KF-NAP and CBS.

	KF-NAP group	$P$	CBS group	$P$
ICC	0.921	<0.001	0.852	<0.001
Cronbach's alpha	0.969		0.904	

correlated with KF-NAP. However, cognitive FIM was not correlated with KF-NAP.

The correlation between the KF-NAP and FIM is shown in Table 4 and Figures 1 and 3. Total FIM and motor FIM were correlated with KF-NAP. However, cognitive FIM was not correlated with KF-NAP.

**3.4. USN Detection Rate.** The USN detection rates of KF-NAP and BIT in the KF-NAP group are shown in Table 5. In the KF-NAP group, KF-NAP could detect more patients with USN than BIT, particularly in patients with left hemisphere damage.

## 4. Discussion

We evaluated USN using the KF-NAP in subacute stroke patients during rehabilitation in Japan. In the Japanese healthcare system, stroke patients are transferred to a rehabilitation hospital within 60 days, and the time between

stroke onset and admission to rehabilitation hospitals is generally 3 to 5 weeks. Subsequently, patients receive intensive rehabilitation treatment for several months.

In this study, both interrater reliability and internal consistency were slightly better in the KF-NAP group than in the CBS group. Each subscale was generally in better agreement in the KF-NAP group than in the CBS group. Previous studies reported that both CBS [9, 10] and KF-NAP [8, 16] displayed excellent reliability. However, to the best of our knowledge, comparisons of interrater reliability between CBS and KF-NAP were not reported. Since KF-NAP was developed for scoring CBS more easily and precisely [8, 11], we hypothesized that the introduction of KF-NAP would improve the reliability of CBS. First, we assessed USN using the CBS and subsequently assessed USN using the KF-NAP in the different patient groups at the same hospital. These results support the hypothesis.

In this study, weighted kappa coefficients of two subscales (auditory attention and navigation) could not be calculated because one rater assigned the same score (zero) on the subscales for all the participants. However, the other rater also scored zero for all except two participants on the auditory attention (scored 1) and except for one (scored 1) on the navigation. Therefore, even these two subscales were in good agreement between the raters. Although most subscales of KF-NAP were in moderate or better agreement, only the personal belonging subscale remained fair even with KF-NAP,



TABLE 3: Interrater reliability of each subscale of KF-NAP and CBS.

Subscale	KF-NAP group Weighted kappa	<i>P</i>	CBS group Weighted kappa	<i>P</i>
Gaze orientation	0.89	<0.001	0.372	0.016
Limb awareness	0.56	<0.001	0.27	0.087
Auditory attention	—		0.535	0.001
Personal belongings	0.353	0.0035	0.297	0.013
Dressing	0.522	<0.001	0.361	0.051
Grooming	0.66	<0.001	0.372	0.016
Navigation	—		0.61	<0.01
Collisions	0.654	<0.001	0.618	<0.001
Meals	0.645	0.001	0.33	0.104
Cleaning after meals	1	<0.001	0.303	0.008

Weighted kappa coefficients of “auditory attention” and “navigation” in KF-NAP could not be calculated because one rater assigned the same score on the subscale to all the participants.

TABLE 4: Correlation between KF-NAP and other assessments.

Spearman	<i>r</i>	<i>P</i>	<i>R</i> <sup>2</sup>
BIT total	-0.405	0.062	0.592
Line cancellation	-0.495	0.019*	0.204
Letter cancellation	-0.278	0.210	0.634
Star cancellation	-0.437	0.042*	0.587
Figure and shape copying	-0.43	0.046*	0.288
Line bisection	-0.282	0.204	0.528
Representational drawing	-0.445	0.038*	0.325
FIM total	-0.521	0.013*	0.266
Motor	-0.565	0.006*	0.280
Cognition	-0.334	0.129	0.107

BIT: Behavioral Inattention Test; FIM: Functional Independent Measure.

\*Significant correlation (Spearman correlation coefficient;  $P < 0.05$ ).  $R^2$ : least square of regression lines.

possibly due to the assessment method and the space constraints in the Japanese hospital room setting. We assessed the personal belonging subscale from 3 to 6 based on the patients' daily use of personal belongings placed in the room and assessed their behavior. It is difficult to evenly position personal belongings around a patient on the left and right because of limited personal space in the hospital rooms in Japan. Therefore, it is challenging to appropriately arrange the room for the assessment. The interrater reliability of the subscales was less consistent than in previous reports both in the KF-NAP and the CBS. The possible reasons are as follows: (1) the participants were in the subacute intensive rehabilitation ward, and most of the patients experience improvement in their function and abilities day by day, and the symptoms of USN fluctuated. Therefore, we expect that the scores would be significantly different between raters compared with those of patients during the acute phase, as reported in previous studies. (2) Most participants with USN had mild to moderate symptoms. Potentially, in these patients, USN symptoms would have been impacted by

intensive rehabilitation more rapidly than in patients with more severe USN, and (3) the raters were not adequately trained, which could be improved by thorough education.

In our study, KF-NAP-J was correlated with the line cancellation test, star cancellation test, and figure and shape copying of BIT. Azouvi et al. [10] reported significant correlations between the CBS and three paper-and-pencil tests, including the Bells test, the copying test, and the sentence reading test in patients with USN. Kim et al. [17] demonstrated that KF-NAP was correlated with the Albert's test and letter cancellation test. Our results suggest that KF-NAP-J could reflect behavioral changes related to USN symptoms such as visual exploration and spatial representation that are assessed by paper-and-pencil tests, as well as the original version of CBS and KF-NAP. However, the correlation coefficients were relatively small in our study. In this study, only 22.7% of patients were diagnosed as USN by BIT, while 63.6% were diagnosed by KF-NAP-J. This could be due to the difference in detection rates between BIT and KF-NAP.

KF-NAP-J was also correlated with motor and total FIM but not with cognitive FIM. Chen et al. [13] showed that the KF-NAP had significant correlations with FIM and the Barthel Index. The subscales of CBS and KF-NAP assess the difficulties in daily life situations due to USN. Moreover, USN affects motor FIM more than cognitive FIM [6]. Our study is therefore consistent with previous studies.

The USN detection rate of the KF-NAP was higher than that of the BIT. Subacute patients receiving rehabilitation treatment may learn to compensate for USN symptoms in the visual search task. In addition, paper-and-pencil tests tend to improve when the tests are repeated regardless of improvement of USN [12]. Therefore, behavioral tests like the KF-NAP were more accurate at detecting USN for these patients [11].

In patients with left hemisphere damage, the USN detection rate of KF-NAP was considerably higher than that of BIT. No USN patients were detected using BIT, whereas 60% were diagnosed with USN by KF-NAP. It is difficult to evaluate USN using paper-and-pencil tests if the patients

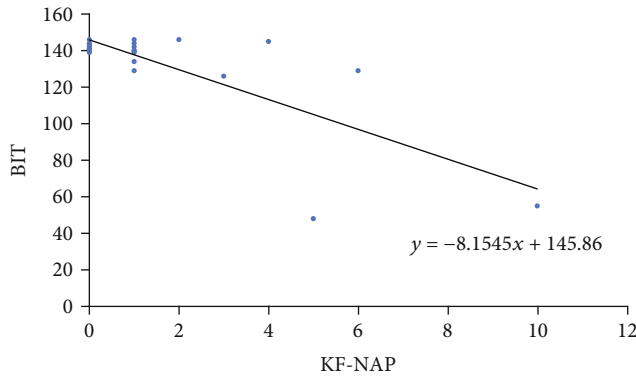


FIGURE 1: Correlation between KF-NAP and BIT total.

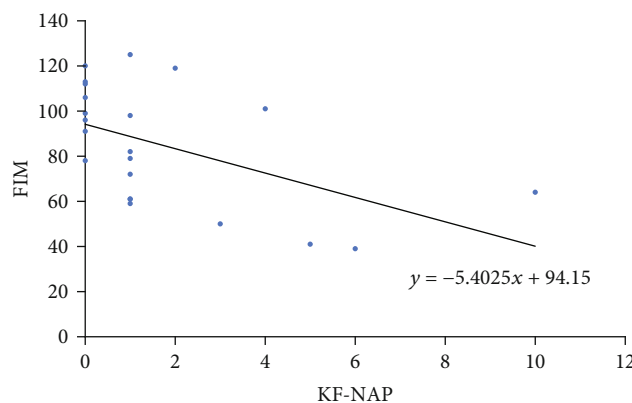


FIGURE 2: Correlation between KF-NAP and FIM total.

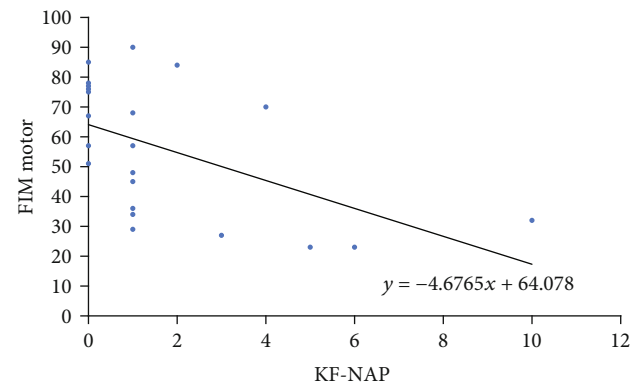


FIGURE 3: Correlation between KF-NAP and FIM-motor.

have aphasia and/or severe dominant hand paresis. However, right-sided USN of patients with left hemisphere damage equally predicts poor functional outcomes as left-sided USN [3, 4]. Therefore, behavioral testing such as KF-NAP is particularly useful for patients with left hemisphere damage.

USN is a strong negative predictor of poor rehabilitation outcomes [2, 6, 24], and recovery of USN affects the achievement of ADLs [6, 25–27] and discharge destination [4] after rehabilitation. Therefore, it is very important to accurately assess USN for subacute stroke patients during rehabilitation.

TABLE 5: USN detection rates measured in the KF-NAP group.

	Total %	Right lesion %	Left lesion %
KF-NAP ( $n = 22$ )	63.6	68.8	60.0
BIT ( $n = 22$ )	22.7	31.2	0

KF-NAP-J exhibited good reliability and validity and may be useful for predicting rehabilitation outcomes and planning appropriate rehabilitation treatment.

One of the main limitations of this study is the small sample size. There were only 22 participants in the KF-NAP group and 25 participants in the CBS group. Therefore, we could not match the lesion side and distribution of severity between the two groups. Future studies with a large number and a wide spectrum of participants are required to ascertain the reliability and validity of the method. In addition, we assigned the participants and the raters to either the CBS group or the KF-NAP group. Ideally, to effectively compare the reliability between the CBS and KF-NAP is to assess the same participants by two KF-NAP trained raters and two other raters trained with the original CBS but not KF-NAP trained. However, it is also difficult to retain blindness and independence among raters if many raters assess the same participants in a small hospital. Therefore, we initially separated the raters for the two groups, and two raters assessed participants in the CBS group, whereas the other two raters were involved in translating and KF-NAP training. Owing to these limitations in the study design, we cannot confirm the validity and reliability based on the results of this study only. Despite these limitations, the investigators believe that the KF-NAP-J is useful for assessing CBS in stroke patients undergoing subacute rehabilitation.

## 5. Conclusions

In this study, the KF-NAP exhibited good interrater reliability and correlated with the subscales of BIT and FIM, which represent USN and ADLs in subacute stroke patients. Unilateral spatial neglect strongly impacts rehabilitation training and its outcomes, therefore requiring accurate assessment of USN. In addition, behavioral testing is even more important in patients with left hemisphere damage because it facilitates assessment even if the patients experience aphasia and paralysis of the right hand. These results suggest that KF-NAP and CBS are useful in assessing USN in subacute stroke patients.

## Data Availability

Data are available upon reasonable request to the corresponding author.

## Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.



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