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Research Article

The Influence of Screen Size on ARAT Consistency When Scored by Physiotherapists in a Chronic Stroke Patient

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Abstract: Objective: The objective of this study is to explore whether different screen sizes have an influence on ARAT consistency, when scored by physiotherapists with a chronic Stroke patient. **Design:** Quantitative retrospective correlational cohort study. Twenty physiotherapists were recruited using non-probability snowball sampling. The participants viewed a video of a physiotherapist performing ARAT and had to apply the ARAT scoring system to rate the patient's upper limb function. There were two groups of participants: one group viewed the video on a laptop (n=8) and the other with a projector (n=12). Non-parametric data analysis–Spearman's rank correlation coefficient was used to analyse the association between ARAT and screen size. A p-value less than 0.05 was considered significant. **Results:** The mean age of the participants was 32 (SD = 6.989). There were 65% (n=13) male and 35% (n=7) female participants, of seven different nationalities. The ARAT scoring data were approximately normally distributed. Spearman's rho correlation analysis indicated there is no significant association between ARAT scoring and screen size. The p-value equalled 0.282, higher than the significance level of 0.05. **Conclusions:** This is the first study to focus on the influence of extraneous variables (specifically screen size) on ARAT evaluation. The results show that there is no correlation between screen size and ARAT scoring, adding to the existing evidence that ARAT is a reliable tool and therefore should be seen as one of the best options for use clinically with chronic stroke patients for assessing impairment of the upper limbs. However, there are some limitations to the study. A study with a random sample and higher sample size is required to increase the representativeness of the findings and allow generalisation.
Keywords: Action Research Arm Test, ARAT, Screen Size, Extraneous Variables, Chronic Stroke, Consistency, Upper Limb Assessment.

Introduction

According to the World Health Organisation (WHO), a Stroke is defined as "rapidly developing clinical signs of focal (global) disturbance of cerebral function, with symptoms lasting 24 hours or longer, or leading to death, with no apparent cause other than vascular origin"[1]. Overall, more than 100,000 strokes occur in the United Kingdom (UK) each year, with over 1.2 million Stroke survivors[2]. Stroke recovery utilises the restoration and replacement of lost function through the processes of neuroplastic reorganisation and learning that continue for more than six months in chronic cases; physiotherapy may enhance the adaptation of the upper limb learning[3-6].

Evidence suggests that between fifty and seventy five percent of Stroke sufferers experience impaired arm function[7-9]. Sixty percent out of those with impaired arm function still have impairment six months post-stroke[10]. A key aim of rehabilitation is to restore activities of daily living and the quality of movement [6,11-15]. There is a variety of outcome measures used to evaluate the severity of damage to upper limbs and to detect changes in upper limb function. These measures also allow the evaluation of how effective any treatment may have been. There are five commonly used options for UL assessment: the Action Research Arm Test (ARAT), the Box and Block Test (BBT), the Nine Hole Peg Test (NHPT), the Wolf Motor Function Test (WMFT), and the Fugl-Meyer Test (FMT). In this article, the main focus will be on the 19-item ARAT.

A literature search was conducted in order to identify literature for the study. The keywords were Action Research Arm Test, ARAT, screen size, chronic Stroke, extraneous variables, upper extremity function. The databases used were Cochrane, Medline, CINAHL, and Google Scholar.

The International Classification of Function, Disability and Health (ICF) suggest the ARAT is an activity measure for the impairment of upper limb function[16]. The Royal Dutch Society for Physical Therapy suggest ARAT is the tool that should be used for the assessment of upper limb extremity in chronic stroke patients[17]. Administration of ARAT[17,18] involves the testing of nineteen items from four domains: grip, pinch, grasp and gross movement. This means it covers both distal fine movement of the hand and gross proximal movement. Each of the four subtests is scored on an ordinal 4-point scale–0 indicates no movement; 1 indicates the movement task is partially performed; 2 indicates the movement task is completed but takes abnormally long; and 3 indicates the movement is performed normally. ARAT[17] is a shortened version of the 33-item Upper Extremity Function Test (UEFT)[18]. ARAT is simple to apply, takes only a short time and does not require any training. It is used in moderate to severe cases of impairment in Stroke patients. The minimal clinically important difference (MCID) for the 19-item ARAT is 5.7 points[19]. This represents ten percent of the 57-point scale. The standard error of measurement (SEM) for ARAT has not been established.

Reliability testing of the ARAT has been conducted by Lyle[17], van der Lee et al.[19] and Yozbatiran et al.[20] which has shown that ARAT has very high inter-rater reliability in chronic cerebrovascular accident (CVA). Intra-rater reliability has also been shown to be high[19,20] and Lyle's study[17] also demonstrated high test-retest reliability. There are some issues with the methodology of these reliability studies. Sheikh[21] and Rankin and Stokes[22] suggest there may be some issues with the statistical methods employed by Lyle[17], who used correlation rather than an inter-rater reliability, and Ottenbacher[23] suggests that Yozbatiran[20] employed a small sample size so the sample may not have been representative, limiting the generalisability of the results.

Yozbatiran[20] and Nijland[24] studied concurrent validity and found that ARAT was highly correlated to FMA[20] and to WMFT[24], demonstrating ARAT has high concurrent validity within the chronic Stroke population. ARAT has also shown high construct validity in assessing upper limb function. Van der Lee[19] showed it to be more responsive than the FMAT in people with chronic Stroke and ARAT had higher responsiveness than both the FMA and WMFT.

In the current research, a retrospective analysis is conducted on previous studies related to videotaped assessments that were conducted in the same department at the University of Salford. Videotaped evidence was chosen for use over laboratory assessments, as this approach more closely resembles the efficacy of rating a patient[19]. Accordingly, several studies have emphasised the advantages of rating a video through a focus on particular angles, aspects or issues[25,26], which can be stored and re-analysed for future research[27]. Thus, the use of a videotape for the purpose of analysis can enhance accuracy of the assessment and minimise bias, while becoming a reliable choice for many physiotherapists[26,28].

Methodology

The current study consists of a quantitative retrospective cohort study, using a correlational design to investigate the influence of extraneous variables, in particular screen size (projector or laptop), on ARAT consistency.

Objectives

The current research group's objectives are:

- ✓ To investigate the impact of screen size, fatigue, clinical experience, and wearing glasses on ARAT consistency, as scored by physiotherapists for a chronic Stroke patient.

Null Hypothesis (H0)

There will be no relationship between the ARAT ratings and screen size. Therefore, results from the current research will be due to random error or chance factors, and not because of real relationships among physiotherapists[29,30] .

Experimental Hypothesis (H1)

There will be a relationship between ARAT ratings and screen size. Screen size has been shown to affect the perception of the viewer[31]. A larger screen size may provide a clearer view of the patient and therefore differing results from a smaller screen size.

Variables

The focus of the current study is to investigate the association between screen size (measured by use of a projector or laptop) and ARAT consistency of scoring, as scored by physiotherapists for chronic Stroke patients. The 19-item ARAT is employed. The correlational design employed means there are no formal independent or dependent variables[30].

Table 1 shows the potential extraneous variables in this study and how they have been controlled.

Table 1. Extraneous variables and strategies for control

Extraneous variables		Strategies for Control
Situational Variables	Noise Temperature Light Hygiene An Isolated Room[32]	Test was carried out in a quiet, isolated room at Salford University. Appropriate levels of heat and light were set for the test[33].
Personal Variables	Fatigue Glasses Need Experience Emotional State Mental Health[34]	The study measured glasses use, experience and fatigue in the participants. Information pertaining to the study purpose was given out to participants before the start of the test. The wellbeing of participants was ensured at all times by the researcher.
Other Variables	Interpretation Talking during assessment[28]	Each participant was given the same administration before the test began.

Sampling and Recruitment Methods

In the original study, a non-probability sampling method (snowball sampling) was employed. Physiotherapists at the University of Salford were invited to participate in the study via email and by posters located in the physiotherapy department. An information sheet was provided to participants. Participants were allowed a minimum of 24 hours to agree or decline to take part. Participants who agreed were asked to sign a consent form to provide their informed consent. Table 2 shows the inclusion exclusion criteria.

Table 2. Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
Physiotherapists with at least one year or more experience	Non-physiotherapists. Undergraduate (Non-qualified) physiotherapists.

Procedure

Each participant was shown a videotape of a physiotherapist administering the 19-item ARAT for a single patient, using a version of the standardised ARAT protocol[20]. Participants scored the patient doing ARAT. Participants either viewed the video on a 14-inch (1920x1080 pixel) laptop or 20-inch (1280x720 pixel) projector. The video was not paused during the process, in order to provide a process similar to what would be used in practice.

Ethics

This a secondary study so most of the ethical issues relate to the original data analysis. Ethical approval was granted in the original study. Participants were provided with an information sheet which thoroughly explained the procedure, as recommended by Gelling[35]. Each participant consented willingly to participation in the study, as is indicated in the literature[36,37,38]. The questionnaires were kept in a locked cabinet and on a password-protected PC. The participants' names were code protected (ensuring confidentiality).

A further ethical aspect relates to risks and benefits to the patient[35,39] . In terms of risks, these were very small. The study's environment was safe and there were no excessive time demands. Neither was the study likely to lead to feelings of fatigue or anxiety. The benefits of the study (providing information about the reliability of ARAT) therefore outweighed the minimal risks.

Data Analysis

Secondary data analysis was conducted in SPSS version 25. ARAT is scored on a four-point ordinal scale ranging from 0 to 3. Screen size is a nominal variable (each participant either watched the video on a small and large screen). Normality of the ARAT scale was assessed using the Shapiro Wilk test, although due to the ordinal nature of the ARAT variable non-parametric methods were more suitable regardless of the distribution[40].

Spearman's rank correlation coefficient was therefore employed to investigate the correlation between ARAT and screen size. The significance level was set at 0.05.

Results

Age: The sample had a mean age of 32 years with standard deviation of seven years.

Table 3. Age of participants

	N	Minimum	Maximum	Mean	Std. Deviation
Age of Respondent	20	25	53	32.00	6.989

Gender: We had 13 males and seven females.

Table 4. Gender of participants

	Frequency	Percent (%)
Male	13	65.0
Female	7	35.0
Total	20	100

Nationality: Twenty physiotherapists with different nationalities as shown in the following table were involved.

Table 5. Nationality of participants

	Frequency	Percent (%)
Brazil	4	20
Greece	4	20
India	1	5
Nigeria	1	5
Saudi Arabia	4	20
UK	3	15
USA	3	15
Total	**20**	**100**

Experience: We had a mean experience of 7.8 years with standard deviation of 7.7 years.

Table 6. Experience

	N	Minimum	Maximum	Mean	Std. Deviation
Years of experience	20	1	30	7.80	7.661

The following table illustrates information regarding the size of the devices used by the researcher. Twenty observations were performed–in eight observations the video was played through a small device (14-inch laptop) with high resolution (1920 x 1080) and 12 observations via a large device (120-inch projector) with lower resolution (1280 x 720).

Table 7. Screen size

	Frequency	Percent (%)
Small	8	40.0
Big	12	60.0
Total	20	100

The ARAT sum scores for each questionnaire shown in the following table with mean 17.4 and standard deviation of 1.9029.

Table 8. ARAT scores

	N	Min.	Max.	Mean	Range	SD
Sum Scores	20	14.00	22.00	17.40	7.00	1.90291

Table 8a. ARAT sum score

Sum scores	Frequency
14.00	1
15.00	1
16.00	5
17.00	4
18.00	5
19.00	2
21.00	1
22.00	1
Total	20

To test whether the ARAT sum scores in this study are normally distributed or not, a Shapiro Wilk test was used.

Table 9. Shapiro Wilk test

	Tests of Normality					
	Kolmogorov-Smirnov[a]			Shapiro Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
Total Scores	.176	20	.104	.937	20	.213

ARAT sum scores are shown in the following chart.

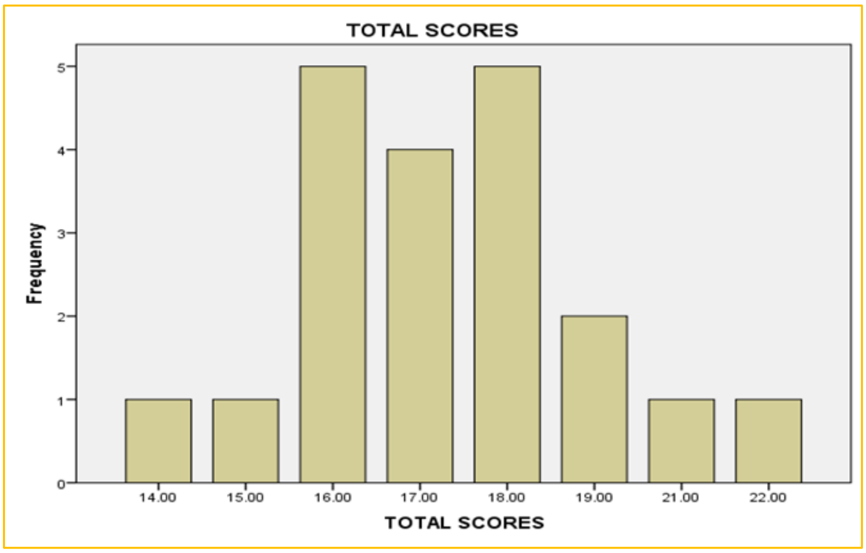

Figure 1. ARAT sum scores

Table 10. Non-parametric correlations

Correlations				
			Screen Size	Total Scores
Spearman's rho	Screen Size	Correlation Coefficient	1.000	-.253
		Sig. (2-tailed)	.	.282
		N	20	20
	Total Scores	Correlation Coefficient	-.253	1.000
		Sig. (2-tailed)	.282	.
		N	20	20

Discussion

The objective of this study was to investigate the association between sum ARAT scores and the screen size of the viewing platform (namely a projector or laptop).

The evidence from the Shapiro Wilk test indicated the data was normally distributed. This was concluded because the p-value is 0.213, which is greater than the alpha value of 0.05, so the null hypothesis that the data are normally distributed was not rejected.

Despite the data being approximately normally distributed, Spearman's rho was used to evaluate the association between ARAT scores and screen size. The Spearman's rank correlation coefficient equalled -0.253, indicating a small to moderate negative correlation coefficient. However, when the sample size is small, for the correlation coefficient to be significant the value must be large (close to 1 or -1). In this case, p = .282 (see Table 10), which is less than 0.05, indicating that the correlation between screen size and ARAT score is not statistically significant. Therefore, the experimental hypothesis is rejected and the null hypothesis that there is no correlation between ARAT scoring and screen-size is accepted. In other words, screen size does not appear to influence ARAT scoring, and cannot be attributed as an extraneous variable for the ARAT with chronic Stroke.

To the best of the author's knowledge, there is no existing research focused on screen size as an extraneous variable for ARAT scoring, or for any other medical assessment method. Therefore, it was necessary to draw on wider literature such as the body of work examining the link between screen size and viewer perception/enjoyment. Lombard et al.[41] examined the effect of screen size on subjects' evaluative responses. Viewers reported no overall greater enjoyment with a larger screen, but did report more intense responses to the large screen. Neuman[31] conducted a study comparing three screen sizes and three resolutions. Subjects preferred a larger screen with a higher resolution. Reeves et al.[42] found no link between screen size and enjoyment. These studies show that screen size may be an important factor in terms of some aspects of viewer perception but the current study shows that screen size is not associated with scoring of the ARAT scale.

In a study conducted by Nomikos et al.[43] using the same participants as described in this dissertation, the conclusion was reached that the ARAT is a reliable and reproducible outcome measure. This was demonstrated through a test-retest methodology. The evidence from the current study adds to these findings by providing evidence that screen size also does not influence ARAT scoring. Other members of the research group have found that clinical experience, fatigue levels, and wearing glasses are not significantly correlated with ARAT scoring. These findings provide further evidence for the consistency and reliability of the ARAT.

The Royal College of Physicians (RCP) suggest that the clinical instrument to be used in a given situation should be chosen depending on the WHO ICF framework. Guidelines provided in the Canadian Evidence-Based Review of Stroke Rehabilitation (EBRSR) suggest that the ARAT can be administered with no need for specialised training and that it is simple and easy to use, as well as covering various aspects of UL function[44]. Furthermore, the EBRSR suggest that the ARAT has been shown to have excellent reliability for Stroke patients. The findings of this study agree with these guidelines, suggesting ARAT is reliable by showing that screen size is independent from ARAT scoring.

Strengths

The strengths of the study are as follows:

Firstly, this research employed a retrospective design which was found to be efficient with regards to time consumption as well as being a cost-effective way of answering the forthcoming questions with the data at hand[45]. In the study there were seven different nationalities with a relatively even gender split and a variety of ages, so there was broad coverage of demographic groups.

Secondly, the PT researchers attempted to minimise situational variables by situating the research within a quiet, smart room with ample lighting to avoid distracting the participants.

Thirdly, the findings in the current study represent a new area of investigation in that the trial addressed a number of areas of interrogation that have not been previously discussed in former research. The results provide the first empirical evidence about the link between screen size (and other extraneous variables) in relation to ARAT score. None of the extraneous variables were found to be linked to ARAT score. The findings of this research therefore provide evidence about a previously unresearched topic and provide further evidence about the reliability, usefulness and applicability of ARAT.

Limitations

The limitations of the current study may be thus considered:

Firstly, the sample size was small (n=20), thus reducing statistical power and increasing the risk of type II error to the results, meaning the result could be a false negative. McNutt and Woolson[46] recommend a sample size of 60 for studies using a similar retrospective design with a power of 80% and type II error rates of 0.05.

Secondly, the original study employed snowball sampling–a non-random sampling technique–that raises the probability of a biased sample and tends to decrease the validity of the study sample[47,48]. There were 13 men and seven women in the sample (see Table 4) and seven different nationalities of physiotherapists (see Table 5), but it is not possible to know how this compares to the population as a whole. This means that the sample is not representative and the results of the study cannot be generalised.

Thirdly, two different screen sizes were employed in this study, with different resolutions. If one wants to compare screen size then the same resolution should be used in both cases. Neuman[31] found that a bigger screen size with a higher resolution led to a greater sense of happiness but in this case the resolution was lower for the larger size screen, so resolution was not controlled. In future, a similar study should use a standardised resolution in order to eliminate other potentially confounding factors that may have an effect, alongside screen size.

Future Research

There are numerous gaps in this study which offer compelling possibilities for continued investigation. Future researchers conducting research into the influence of extraneous variables on ARAT scoring should use a minimum sample size of 60 participants thus decreasing the margin of error and increasing the chance of attaining level 1 evidence. A larger sample size is often more representative of a wider population and generalisations from the findings are more likely to be valid and find wider academic approval. Additionally, a random sampling method ought to be employed to produce a representative sample, and therefore decrease allocation and selection bias.

Approaches in future studies ought to be standardised in order to limit the influence of participant and situational variables, namely the environment in which the study is conducted. The physiotherapist in this study used Yozbatiran's[20] standardised protocol to administer the test, and other studies examining the ARAT should also do this.

Additionally, motivation could be assessed by the use of the Situational Motivation Scale (SIMS) questionnaire. Investigators may wish to omit unmotivated participants in order to limit the probability of error.

Conclusion and Clinical Message

It is hard to extract valid generalisations from this study and conclusions ought to be drawn cautiously due to the small sample size and the non-representative sample. Despite this, the evidence collated in this research study and the other studies in the research group suggests that ARAT score is independent from clinical experience, fatigue, the use of eye glasses, and screen size. PT researchers were able to attain consistent, valid information from this outcome measure regardless of the screen size viewed by the participants. This adds to the body of literature showing the reliability of ARAT. The main clinical message from the study is therefore that ARAT should be considered a valuable tool in appraising the recovery of upper limb motor functionality and dexterity in chronic Stroke assessment. ARAT should continue to be used in clinical practice by physiotherapists with chronic Stroke patients.

Declarations

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