

Development, Reliability, and Validity of the Multiple Errands Test Home Version (MET-Home) in Adults With Stroke

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OBJECTIVE. Our objective was to perform initial psychometric analysis of the Multiple Errands Test Home Version (MET-Home), which was designed to assess the influence of poststroke executive dysfunction on in-home task performance.

METHOD. We examined the reliability and validity of the MET-Home in adults with stroke ($n = 23$) and individually matched control participants ($n = 23$). All participants completed a series of assessments during a single in-home visit.

RESULTS. Notable differences in MET-Home subscores were discovered between participants with stroke and control participants. Participants with stroke omitted more tasks, broke more rules, passed by tasks more often, and were less efficient than matched control participants. The MET-Home demonstrated evidence of adequate internal consistency, excellent interrater reliability, and significant moderate associations with several tests.

CONCLUSION. This preliminary study suggests that the MET-Home differentiates between adults with stroke and matched control participants. The MET-Home provides evidence of initial reliability and validity among adults with stroke.

Stroke is a chronic condition, and survivors often live with participation restrictions and persistent unmet needs in the community (McKevitt et al., 2011). Many adults with stroke (between 20% and 80% of survivors) experience poststroke cognitive impairment, which ranges in severity (Sun et al., 2014). *Executive function* is a neurocognitive domain that contributes to purposeful and goal-directed behaviors; it comprises skills such as planning, decision making, working memory, inhibition, set-shifting, and self-monitoring, which are necessary during complex task execution, often occurring within the lived environment (Lezak, 1982; Sachdev et al., 2014).

The Ecology of Human Performance (EHP; Dunn et al., 1994) practice framework can be applied to adults with poststroke executive dysfunction. It provides a method of investigating the relationship between the person and the environment and how that interaction affects human behavior and performance. The Multiple Errands Test Home Version (MET-Home) is an environment-specific tool we developed on the basis of the assumptions, rationale, and premise of this practice framework. The EHP framework assumes that performance cannot be understood out of context and that behaviors adapt to shifts in context. Thus, practitioners should evaluate each client in context to develop an enhanced understanding of real-world performance.

Occupational therapy maintains a distinct role in understanding the influence of executive dysfunction on task performance occurring in the lived environment (Morrison et al., 2015). Practitioners are often afforded the opportunity to assess the influence of executive dysfunction on everyday life tasks to determine real-world performance problems in the home (Burns & Neville, 2016). Task demands are unique in the home, and performance-based assessments with ecological validity offer a unique opportunity extending beyond traditional paper-and-pencil assessments that tend to focus on impairments alone (Dawson et al., 2009).

One assessment designed to examine the influence of executive dysfunction is the original MET (Shallice & Burgess, 1991). The MET consists of a list of everyday tasks constrained by a set of rules, providing an opportunity for participants to structure, plan, organize, and monitor task performance with multitasking demands. The MET was first tested with 3 adult participants with traumatic injuries to prefrontal structures (Shallice & Burgess, 1991). The participants with high-level executive dysfunction were substantially less organized and efficient than the control participants. Various context-specific versions of the MET have been developed and include the U.K. MET Hospital Version (Knight et al., 2002), Baycrest MET (Dawson et al., 2009), MET-Revised (Morrison et al., 2013), and Baycrest MET-Revised (Clark et al., 2015).

Although various MET versions have demonstrated evidence of reliability and validity in adults with stroke, it is necessary to conduct initial psychometric analysis of the newly developed MET-Home. In this study, we describe the development, initial reliability, and validity testing of the MET-Home.

Method

Research Design

This study consisted of two phases: (1) adaptation of the MET with standardized administration and scoring protocol for use in the home environment and (2) psychometric analysis. Ethical clearance was obtained from the institutional review board of the Texas Woman's University, and participants provided written informed consent before participating in the study.

Participants

Purposive, convenience, and snowball sampling techniques were used to recruit home-dwelling adults with stroke ($n = 23$) and control participants ($n = 23$) who were individually matched for age (± 3 yr), education (± 3 yr), and gender. A priori power analysis (with G*Power; Faul et al., 2009) indicated that 46 participants would be sufficient to detect difference with a power level set at .80, an α level of .05, and a moderate to high effect size of .40 for correlation analysis. We used the following inclusion criteria: ≥ 90 days poststroke; mild to moderate stroke severity; no dementia; independent before stroke; less than moderate depression; home dwelling >30 consecutive days; ≥ 18 yr old; and English speaking, reading, and understanding. Control participants met the same criteria except that they were fully independent at the time of the study. Exclusion criteria included history of previous stroke or other neurological condition, other conditions that could affect executive function, or other impairments that affect the ability to carry out the study protocol using National Institutes of Health Stroke Scale (Brott et al., 1989) in-scale cutoffs and clinical judgment.

Multiple Errands Test Home Version Development

The MET-Home was designed to reflect previously developed versions of the MET administered in various locations such as hospitals, shopping centers, and virtual environments. We initially developed a task and rule list designed to mirror other MET versions. However, several MET-Home task items were modified to fit the home. For example, the Baycrest MET (Dawson et al., 2009) and the MET-Revised (Morrison et al., 2013) provide maps for navigation; however, the home is familiar, and map use is not indicated. Instead, we added several tasks that involved locating items. We anticipated this modification would press participants to navigate to a greater number of rooms in the home and add to the complexity with spatial planning. Completing a monetary transaction is a task that also appears on other MET versions (e.g., Dawson et al., 2009; Shallice & Burgess, 1991); however, simple transactions for goods are not typical in the home. Therefore, the MET-Home integrated day-to-day purchases by including tasks for locating prices through whatever means were available in the home (e.g., phonebook, ads, computer, smartphones). Rules were modified to fit the home but included the same basic aims.

The developed task list was provided to adults with stroke at a local rehabilitation facility to review for applicability and was found to be relevant, contributing to its face validity. The tool underwent expert panel review, and revisions were made on the basis of the following feedback: integration and adaptation of the strategy classification sheet from the Baycrest MET (Dawson et al., 2009), addition of a prospective memory component to one task, and modification of wording for clarity. The tool was then given to five home health occupational therapy practitioners to use in the field who provided feedback after 2 mo. Revisions were made that included modifications to wording, and technology use was added to the strategy list. Next, the tool was piloted ($N = 4$), and additional revisions were made that included scoring simplification.

The MET–Home (Supplemental Figure 1, available online at <http://otjournal.net>; navigate to this article, and click on “Supplemental”) consists of a list of 14 tasks constrained by six rules. The assessment contains the following subscores: total time planning, total time elapsed, task completion (accurately, partially, or omitted), frequency and types of rule breaking, frequency and types of strategies used, number of passes (passing by a task that could have been carried out), number of tallied inefficiencies (becoming distracted and not being efficient with a task), and qualitative description of the environmental influence on performance. Findings from the subscores can provide information about how errors are made in context, potential influences on performance, and how naturalistic strategies are used to support performance.

Study Assessments

Participants initially completed a structured questionnaire on demographic characteristics and relevant clinical variables (e.g., age, gender, diagnosis, date of stroke). The Barratt Simplified Measure of Social Status (Barratt, 2006) was used to measure socioeconomic status (SES), which involves calculations of an aggregate score based on the education and occupation of the participant, the participant’s spouse or partner, and the participant’s parents.

We integrated the following series of assessments for screening and MET–Home analysis:

- The Short Blessed Test (Katzman et al., 1983) is a weighted screen used to identify possible dementia. It has been validated in community populations and has an 88% sensitivity and 94% specificity, respectively, for people without dementia and those with vascular or degenerative dementia (Davous et al., 1987; Katzman et al., 1983; Morris et al., 1989). We used scores of ≥ 10 (indicative of impairment consistent with dementia), as published in the screening tool, as a cutoff for this study.
- The Barthel Index (Mahoney & Barthel, 1965) is valid and reliable in the stroke population (Hsueh et al., 2001; Wade & Hewer, 1987), and it is used to measure assistance levels on 10 daily self-care and mobility tasks. We used scores ≥ 90 to indicate independence.
- The Beck Depression Inventory–II (Beck et al., 1996) is a screen used as an indicator for depression severity, with scores <20 indicating mild depression. It has demonstrated evidence of internal consistency and validity among adults with stroke (Aben et al., 2002; Desrosiers et al., 2002).
- The National Institutes of Health Stroke Scale (Brott et al., 1989) is used to classify stroke severity. Stroke severity cutoffs were 0–4 for mild and 5–15 for moderate (e.g., Adams et al., 1999; Corso et al., 2014).

We selected a series of assessments to examine convergent and concurrent validity. *Convergent validity* is used to measure the degree to which one instrument is comparable with another that measures similar traits, and *concurrent validity* is used to examine the relationship between a specific instrument and another instrument that is already considered valid (Kielhofner, 2006). We selected neuropsychological assessments of executive function and a cognitive screen for examining convergent validity and the Executive Function Performance Test (EFPT; Baum et al., 2008) for examining concurrent validity.

- The Symbol Digit Modalities Test (SDMT; [Smith, 1968](#)) is a brief assessment recognized for being particularly sensitive in identifying slowed processing speed. It is a well-studied tool that involves a substitution task with numbers and symbols, and it has demonstrated evidence of reliability and validity in stroke and community-based samples ([Koh et al., 2011](#); [Sheridan et al., 2006](#); [Tung et al., 2016](#)).
- The Delis–Kaplan Executive Function System (D–KEFS; [Delis et al., 2001](#)) is a standardized battery composed of nine subtests, is valid for detecting executive dysfunction, and has published normative data ([Delis et al., 2001, 2004](#)). Subtests may be used individually, and we selected two for the current study: Sorting Test and Tower Test. The Sorting Test is an assessment of concept formation, initiation of problem solving, set-shift, and abstraction. The Tower Test is used to measure spatial planning, rule learning, and inhibition of impulsive and perseverative responses ([Delis et al., 2001](#)).
- The Dysexecutive Questionnaire ([Wilson et al., 1996](#)) is a 20-item rating scale that is a component of the Behavioural Assessment of Dysexecutive Syndrome battery. It is used to measure executive and emotional dysfunction after an acquired brain injury and emphasizes emotion, personality, motivation, cognition, and behavior.
- The Montreal Cognitive Assessment (MoCA; [Nasreddine et al., 2005](#)) is a brief measure of global cognitive function intended to detect mild cognitive impairment. The MoCA is valid for use in stroke ([Cumming et al., 2013](#)), and scores of <26 indicate impairment in adults who have completed high school ([Nasreddine et al., 2005](#)). However, normative data from a population sample were developed, and study findings emphasized the importance of exercising caution when interpreting scores because most of the participants scored below the published cutoffs ([Rossetti et al., 2011](#)).
- The EFPT ([Baum et al., 2008](#)) is an ecologically valid assessment that integrates a top-down approach to assess performance of the following daily tasks: cooking, telephone use, medication management, and bill payment. The assessment is reliable, valid, and able to distinguish between adults with stroke and control participants ([Baum et al., 2008](#)).

Data Collection

All assessments were completed during a single visit in the participants' homes. Each participant selected the time of day on the basis of his or her perspective of best performance and was asked to have the home inhabited naturally. Distractions were minimized during administration of the neuropsychological assessments to maintain instrument validity. The assessments were administered in a random sequence determined a priori, with the MET–Home administered first to mitigate potential learning from other assessments (i.e., EFPT). During MET–Home administration, participants were given a one-page task and rule list (Supplemental Figure 1), a clipboard with loop for ease of handling, and a pen or pencil. The evaluator read directions from the instruction sheet aloud and described the rules while panning the participant page with her hand to describe different test components. Participants were asked to repeat the rules to ensure comprehension and were prompted to ask questions, review the page for as long as desired, and verbalize when ready to begin, thus signaling the rater to initiate timing.

Data Analysis

We conducted all data analysis with IBM SPSS Statistics (Version 22; IBM Corp., Armonk, NY). Internal consistency of the MET–Home task list was calculated with Cronbach's α , which increases as intercorrelations between test items increase. For interrater reliability, the two raters reviewed the scoring protocol before scoring and then independently scored video recordings. Results were not shared until after analysis. We conducted and estimated a two-way random method for calculating intraclass correlation coefficients (ICCs) using 95% confidence intervals for six

subscores of the MET–Home: accurately completed, partially completed, omitted, rule breaks, passes, and inefficiencies.

We computed convergent and concurrent validity. Scores were visually inspected for normality with histograms, which indicated that distributions were heavily skewed. Spearman's correlation coefficient (ρ) was used for data analysis because variation in data normality existed. Correlations were analyzed for the group of adults with stroke only because significant differences in scores were discovered (Supplemental Table 1). In addition, we examined MET–Home performance differences between adults with stroke and matched control participants. Because of violations of normality, the nonparametric Mann–Whitney U test was conducted to examine differences between adults with stroke and matched control participants. We calculated effect sizes to quantify the magnitude of difference between groups using Cohen's d .

Results

Participants

Demographic characteristics of the participants are reported in Table 1. Participants represented a variety of living situations. Adults with stroke ranged in chronicity and hemisphere localization. Significant differences in race/ethnicity and SES were identified (see Table 1). Control participants had a higher SES, and race/ethnicity varied between groups.

Internal Consistency and Interrater Reliability

We computed internal consistency reliability and found the MET–Home item task list acceptable (14 items; $\alpha = .73$). Each task item α ranged from .68 to .74. For interrater reliability, the two raters achieved excellent interrater reliability of $\geq .80$ during MET–Home piloting. Interrater reliability for subscores ranged from .88 to .96, indicating excellent interrater reliability (Cicchetti, 1994; Table 2).

Convergent Validity

Some significant moderate correlations were discovered among the MET–Home subscores and the SDMT and D-KEFS Tower Test (Table 3). Significant positive and negative correlations were expected because MET–Home

subscores increase both on the accuracy scale and with higher frequency of rule breaks, omissions, passes, and inefficiencies. Correlations with the MoCA, Dysexecutive Questionnaire, and D-KEFS Sorting Test were not significant.

Table 1. Participant Demographics

Characteristic	Adults With Stroke (<i>n</i> = 23)	Control Participants (<i>n</i> = 23)	<i>p</i>
Age, yr, <i>M</i> (<i>SD</i>)	56.7 (10.6)	56.3 (9.9)	.89
Gender, female, <i>n</i> (%)	10 (43)	10 (43)	.56
Race, <i>n</i> (%)			.04
Non-Hispanic White	16 (70)	14 (61)	
Hispanic	2 (9)	7 (30)	
Black or African-American	5 (22)	2 (9)	
Education, <i>n</i> (%)			.89
<High school	1 (4)	0 (0)	
High school or GED	13 (57)	11 (48)	
Some college	4 (17)	6 (26)	
Bachelor's degree	4 (17)	5 (22)	
Graduate	1 (4)	1 (4)	
BSMSS, <i>M</i> (<i>SD</i>)	35.3 (8.6)	42.8 (8.3)	.004
Hemisphere, left, <i>n</i> (%)	10 (43)		
Chronicity years, <i>M</i> (<i>SD</i>)	1.25 (± 3.0)		

Note. Values are not presented for control participants or the total sample with stroke-specific items. BSMSS = Barratt Simplified Measure of Social Status; GED = general equivalency diploma; *M* = mean; *SD* = standard deviation.

Concurrent Validity

We analyzed scores for adults with stroke and found a significant negative moderate correlation between MET–Home accurate completion subscore and EFPT total score; we also found positive correlations among two EFPT cognitive construct subscores and MET–Home omissions, passes, inefficiencies, and rule breaks

Table 2. Interrater Reliability for MET–Home Subscores and Strategy Subcategories

Variable	ICC	95% CI	p <
Accurately completed	.96	[.92–.97]	.001
Partially completed	.91	[.84–.95]	.001
Omitted	.92	[.86–.96]	.001
Rule break frequency	.96	[.86–.96]	.001
Passes	.88	[.79–.93]	.001
Inefficiencies	.93	[.87–.96]	.001

Note. CI = confidence interval; ICC = intraclass correlation coefficient; MET–Home = Multiple Errands Test Home Version.

(see Table 2). Negative and positive relationships were expected as a result of scale differences because the EFPT is scored on levels of cueing in which fewer cues indicate better performance. Refer to Supplemental Table 1 (available online) for the assessment scores used for convergent and concurrent validity analyses.

Performance Differences

The sample of adults with stroke demonstrated significant differences in MET–Home performance compared with the matched control participants (Table 4). Adults with stroke completed fewer tasks accurately and had a greater frequency of tasks partially completed or omitted, rule breaks, passes, and inefficiencies. All effect sizes were large or very large except for “planning time.”

Discussion

This study offers preliminary support for the reliability and validity of the MET–Home for use in stroke rehabilitation. The MET–Home was developed to provide an ecologically valid method for understanding the influence of executive dysfunction on everyday task performance in the home. The MET–Home is unique because it was developed to reflect everyday performance in the home environment.

Reliability

This study revealed that the MET–Home subscores have adequate internal consistency and excellent interrater reliability. Similar, [Knight et al. \(2002\)](#) achieved adequate internal consistency ($\alpha = .77$) and excellent interrater reliability (ICCs = .81–1.00) on the MET Hospital Version subscores. In addition, [Dawson et al. \(2009\)](#) achieved adequate to excellent interrater reliability (ICCs = .71–.88) on the Baycrest MET among adults with acquired brain injury. In our opinion, reviewing the assessment protocol before the scoring sessions supported the excellent interrater reliability for assessment subscores.

Validity

The MET–Home demonstrated evidence of convergent and concurrent validity. First, the MET–Home had significant correlations with two of the neuropsychological assessments. Associations were noted in some of the MET–Home

Table 3. Correlations for Adults With Stroke (n = 23)

Assessment	MET–Home				
	Accurately Completed	Omissions	Passes	Inefficiencies	Rule Breaks
EFPT					
Total	-.49*	.46*	.25	.30	.35
Initiation	-.18	.00	.15	-.04	.10
Organization	-.48*	.59**	-.07	.05	.14
Sequencing	-.11	-.01	.48*	.41	.57**
Judgment	-.22	.25	.35	.26	.33
MoCA	.37	-.18	-.25	-.37	.03
SDMT	.51*	-.40	-.14	-.49**	-.50*
D–KEFS Sorting Test	-.04	.29	.09	.03	-.06
D–KEFS Tower Test					
Total Achievement Score	.09	.03	-.35	-.22	-.35
Rule Violations	.23	.06	-.49*	-.23	-.15
Dysexecutive Questionnaire	-.02	-.02	.17	.22	.23

Note. D–KEFS = Delis–Kaplan Executive Function System; EFPT = Executive Function Performance Test; MET–Home = Multiple Errands Test Home Version; MoCA = Montreal Cognitive Assessment; SDMT = Symbol Digit Modalities Test.

*p < .05 (two-tailed). **p < .01 (two-tailed).

Table 4. Performance Differences on the MET-Home

Subscore	Adults With Stroke (n = 23), M (SD)	Control Participants (n = 23), M (SD)	p	d
Planning time, s	32.57 (53.99)	33.39 (28.68)	.071	0.02
Total time, s	994.57 (401.79)	571.52 (199.61)	<.001	1.30
Accurately completed (out of 14)	9.43 (1.93)	12.35 (1.43)	<.001	1.72
Partially completed (out of 14)	3.52 (1.44)	1.43 (1.16)	<.001	1.59
Omitted (out of 14)	1.00 (1.08)	0.13 (0.46)	<.001	1.05
Frequency of rule breaks	5.47 (4.52)	3.00 (1.98)	.074	0.71
Passes	2.52 (1.75)	1.09 (1.44)	.002	0.89
Inefficiencies	1.26 (1.68)	0.13 (0.45)	.001	0.92

Note. M = mean; MET-Home = Multiple Errands Test Home Version; SD = standard deviation.

subscores, suggesting that specific skills assessed with the neuropsychological assessments emerge during the MET-Home. The SDMT was associated with three MET-Home subscores, suggesting that skills such as processing speed and shifting attention may emerge during MET-Home execution. In addition, Nocentini et al. (2006) suggested that working memory substantially influences SDMT scores. Working memory can be described as a system that coordinates processing when several goals are present and guides behavior with information that may not be immediately present in the environment (D'Esposito & Postle, 2015).

In our opinion, working memory emerges throughout MET-Home performance. We also discovered associations between the D-KEFS Tower Test Rule Violations and MET-Home passes subscore. The Tower Test assesses skills such as spatial planning, inhibition of responses, and establishing and maintaining instructional set. It is likely that these skills emerge to prevent "passes" because to prevent a pass on the MET-Home, one must plan a route and follow rules (i.e., not enter a space more than once). We found no significant association with the D-KEFS Total Achievement Score, indicating that the skills for preventing rule violations may have primarily contributed to the association.

The D-KEFS Sorting Test, MoCA, and Dysexecutive Questionnaire demonstrated no significant associations with the MET-Home. It is surprising that no significant associations were found with the D-KEFS Sorting Test, which measures initiation of problem solving, flexibility of thinking (set-shift), and concept formation; however, this finding may be explicated by the fact that the Sorting Test uses modality-specific problem solving (verbal and perceptual) versus problem solving embedded in complex everyday task performance. This outcome is consistent with literature on integrating an ecologically valid approach to assess executive dysfunction, which suggests that real-life tasks are often complex and multidimensional (Morrison et al., 2015). The difference in how the skills were evaluated may contribute to the findings. We expected the limited associations with the MoCA because this tool contains a domain for executive and visuospatial screening, but the total score is used as a screen of general cognition.

In addition, we found no significant associations with the Dysexecutive Questionnaire, which is self-reported and reflects the personal experience of executive dysfunction. Toplak et al. (2013) suggested that rating measures of executive function assess different underlying neurocognitive constructs than performance-based assessments, and although both assessment categories are valuable, they provide different types of information. It is possible that the MET-Home and Dysexecutive Questionnaire are not correlated because they may not capture the same underlying process or neural substrates (Toplak et al., 2013). We anticipated the general strength of associations with neuropsychological assessments because it is likely that other skills affected performance. For instance, the neuropsychological assessments used in this study did not demand the same degree of motor involvement as the MET-Home.

The EFPT is an established and well-accepted assessment in stroke rehabilitation. Significant moderate correlations with the EFPT support the concurrent and ecological validity of the MET-Home. Correlations among the

assessments were stronger than anticipated because we expected the novel and loosely structured method of presenting everyday tasks on the MET–Home to affect the strength of the association. Although the EFPT and MET–Home are both performance-based assessments of everyday task performance, the administration and assessment content are dissimilar. For instance, when administering the EFPT, the evaluator presents one task at a time (e.g., medication management, bill payment), and scoring is based on the level of cueing needed to support performance. Alternatively, the MET–Home task list is loosely structured, and the evaluator does not provide cues. The EFPT and MET–Home both use an occupation-focused approach, which likely contributed to the significance and strength of the correlation. In fact, the EFPT and MET–Home both lend themselves to the assessment of the effects of executive dysfunction on daily tasks typically carried out in the home environment and thus may provide complementary findings that may support an enhanced understanding of real-world performance.

Performance Differences

In this study, we found that the MET–Home distinguished between adults with poststroke executive dysfunction and matched control participants. The adults with stroke achieved significantly lower scores for tasks accurately completed and demonstrated higher frequency of omissions, tasks partially completed, rule breaks, passes, and inefficiencies. These findings are consistent with literature supporting other context-specific versions of the MET (e.g., [Alderman et al., 2003](#); [Dawson et al., 2009](#)).

Study Limitations

The sample of adults with stroke was primarily recruited through a single rehabilitation facility where both raters were employed at the time of data collection. In addition, the current study has insufficient power for generalization. Additional psychometric testing is needed with a larger sample size, with participants matched for other socio-demographic variables known to influence cognitive assessment outcomes (e.g., SES) in varying regions beyond the southwestern United States, with blinded raters, and with other validated measures to explore potential associations.

Implications for Occupational Therapy Practice

The results of this study have the following implications for occupational therapy practice:

- The MET–Home offers a client-centered approach for understanding executive functions in the home environment.
- The MET–Home offers an ecologically relevant procedure for examining the influence of executive dysfunction in a naturalistic setting. The study results show promise, but the psychometrics of the MET–Home require further testing with other samples before they can be considered conclusive.

Conclusion

Adults with stroke may have underlying executive dysfunction that does not emerge until complex roles are resumed in the lived environment. The MET–Home was developed to objectively assess the influence of poststroke executive dysfunction on everyday task performance in the home. MET–Home subscores can be used to interpret how complex tasks in the home are approached, how errors are made in context, potential influences on performance, and how naturalistic strategies are used to support performance. The MET–Home has evidence of initial reliability and validity, and the subscores can be used to differentiate between adults with poststroke executive dysfunction and matched control participants. The strength of the associations is moderate, suggesting that the MET–Home measures other factors beyond those assessed with traditional neuropsychological assessments.

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