



FOCUS ON
HEALTH

Occupational Therapy, Medical Orthotics, Prosthetics & Arts Therapy

Self-study CPD activity

Activity Reference Number

J3(25) 2030

Topic

Electronic activity card sort (ACS3)

Article(s)

Discriminant validity of the electronic activity card sort (ACS3) among adults with traumatic brain injury and multiple sclerosis

Profession(s)

Medical Practitioners
Occupational Therapy

This activity is approved for **TWO (2) Clinical** Continuing Education Units (CEU's)

Discriminant Validity of the Electronic Activity Card Sort (ACS3) Among Adults With Traumatic Brain Injury and Multiple Sclerosis

Amanda Gahlot, Yael Goverover

Importance: The Electronic Activity Card Sort (ACS3) is an online adaptation of the in-person Activity Card Sort (ACS). It is important to validate the ACS3 within clinical populations.

Objective: To assess the discriminant validity of the ACS3 between persons with multiple sclerosis (MS) and those with traumatic brain injury (TBI).

Design: Cross-sectional.

Setting: Telehealth.

Participants: Community-dwelling adults with either MS ($n = 11$) or TBI ($n = 11$).

Outcomes and Measures: The ACS3 was administered via virtual interview. Analyses (t tests) were conducted to compare persons with TBI and those with MS on the ACS3 and compare the preinjury or preillness and current activity scores for each group. Correlations between demographic characteristics and ACS3 scores were computed, using Pearson correlations for continuous variables and Spearman correlations for categorical data.

Results: All participants ($n = 22$) demonstrated significant reductions from before to after injury/illness for each domain and total ACS3 scores. Furthermore, the MS group retained fewer activities than the TBI group in the ACS3 total score.

Conclusions and Relevance: The results provide preliminary evidence for the discriminant validity of the ACS3's capacity to distinguish between adults with MS and those with TBI. The ACS3 may be a clinically useful tool for evaluating life participation in persons with chronic neurological conditions.

Plain-Language Summary: Involvement in life situations, or participation, is an essential outcome in rehabilitation, and is associated with higher quality of life, decreased depression, and better overall well-being. Changes in health can reduce participation in meaningful life activities, which can negatively affect independence and life satisfaction. Meaningful patient engagement emphasizes and supports patient participation as an essential outcome in rehabilitation that includes occupational therapy. The Electronic Activity Card Sort (ACS3) is an online adaptation of the in-person Activity Card Sort (ACS). The ACS3 is a virtual option for measuring participation in adults with chronic neurological conditions. This study explored using ACS3 to identify changes in participation levels between adults with multiple sclerosis (MS) and those with traumatic brain injury (TBI). The study factored in both current and previous participation levels. Using ACS3, occupational therapists were able to differentiate participation patterns among those with MS and those with TBI. In a clinical setting, ACS3 can be used to guide personalized rehabilitation strategies for two distinct neurological conditions, thereby improving patient outcomes.

Gahlot, A., & Goverover, Y. (2025). Brief Report—Discriminant validity of the Electronic Activity Card Sort (ACS3) among adults with traumatic brain injury and multiple sclerosis. *American Journal of Occupational Therapy*, 79, 7904205090. <https://doi.org/10.5014/ajot.2025.050829>

Participation, or involvement in life situations (World Health Organization, 2001), is an essential outcome in rehabilitation, and it has garnered more attention in recent years, including heightened health care reimbursement (Centers for Medicare & Medicaid

Services, 2023; Goverover & Chiaravalloti, 2023). Participation is associated with higher quality of life (QOL), decreased depression, and better overall well-being (Santini et al., 2020). Changes in health status can disrupt established activity patterns, often

leading to reduced participation in meaningful life activities, negatively affecting independence and life satisfaction (Marzo et al., 2023).

The Activity Card Sort (ACS; Baum & Edwards, 2008) measures participation across multiple domains of daily living by comparing current activity levels with preinjury or prediagnosis baselines. This patient-centered approach to measurement eliminates reliance on normative data to detect meaningful participation changes (Tyminski et al., 2020). A recent virtual adaptation, the Electronic Activity Card Sort (ACS3; Boone et al., 2022), features 100 activities across diverse participation domains. Although the ACS3 has been shown to have high validity with the original ACS among healthy control participants (Boone et al., 2022), its application across clinical populations remains unexplored.

Measuring participation across health conditions that entail distinct trajectories provides unique insights into a particular instrument's sensitivity and validity. Traumatic brain injury (TBI) and multiple sclerosis (MS) represent two distinct neurological conditions for such a comparison (Warren et al., 2013). MS is a progressive neurodegeneration condition that leads to a gradual decline in functional abilities and participation over time (Goverover et al., 2020; Johansson et al., 2020). In contrast, TBI typically involves an acute onset followed by a recovery period and chronic stable participation outcomes (Erler et al., 2018; Goverover & Chiaravalloti, 2023). Studies using the ACS have shown significant participation reduction in both people with MS (Goverover et al., 2020) and those with TBI (Goverover et al., 2017) compared with healthy control participants, with those with MS showing more pronounced decline in high-demand leisure and social activities than those with TBI. However, direct comparisons have been limited by methodological differences.

In this exploratory cross-sectional study, we compared the performance of the ACS3 between TBI and MS groups and within each group. On the basis of previous research showing distinct patterns in these conditions, we hypothesized that the ACS3 will detect different participation profiles between MS and TBI. Understanding these distinctions will advance the utility of the ACS3 in capturing nuanced participation changes across diverse populations, informing both clinical practice and rehabilitation outcomes research.

Method

Participants

Participants ($n = 22$; 11 with TBI, 11 with MS) were recruited through community flyers, support groups, social media, and word of mouth between May and November 2023. Participants were eligible if they were an adult (≥ 18 yr), community dwelling, fluent in English, had adequate vision to view study materials, had access to internet-connected devices, and could

provide informed consent. Participants with MS (Thompson et al., 2018) had no recent (past-month) exacerbation and expressed concerns about memory. Persons with moderate to severe TBI who were at least 6 mo postinjury were matched by age to the MS cohort. Data were collected via Zoom, with participants completing a demographic questionnaire and the ACS3. The virtual format was selected to align with the ACS3 online delivery and trends toward telehealth (Wosik et al., 2020). The study was approved by the New York University Institutional Review Board.

ACS3

The ACS3, a measure of life participation, was adopted from the paper form of the ACS (Baum & Edwards, 2008) and is intended to be used electronically. It includes 100 activities across four domains: instrumental activities of daily living (IADLs), social activities, leisure activities, and fitness or exercise activities (previously called "high-demand leisure activities"). Individuals view photographs of adults performing these activities and rate their own involvement on the basis of five categories: (1) "I have never done [this]," (2) "I continue to do [this] (since illness or injury onset)," (3) "I do [this] less since my injury/illness," (4) "I have given up [doing this]," or (5) "I would like to start [doing this]." The retained activity score from before onset to current engagement is calculated by dividing the sum total of current activities by the sum total of previous activities. The ACS3 demonstrates concurrent validity with the ACS ($r = .86$) with respect to total scores, with no significant difference between the ACS and ACS3 in retained activity scores in community-dwelling adults ($p = .39$; Boone et al., 2022).

Data Analysis

We used descriptive statistics to summarize ACS3 total and domain scores in each group. Independent t tests were used to compare the ACS3 total and domain scores between the TBI and MS groups. Within each group, paired t tests were used to compare preinjury or preillness and current activity scores. Associations between demographic variables (e.g., age, time since injury or illness onset, marital status, education, and gender) and ACS3 total and retained activity scores were analyzed for the whole sample. Pearson correlations were used for continuous demographic variables, and Spearman correlations were applied for categorical variables. The statistical significance was set at $p < .05$. All analyses were completed using R with the tidyverse, gtsummary, and ggplot2 packages (Sjoberg et al., 2021; Wickham, 2016; Wickham et al., 2019).

Results

Demographic Characteristics

Demographic characteristics for the total sample and each group are presented in Table 1. The TBI group

Table 1. Demographic Characteristics of the Sample

Characteristic	n (%)		p ^a
	MS (n = 11)	TBI (n = 11)	
Current age, yr, M (SD)	58.4 (7.6)	52.1 (9.5)	.10
Education, yr, M (SD)	15.1 (1.8)	16.7 (2.0)	.06
Marital status			.13
Single	1 (9.1)	5 (45.5)	
Married	3 (27.3)	1 (9.1)	
Divorced	5 (45.5)	5 (45.5)	
Widowed	2 (18.1)	0 (0.0)	
Gender			.36
Male	2 (18.1)	5 (45.5)	
Female	9 (81.9)	6 (55.5)	
Race/ethnicity			.001
Black	6 (55.5)	0 (0.0)	
Hispanic	0 (0.0)	1 (9.1)	
White	4 (36.4)	10 (91.9)	
Biracial	1 (9.1)	0 (0.0)	
Time since onset, yr, M (SD)	19.3 (5.4)	12.3 (8.3)	.03
Current employment			.04
Employed	1 (9.1)	6 (55.5)	
Disability	9 (81.8)	4 (36.4)	
Retired	1 (9.1)	0 (0.0)	
Volunteer	0 (0.0)	1 (9.1)	

Note. MS = multiple sclerosis; TBI = traumatic brain injury.

^aWelch two-sample *t* test or Fisher's exact test.

consisted of five individuals with moderate TBI and six with severe TBI. For the MS group, three individuals had relapsing–remitting MS, three had primary progressive MS, and five had secondary progressive courses of MS. The groups were matched for comparison, with no significant difference in any of the demographic variables, except for time since onset, race/ethnicity, and current employment status.

ACS3

The means and standard deviations for the ACS3 are provided in Table 2. Participants in the MS group significantly retained fewer activities compared with those in the TBI group for the total ACS3 score, $t(19.34) = -2.64$, 95% confidence interval (CI) $[-28.33, -3.30]$; IADL retained activity scores, $t(18.54) = -3.52$, 95% CI $[-31.9, -8.10]$; leisure retained activity scores, $t(19.8) = -2.3$, 95% CI $[-33.3, -1.66]$; and current fitness scores, $t(12.8) = -2.14$, 95% CI $[-66.4, 0.36]$. The MS group's before-illness leisure ACS3 scores were significantly higher than those of the TBI group.

Table 2. ACS3 Scores: Before Injury or Illness, Current Participation, and Percentages Retained for the Total Sample and the MS and TBI Cohorts

ACS3 Score	M (SD) or %			p ^a
	Total Sample (N = 22)	MS (n = 11)	TBI (n = 11)	
Total				
Before	71.3 (11.2)	74.6 (9.4)	67.9 (12.2)	.16
Current	50.5 (13.4)	47.1 (10.8)	53.8 (15.3)	.25
Retained (%)	71.0 (15.9)	63.1 (12.7)	78.9 (15.3)	.02
IADLs				
Before	22.4 (3.3)	23.1 (3.5)	21.7 (3.0)	.34
Current	17.5 (4.6)	15.8 (4.5)	19.2 (4.3)	.08
Retained (%)	77.6 (16.5)	67.6 (15.1)	87.6 (11.3)	<.01
Leisure				
Before	22.9 (5.9)	25.6 (3.6)	20.2 (6.6)	.03
Current	17.2 (5.8)	17.4 (5.4)	17.1 (6.5)	>.9
Retained (%)	76.3 (19.5)	67.5 (18.5)	85.0 (16.9)	.03
Fitness				
Before	12.5 (4.1)	11.9 (3.5)	13.0 (4.8)	.55
Current	6.2 (3.5)	4.1 (2.1)	7.9 (3.7)	.01
Retained (%)	52.3 (39.1)	35.8 (18.2)	68.8 (47.8)	.05
Social				
Before	12.9 (3.1)	12.7 (4.3)	13.0 (1.5)	.84
Current	9.8 (2.9)	9.9 (3.0)	9.7 (2.9)	.89
Retained (%)	73.0 (21.1)	71.0 (20.0)	75.1 (22.9)	.66

Note. ACS3 = Electronic Activity Card Sort; IADLs = instrumental activities of daily living; MS = multiple sclerosis; TBI = traumatic brain injury.

^aWelch two-sample *t* test.

Comparisons between preinjury or preillness and current ACS3 scores revealed significant changes ($p < .001$) in both the total sample ($N = 22$) and within each group (MS and TBI) across all domains (IADLs, leisure activities, fitness activities, social activities) and total scores (see Table 2).

Last, correlations between demographic characteristics (age, time since injury or illness onset, marital status, education, and gender) with ACS3 retained activity scores are presented in Table 3. For total retained activity scores, single or married participants had higher activity retention than divorced participants, and women demonstrated higher retained activity scores than men, regardless of their diagnosis. For the specific domains, younger individuals demonstrated higher leisure retention, and those with more education demonstrated higher fitness retention.

Discussion

The ACS3 demonstrates preliminary discriminant validity between people with MS and those with TBI, with participants with MS demonstrating decreased participation in life activities compared with those with TBI. Both groups experienced a significant participation decline from preinjury or illness baselines, with the MS

Table 3. Associations Between ACS3 Retained Activity Scores and Demographic Characteristics: Total Sample

Variable	ACS3 Retained Activity Scores				
	IADLs	Leisure Activities	Fitness Activities	Social Activities	Global
Age	-.32	-.48*	-.03	-.35	-.39
Time since onset	-.31	.19	.14	.13	-.09
Education	.26	.39	.48*	.36	.43*
Marital status	-.30	-.36	-.36	-.25	-.50*
Gender	-.12	-.29	-.32	-.30	-.36

Note. Marital status (single/married vs. divorced) and gender correlations with activity retention were analyzed using Spearman's rank correlation coefficients because of their categorical nature. ACS3 = Electronic Activity Card Sort; IADLs = instrumental activities of daily living.

* $p < .05$.

group showing lower scores in total ACS3 retained activity scores, IADL current and retained activity scores, and current fitness scores.

The findings from this study are consistent with those of previous research that have used the in-person ACS. The MS group's mean total ACS3 scores ($M = 47.1$, $SD = 10.8$) closely matched those of prior studies ($M = 48.5$, $SD = 10.7$; Goverover et al., 2020). Participants in the TBI group, although their current total scores were similar to those of community-dwelling adults (Boone et al., 2022), and higher than those found in a previous in-person ACS study (Goverover et al., 2017), still demonstrated significant postinjury participation decreases.

The magnitude of participation decline is noteworthy. Previous studies have found that healthy control adults retained more than 90% of their participation levels over 10 yr (Goverover et al., 2017, 2020), whereas in the current study the MS and TBI groups retained only 63% and 79%, respectively. These findings not only validate the observed participation declines but also demonstrate the ACS3's ability to detect distinct patterns between conditions. These distinct patterns suggest condition-specific impacts rather than measurement artifacts from retrospective reporting.

The MS group's lower current fitness participation aligns with the results of previous studies showing less physical activity in persons with MS compared with those with stroke or TBI (Hale et al., 2008; Nosek et al., 2006), which is particularly significant given the known benefits of physical activity for MS (Proschinger et al., 2022). Moreover, the social participation scores were similar between the MS and TBI groups, both of which demonstrated significant changes in retained activity scores. This is crucial given that social participation correlates with QOL, life satisfaction, and overall well-being in both groups (Erler et al., 2020; Pokryszko-Dragan et al., 2020; Sparling et al., 2017; Vos et al., 2019).

Limitations

Limitations of this study include its modest sample size, demographic skew (predominantly female with above-average education), and reliance on

retrospective self-reports. The significant difference in time since diagnosis or injury between groups ($MS = 19$ yr, $TBI = 12$ yr) may have influenced participation patterns and recall accuracy. Although the ACS3 was validated in an in-person format (Boone et al., 2022), its virtual administration in the current study lacks validation, potentially affecting the findings. Last, recalling preinjury or preillness activities over extended periods may reflect natural life transitions rather than purely condition-related changes. However, the comparable age between cohorts helps control for aging-related effects on participation outcomes.

Conclusions

Emphasizing participation as a rehabilitation outcome is essential for meaningful patient engagement. The ACS3 differentiated participation patterns between adults with MS and those with TBI, revealing significant declines in participation from preinjury or preillness to current status. It is valuable for capturing changes in participation by considering both current and previous participation levels. With respect to clinical work, it can guide personalized rehabilitation strategies, thereby improving patient outcomes. Future research should explore the ACS3's validity and reliability in larger and more diverse populations to enhance generalizability. 

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QUESTIONNAIRE

J3(25)

Discriminant validity of the electronic activity card sort (ACS3) among adults with traumatic brain injury and multiple sclerosis

INSTRUCTIONS

- Read through the article and answer the multiple-choice questions provided below.
- **Some questions may have more than one correct answer;** in which case you must mark **all** the correct answers.

Question 1: Involvement or participation in life situations is an essential outcome in rehabilitation, and is associated with which of the following?

- A: Higher quality of life
- B: Lower physical activity
- C: Decreased depression
- D: Better overall well-being

Question 2: Changes in health status can disrupt established activity patterns, often leading to reduced participation in meaningful life activities, negatively affecting which of the following? Select BOTH correct options.

- A: Hearing acuity
- B: Independence
- C: Visual acuity
- D: Life satisfaction

Question 3: The Electronic Activity Card Sort (ACS3) is an online adaptation of the in-person Activity Card Sort (ACS) for measuring participation in meaningful life activities in adults with chronic neurological conditions and features 100 activities across diverse participation domains.

- A: TRUE
- B: FALSE

Question 4: _____ is a progressive neurodegeneration condition that leads to a gradual decline in functional abilities and participation over time. In contrast, _____ typically involves an acute onset followed by a recovery period and chronic stable participation outcomes.

- A: Stroke; Multiple sclerosis (MS)
- B: Ischaemic stroke; Osteoporosis
- C: Multiple sclerosis (MS); Traumatic brain injury (TBI)

Question 5: Which the following is a score of 2 on the ACS3?

- A: "I continue to do [this] (since illness or injury onset)"
- B: "I do [this] less since my injury/illness,"
- C: "I have given up [doing this],"
- D: "I would like to start [doing this]."

Question 6: Participants in the _____ group significantly retained fewer activities compared with those in the _____ group for the total ACS3 score.

- A: Traumatic brain injury (TBI); Multiple sclerosis (MS)
- B: Multiple sclerosis (MS); Traumatic brain injury (TBI)

Question 7: For total retained activity scores, single or married participants had higher activity retention than divorced participants, and women demonstrated higher retained activity scores than men, regardless of their diagnosis.

- A: TRUE
- B: FALSE

Question 8: For the specific domains, _____ individuals demonstrated higher leisure retention, and those with _____ demonstrated higher fitness retention.

- A: Fit; less education
- B: Younger; less education
- C: Younger; more education

Question 9: The ACS3 demonstrates preliminary _____ validity between people with MS and those with TBI.

- A: Construct
- B: Content
- C: Criterion
- D: Discriminant

Question 10: The findings from this study are consistent with those of previous research that have used the in-person ACS. These findings not only validate the observed participation declines but also demonstrate the ACS3's ability to _____?

- A: Measure client satisfaction with participation rather than actual participation patterns
- B: Determine causal relationships between diagnosis and participation outcomes
- C: Detect distinct patterns between conditions

THE END



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ANSWER SHEET

J3(25)

Discriminant validity of the electronic activity card sort (ACS3) among adults with traumatic brain injury and multiple sclerosis

*Time spent on activity						hour		min				
	A	B	C	D	E		A	B	C	D	E	
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2						7						
3						8						
4						9						
5						10						

How relevant was the content of this activity to your scope of practice?			
			
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