Abstract

Objective: This study examined the parallel forms reliability of a web application version (app) of the Activity Card Sort Australia for adults aged 18-64 and assessed clinical utility.

Methods: Forty eight participants completed the app and card versions of the tool within a 2- to 3-week interval and provided feedback via a purpose-designed survey. Intra-class

correlation analysis tested parallel forms reliability. **Results:** The app demonstrated

acceptable parallel forms reliability for the overall retained activity level ($r = 0.75, p <$

0.001), daily life domain ($r = 0.77, p < 0.001$), and recreation and relaxation domain ($r =$

$0.74, p < 0.001$) but not the physical activity domain ($r = 0.59, p < 0.001$). Clinical utility

responses suggested good acceptance of both versions. **Conclusion:** The results suggest that

further studies are required before the app version can be used for research or in clinical

settings.

Key Words: activities of daily living, occupational therapy, mobile applications, outcome measure.

Introduction

Activities that people do as individuals, in families, and with communities are central to the profession of occupational therapy and to health and well-being (Pierce, 2003). The Activity Card Sort (ACS) (Baum & Edwards, 2001) is a tool that has been developed in response to the need for a formal assessment of engagement that is culture specific. The original ACS (Baum & Edwards, 2001) was developed for use with older adults in North America, but culturally relevant versions have been developed based on the activities that are common for older people in different cultural contexts (Poerbodipoero, Sturkenboom, van Hartingsveldt, Nijhuis-van der Sanden & Graff, 2016). The ACS Aus (18-64) (Gustafsson, de Jonge, Lai, Muuse, Naude, & Hoyle, 2014) has been developed in response to the need to develop versions that are representative of activities common for adults across the earlier lifespan. Over the last 10 years, healthcare has been increasingly influenced by developing technology, especially the use of web applications (apps) in practice (Cason, 2014; Peterson & Watzlaf, 2014). The purpose of this study was to evaluate the parallel form reliability and clinical utility of a recently developed app-based version of the ACS Aus (18-64) against the original card version of the tool.

What is the ACS Aus (18-64)?

The ACS Aus (18-64) measures activity engagement of Australian adults (Gustafsson et al., 2014) and may be used to identify reductions in activity engagement, collaboratively identify priorities for goal setting, and measure changes in response to interventions. This version consists of 85 cards that depict pictures of adults engaged in representative activities, which have been assigned to one of three domains: daily life; recreation and relaxation; and physical activities (Gustafsson et al., 2014). Daily life contains all daily activities completed for maintenance of self, the home, and life/roles within the community; recreation and relaxation includes activities completed in free time for fun, as a hobby or interest, including

socialising with others; and physical activities includes participation in any form of physical activity whether high or low intensity, team or individual sports. To complete the assessment, the client sorts each card to represent former and current activity engagement. Throughout the literature, the ACS was identified as a unique assessment of activity engagement (Duncan & Earhart, 2010). The first unique advantage of the ACS is that the cards include pictures of people completing the activity, which is non-threatening and effective in prompting a client's memory recall of activity engagement (Doney & Packer, 2008; Sachs & Josmon, 2003). The second unique advantage is that the ACS is a client-centred measure of activity engagement – irrelevant activities are not counted in the final score, giving a more accurate level of retained activity (Lyons, Li, Tosterson, Meehan & Ahles, 2010; Packer, Boshoff & de Jonge, 2008).

Psychometrics of the ACS Aus (18-64)

The psychometrics of the ACS for older adults have been comprehensively examined and supported cross-culturally (Laver-Fawcett & Mallinson, 2013). The findings of these studies can be considered collectively, as the ACS is culturally adapted by modifying the activity cards to represent the given culture while the underlying methodology remains consistent (Katz, Karpin, Arit, Furman, & Hartman-Maeir, 2003). Initial psychometric testing of the ACS Aus (18-64) has also been completed with 54 healthy adults aged 18-64 years, indicating high test-retest reliability ($ICC = 0.92, p < 0.001$) and acceptable internal consistency ($\alpha = 0.83$) for all domains (Gustafsson, Hung, & Liddle, 2017). In a second study, discriminative construct validity is supported by differences in activity engagement between healthy adults ($n = 16$) and adults with Parkinson's disease ($n = 16$) (Bryant, Gustafsson, Liddle, & Stillerova, 2017). In this study, participants with and without Parkinson's disease were matched by age, gender and education, and reported significantly different activity retention for the physical activities domain, ($p = .035$) in favour of the group with Parkinson's disease (54% activity retention compared to 38% for healthy adults). The

daily life domain demonstrated a non-significant trend ($p = .80$) in favour of the healthy adults (79% activity retention compared to 69% for the adults with Parkinson's disease) (Bryant et al., 2017).

Technological Developments in Occupational Therapy

Technologies such as apps can be used in healthcare to ensure equity in access to services, regardless of geographical location (Stillerova, Liddle, Gustafsson, Lamont & Silburn, 2016; Street, Gold & Manning, 2009). However, there is a lack of research regarding which face-to-face assessments are viable as apps (Cason, 2014). Recently the Canadian Occupational Performance Measure (Law et al., 2014) has been adapted and made available as a web based app that can interface with electronic health records (The Canadian Occupational Performance Measure, 2017). A second assessment that is available as an app is the Multidimensional Task Ability Profile (MTAP). The MTAP uses a pictorial card-sorting methodology similar to that of the ACS, where participants with musculoskeletal injuries sort cards into categories presented along a 5-point Likert scale from 'Able' to 'Unable' (Mayer et al., 2005). Mayer and colleagues (2005) found evidence of high test-retest reliability ($r = 0.95$, $p < 0.05$) when comparing MTAP scores with a 2-day interval and high concurrent validity when compared to the Spinal Function Sort and the EPIC Lift Capacity test (Mayer et al., 2005). The high levels of reliability and concurrent validity suggest the MTAP may be useful for tracking client changes and treatment program outcomes over time (Mayer et al., 2005).

The MTAP study provides preliminary evidence that assessments administered as apps may be valid, reliable and clinically useful. However, it is important to note that app and mobile technologies are proliferating faster than clinical evidence and the effectiveness of apps in improving health must be evaluated before use in therapeutic and clinical settings (Anthes, 2016; Carter, Liddle, Hall & Chenery, 2015). An android app version of the ACS

Aus (18-64) has been developed in order to promote accessibility for clients aged 18-64 years who are unable to attend occupational therapy clinics, provide a possible interface with electronic health records, and to support the use of the tool with people who have trouble holding and sorting physical cards, for example people with Parkinson's disease who have a tremor in their hands (Gustafsson et al., 2017).

Current Study

The primary aim of this study was to test the parallel forms reliability of the ACS Aus (18-64) app with the original card sort version. That is, to determine the consistency of results of two versions of a test constructed with the same content but differing forms of administration. The secondary study aim was to assess the clinical utility, including acceptability, ease of administration, and participant experiences, of the app version. It was hypothesised that the ACS Aus (18-64) app will demonstrate sound parallel forms reliability and clinical utility.

Methods

This exploratory research sought to recruit a cohort of healthy adults to complete both versions of the ACS-Aus (18-64) and complete an additional questionnaire to provide feedback on the two versions of the tool. Prior to commencement of the study, ethical approval was obtained from The University of Queensland Behavioural & Social Sciences Ethical Review Committee (2015000143).

Participants

A total of 48 healthy adults were recruited through convenience and snowball sampling of personal and professional networks, via emailing and advertising on social media platforms. All participants met the eligibility criteria of: living in Australia, aged 18-64 years at the time of participation, able to follow instructions and respond to study questionnaires. Participants who were unable to complete data collection face-to-face, or who were unable

complete the second data collection round within 2 to 3 weeks of the first, were excluded from the study. Participant demographics were collected at the first data collection point including age, gender, geographical region of origin, citizenship, education level and employment status [see table 1]. To aim for a representative sample, the spread of age and gender was considered.

[Insert Table 1 about here]

Instruments/Measures

The ACS Aus (18-64) was used to measure activity engagement of Australian adults aged 18-64 years. Gustafsson and colleagues (2017) demonstrated that the original card sort version has high test-retest reliability and internal consistency, and it was therefore regarded as the accepted form. An android app version of the ACS Aus (18-64) was developed and run on a Samsung Galaxy Tablet®. To sort the cards within the app version, participants were required to tap the picture card and then tap their chosen category [see figure 1]. Throughout the data collection period, the app version had two minor updates in response to participant and researcher feedback for size of font and correction to an incorrectly labelled picture.

[Insert Figure 1]

For both the card and app versions, participants were required to sort each of the 85 cards into five categories to represent their current activity engagement levels: Never done; Do not do now; Do now; Do less now; and Given up. The current, previous and retained activity engagement levels were then calculated. The current activity engagement level is the total number of activities classified as “Do now” multiplied by 1, plus the number of activities classified as “Do less now” multiplied by 0.5. The previous activity engagement

level is the sum of activities classified as “Do not do now”, “Do now”, “Do less now” and “Given up”. The retained activity engagement level is then calculated by dividing the current activity engagement level by the previous activity engagement level.

A feedback questionnaire was developed to evaluate the clinical utility of the app in comparison to the card version of the ACS Aus (18-64). Participants were asked to rate the experience of sorting each version on a Likert scale from 1 (excellent) to 5 (terrible). Participants were also asked to identify their preferred version and why, and comment on aspects of the app version including screen layout, colour contrast, and preferred action for sorting (swipe or touch).

Procedures

Data collection occurred over a 4-month period from April to July 2016. Participation was voluntary, and participants received a detailed information sheet regarding their confidentiality and the study’s benefits and risks, before providing written consent. To reduce variability in results due to environmental factors, small, quiet rooms were used during each data collection session. To reduce potential for bias, participants were alternately allocated either the card or app version at the first data collection point. The alternate version of the tool was completed at a second data collection point, following an interval of 2 to 3 weeks. A 2 to 3 week interval between administrations of the two versions was determined to be an appropriate length for minimising both learning effects and the influence of life changes that may affect an individual’s activity engagement (Ref removed for review). Participant demographic data were collected at the first data collection, and participants completed the feedback questionnaire at the end of the second data collection. Each data collection session was completed within 20 minutes. The app exported the data into a text file and all data were recorded in a Microsoft Excel spreadsheet, and accuracy of data entry was checked by two researchers.

Statistical Analysis

Statistical analysis was undertaken using the statistical program STATA version 14 (StataCorp, 2016). Parallel forms reliability was evaluated by the comparing the app and card version scores for the overall retained activity level and within each domain: daily life; recreation and relaxation; and physical activity. The intra-class correlation (ICC) values were calculated using a two-way analysis of variance (ANOVA) random effects model. The ICC (2, k) equation was proposed to be an appropriate analysis as the assumptions were met. ICC values < 0.75 were considered poor to moderate, and ICC values ≥ 0.75 were considered good to excellent (Portney & Watkins, 2009). Responses to the closed questions and Likert scales on the feedback questionnaire were summarised descriptively. The responses to the open-ended questions were grouped according to content and checked by two researchers.

Results

Parallel Forms Reliability

The ICC calculated for overall retained activity level was 0.75 (95% CI 0.60 – 0.85, $p < 0.001$). Individual analysis of each domain of the ACS Aus (18-64) yielded the following ICC values: daily life was 0.77 (95% CI 0.62 – 0.86, $p < 0.001$); recreation and relaxation was 0.74 (95% CI 0.58 – 0.85, $p < 0.001$); and physical activity 0.59 (95% CI 0.37 – 0.75, $p < 0.001$) [see table 2]. These values suggest that the ACS Aus (18-64) card and app version demonstrated acceptable parallel forms reliability for the overall retained activity level and daily life. The recreation and relaxation domain fell just below the 0.75 cut-off and the physical activity domain did not demonstrate acceptable parallel forms reliability.

[Insert Table 2 about here]

Clinical Utility

The clinical utility of the ACS Aus (18-64) was considered by examining participant ratings of their experience sorting each version, preferred version, suggestions for changes in the app version, and preference to touch or swipe the cards in the app version. The app version was ranked as ‘good’ or ‘excellent’ by 91.7% of participants, compared to 89.6% of participants for the card version. The remaining participants rated each version as ‘neither good nor bad’. The app version was preferred by 47.9% of participants, reporting that the app was able to be completed “*quicker/faster*” (25.0%), was “*easier*” (39.6%), and “*helped maintain attention*” (6.3%). The card version was preferred by 29.2% of participants, most commonly reporting that they preferred being able to “*physically hold cards*” (12.5%) and they “*thought more about the choice with the cards*” (18.8%). The remaining 22.9% of participants had no preferred version. For the app version, participants made 22 suggestions for changes in layout (18.8%) and colour contrast (10.4%), largely related to the size and colour of the category buttons (18.8%). Participants preferred to touch (64.6%) over a swipe action (14.6%) when sorting the cards on the app version.

Discussion

The ACS Aus (18-64) app was developed in response to the current increase in technological developments which can create equitable access to healthcare (Stillerova et al., 2016; Street et al., 2009). Examining parallel forms reliability and clinical utility was the first step in exploring the psychometric properties of the app version. The next step was to examine participant experiences and the clinical utility of the app version. Before discussing the results, it is important to consider how the study demographics compare to those in the ACS Aus (18-64) study conducted by Gustafsson et al. (2017). The distribution of participants across age groups in this study (18-44 years = 47.9%; 45-64 years = 52%) was more equitable than the age group distribution (18-44 years = 61%; 45-64 years = 38.9%) as reported by Gustafsson et al. (2017). Gender was very similarly distributed; however, this

study had a slightly higher percentage of male participants (31.35% compared to 24.07%). More participants identified as Australian/New Zealand ethnicity in this study (83.33% compared to 66.67%) and the distribution of participants across education levels was very similar. Due to a similar spread of demographics, this study appears to have the potential to demonstrate high levels of reliability as found for the card version of the ACS Aus (18-64) (Gustafsson et al., 2017).

This study found that the app version of the ACS Aus (16-84) demonstrated acceptable evidence of parallel forms reliability for the overall retained score; however, the reliability was more variable within each of the domains. Using technologies such as the ACS Aus (18-64) app, may change thinking processes and thus the way people complete tasks (Brazilai & Zohar, 2006). Responses to the feedback questionnaire indicated that participants found both versions of the tool acceptable and that clinical utility does not seem to be an issue for the healthy adult population. However, results and responses indicate that people may have interacted with the card version differently to the app version. Participants reported that the app version was “*quicker/faster*” and “*easier*” to sort, which suggested that less time was spent engaging in decision-making when sorting the app version. These comments are also reported in the literature, where “ease of use” is one positive attitude associated with technology (Mitzner et al., 2010, p.1720). Additionally, participants commented that they “*thought more about the choice with the cards*”, which suggests that more time may have been spent engaging in decision-making when sorting the card version. This is supported by the evidence which states engagement and stimulation of thinking processes is increased through tactile connection and the physical use of hand and fingers (Johnson, 2013). Collectively, the findings suggest that that completing the app version of the ACS Aus (18-64) may engage a different sorting, decision-making and thinking process which requires further exploration.

The underlying methodology of the ACS should also be considered. The original ACS was designed to prompt memory recall and reflection on participation through a physical sorting mechanism of pictorial cards (Laver-Fawcett & Mallinson, 2013). It is possible that using a different modality (an app) impacted on this underlying methodology. It has been found that using different modalities can impact results obtained from subjective questions more than factual questions (Christensen, Ekholm, Glumer & Juel, 2013). In light of this evidence and because the ACS Aus (18-64) is a subjective measure (there are no right/wrong or factual answers), it is appropriate to assume the different modalities may have affected the reliability of results. In other words, introducing the app version may have meant that participants sorted the subjective cards differently, due to memory recall being prompted in a different way and due to the physical sorting being completed in a different way.

The lowest parallel forms reliability value was calculated for the physical activity domain. In the original study of the ACS Aus (18-64), the calculated reliability for the physical activity domain was also the lowest ICC value (Gustafsson et al., 2017). It is important to consider why this domain consistently produces lower scores across studies. There are two possible explanations. Firstly, this domain includes activities that are predominantly discretionary and tend to change through life stages. For example, younger adults report higher levels of participation in team sports than middle-age adults (Brunet & Sabinston, 2011). Therefore, during later life stages, participation in team sports (and other physical activities) is less common, more spontaneous and therefore more variable, even over short periods such as the 2 to 3 week interval used in this study (Brunet & Sabinston, 2011). The second consideration is the smaller number of activities in the physical activity domain (15 out of the 85 cards). In this domain, when cards are swapped between categories the effects may be more pronounced. For example, a spontaneous involvement in a team sport

during the data collection period, moving one card from the “Do not do now” into the “Do now” category would change the retained activity percentage from 73% to 80%.

Clinical Implications

The ACS-Aus (18-64) is a tool that facilitates discussion regarding activity engagement, promotes occupationally-focused goal setting, and allows re-measuring of activity engagement. The results of this study suggest that further research is required before the ACS Aus (18-64) app can be used to explore activity engagement in a clinical or research context. The study results also suggest that the physical action of holding and sorting the cards may engage a different thinking process to that involved when sorting a screen-based tool. This study contributes to the body of evidence for the ACS by piloting research into the reliability of the app version of the tool. Additionally, this study confirms the importance of evaluating new technologies before adoption into clinical practice (Anthes, 2016; Carter et al., 2015).

Limitations and Future Directions

The results of this study should be considered cautiously due to limitations. Firstly, the convenience and snowball sampling used to recruit participants may have resulted in over and under representation of particular demographics. Secondly, participants were not asked to describe their thinking processes during their use of the assessments in this study, and a qualitative study should be conducted in the future to directly elicit and compare what participants consider while sorting the ACS across the different versions. Thirdly, the time taken to sort the card and app versions was not recorded, although it was noted that participants indicated the app version seemed ‘*quicker/faster*’ to complete. In the future, a human-computer interaction study could be conducted to explore the different interactions elicited with different versions of the tool. Important considerations for future studies include reducing the time between administration of the two versions, statistical analysis studying

observed variations in the two versions based on demographic characteristics, and to examine the test-retest reliability of the ACS Aus (18-64) app. If the app is found to be psychometrically sound, future work could investigate different app settings (field on sensitivity, size of buttons, colour contrasts, audio and visual feedback) in order to enhance accessibility for people with motor, visual perceptual and sensory issues.

Conclusion

The ACS is a standardised tool that assists occupational therapists to measure an individual's activity engagement patterns over time. This study provides a pilot investigation into the parallel forms reliability of the ACS Aus (18-64) app when compared to the card version. Results demonstrated acceptable parallel forms reliability scores for all domains, except for the physical activity domain. Further studies are required to investigate the test-retest reliability of the app version and to better understand why the physical activity domain had less than acceptable reliability. This study demonstrates the importance of testing new technologies and further testing is required before the app version can be used for research or clinical practice.

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Table 1: Participant demographic details

Demographic characteristic	N = 48	Percentage of sample (%)
<i>Age</i>		
18-25	9	18.75
26-35	7	14.58
36-45	7	14.58
46-55	16	33.33
56-64	9	18.75
<i>Gender</i>		
Male	15	31.35
Female	33	68.75
<i>Ethnic Group</i>		
Australian/New Zealand	40	83.33
European	6	12.50
Asian	2	4.17
Americas Region	2	4.17
<i>Born in Australia</i>		
Yes	34	70.83
No	14	29.17
<i>Years Lived in Australia</i>		
<1 year	1	2.08
1-10 years	5	10.42
11-20 years	10	20.83
21-30 years	8	16.67

RELIABILITY OF THE ACS AUS (18-64) APP

31-40 years	6	12.50
41-50 years	8	16.67
51-60 years	6	12.50
>60 years	4	8.33
<i>Australian Citizen</i>		
Yes	42	87.50
No	6	12.50
<i>ASTI Origin</i>		
No	48	100.00
<i>Level of Education Attained</i>		
Completed high school	11	22.92
Complete a college apprenticeship or TAFE degree	4	8.33
Complete a degree at university	16	33.33
Completed a postgraduate degree	17	35.42
<i>Current Status</i>		
Full time student	9	18.75
Part time student	0	0.00
Full time work	25	52.08
Part time work	12	25.00
Casual work	7	14.58
Retired	1	2.08

Table 2: Intra-class correlations results

	Intra-Class	95% Confidence	95% Confidence	Prob > F
	Coefficient	Interval – Lower	Interval – Upper	
		Bound	Bound	
Overall Retained	0.75	0.60	0.85	0.000
Activity				
Daily Life	0.77	0.62	0.86	0.000
Recreation and	0.74	0.58	0.85	0.000
Relaxation				
Physical Activities	0.59	0.37	0.75	0.000

Figure 1: Screen captures of the ACS Aus (18-64) app