

A comparative study of the reliability and confirmatory factor analysis (CFA) of a paper- versus app administered resilience scale in Scottish youths

Julienne Mcgeough, Thomas Gallagher-Mitchell, Daniel Philip Andrew Clark, Neil R Harrison

Submitted to: JMIR mHealth and uHealth
on: May 15, 2018

Disclaimer: © The authors. All rights reserved. This is a privileged document currently under peer-review/community review. Authors have provided JMIR Publications with an exclusive license to publish this preprint on its website for review purposes only. While the final peer-reviewed paper may be licensed under a CC BY license on publication, at this stage authors and publisher expressly prohibit redistribution of this draft paper other than for review purposes.

Table of Contents

Original Manuscript..... 5



A comparative study of the reliability and confirmatory factor analysis (CFA) of a paper- versus app administered resilience scale in Scottish youths

Julienne Mcgeough^{1*} PhD.; Thomas Gallagher-Mitchell^{1*} PhD; Daniel Philip Andrew Clark^{1*} PhD; Neil R Harrison^{1*} PhD

¹Liverpool Hope University Department of Psychology Liverpool GB

*these authors contributed equally

Corresponding Author:

Julienne Mcgeough PhD.
Liverpool Hope University
Department of Psychology
Hope Park
Liverpool
GB

Abstract

Background: Adequately measuring resilience is important in order to support young people and children who may need to access resources through social work or educational settings. A widely accepted measure of youth resilience has been developed by Ungar and Liebenberg which has been shown to work within vulnerable youth [1]. While the measure is completed by the young person on paper, it has been designed to be worked through with a teacher or social worker in case further clarification is required. However, this method is time consuming and when faced with large groups of pupils who need assessing can be overwhelming for schools and practitioners. The current study assesses app software with a built-in avatar who can guide the young person through the assessment and its interpretation.

Objective: The primary objective is to compare the reliability and psychometric properties of a mobile software app to a paper version of the Child and Youth Resilience measure (CYRM-28). Secondly, the study will assess the use of the CYRM-28 in a Scottish youth population (11-18 years).

Methods: Following focus groups and discussion with teachers, social workers and young people, an avatar was developed by a software company and integrated into an android smartphone app designed to ask questions via the device's inbuilt text-to-voice engine. Seven-hundred and fourteen students from two schools in North East Scotland completed either a paper version or app version of the CYRM-28. A cross-sectional design was used and students completed their allocated version twice, with a two-week period in between each testing. All participants could request clarification either from a guidance teacher (paper version) or from the in-built software glossary (app version).

Results: Test and retest correlations showed that the app version performed better than the paper version of the questionnaire. Paper ($r(303)=.81, p<.001, 95\%CI [.77, .85]$); App ($r(413)=.84, p<.001, 95\%CI [.79, .89]$). Fisher's r to z transformation found the difference in the correlations to be statistically significant, $Z=-2.97, p<.01$. Similarly, Cronbach's alpha in both conditions was very high (app: $\alpha=.92$; paper: $\alpha=.87$). Such a high Cronbach's alpha indicates there may be item redundancy. Ordinarily this would lead to a possible removal of highly correlated items, however the primary aim of the current study is a comparison of app delivery method over a pen-and-paper mode and therefore outside the parameters of this paper. This will be considered in the discussion. Fisher's r to z transformation found the difference in the correlations to be statistically significant [$Z=-3.69, p<.01$]. A confirmatory factor analysis [2] supported the three-factor solution (individual, relational and contextual) and reported a good model fit ($\chi^2(15, N= 541) = 27.6, p=0.24$).

Conclusions: ALEX, an avatar with an integrated voice guide, increased reliability when measuring resilience compared to a paper version with teacher assistance. The CFA reports similar structure using the avatar when compared against the original validation.

(JMIR Preprints 15/05/2018:11055)

DOI: <https://doi.org/10.2196/preprints.11055>

Preprint Settings

1) Would you like to publish your submitted manuscript as preprint?

✓ **Please make my preprint PDF available to anyone at any time (recommended).**

Please make my preprint PDF available only to logged-in users; I understand that my title and abstract will remain visible to all users.

Only make the preprint title and abstract visible.

No, I do not wish to publish my submitted manuscript as a preprint.

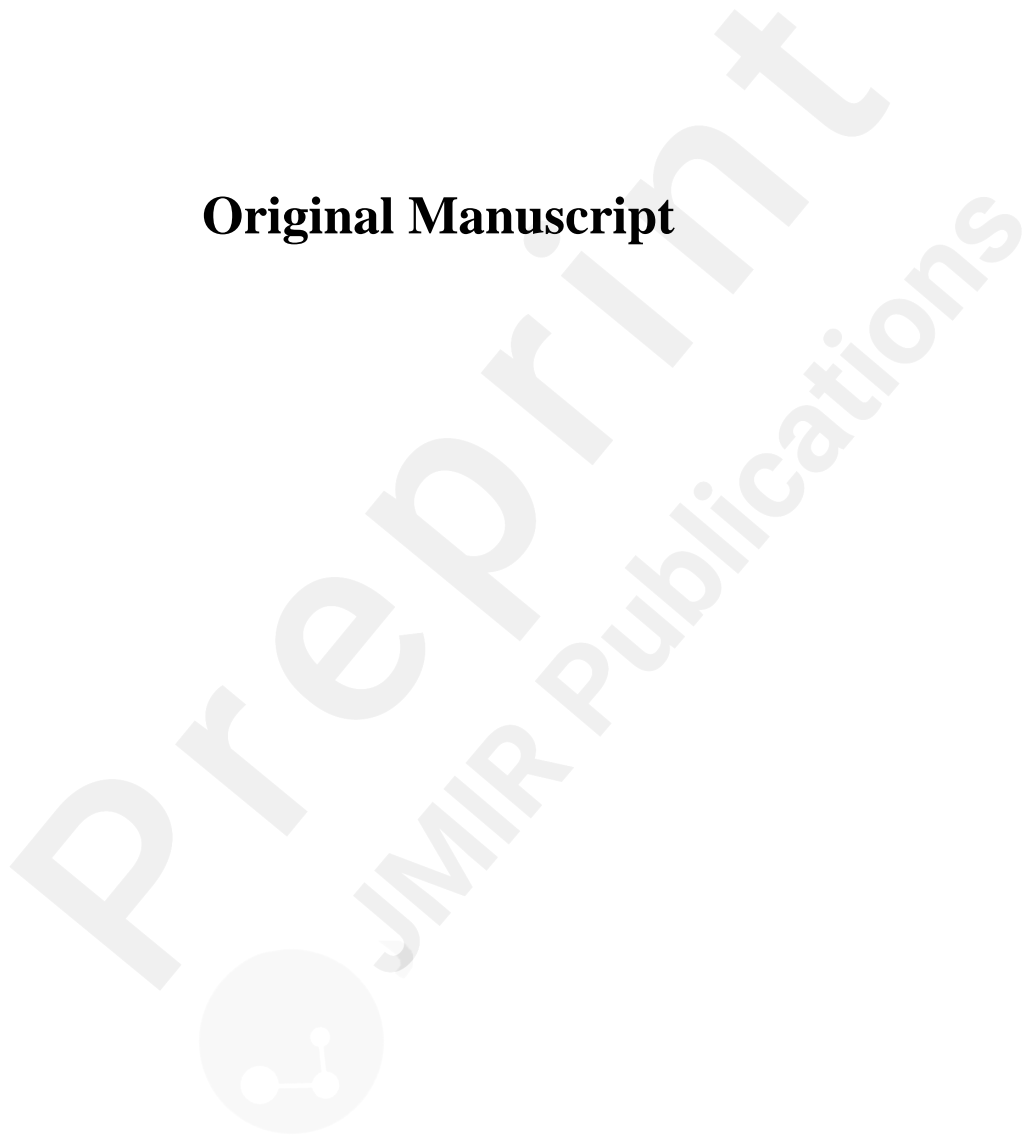
2) If accepted for publication in a JMIR journal, would you like the PDF to be visible to the public?

✓ **Yes, please make my accepted manuscript PDF available to anyone at any time (Recommended).**

Yes, but please make my accepted manuscript PDF available only to logged-in users; I understand that the title and abstract will remain visible to all users.

Yes, but only make the title and abstract visible (see Important note, above). I understand that if I later pay to participate in [JMIR Publications](#)

Original Manuscript



Original Paper

A comparative study of the reliability and confirmatory factor analysis (CFA) of a paper- versus app administered resilience scale in Scottish youths

Abstract

Background:

Adequately measuring resilience is important in order to support young people and children who may need to access resources through social work or educational settings. A widely accepted measure of youth resilience has been developed by Ungar and Liebenberg which has been shown to work within vulnerable youth [1]. While the measure is completed by the young person on paper, it has been designed to be worked through with a teacher or social worker in case further clarification is required. However, this method is time consuming and when faced with large groups of pupils who need assessing can be overwhelming for schools and practitioners. The current study assesses app software with a built-in avatar who can guide the young person through the assessment and its interpretation.

Objective:

The primary objective is to compare the reliability and psychometric properties of a mobile software app to a paper version of the Child and Youth Resilience measure (CYRM-28). Secondly, the study will assess the use of the CYRM-28 in a Scottish youth population (11-18 years).

Methods:

Following focus groups and discussion with teachers, social workers and young people, an avatar was developed by a software company and integrated into an android smartphone app designed to ask questions via the device's inbuilt text-to-voice engine. Seven-hundred and fourteen students from two schools in North East Scotland completed either a paper version or app version of the CYRM-28. A cross-sectional design was used and students completed their allocated version twice, with a two-week period in between each testing. All participants could request clarification either from a guidance teacher (paper version) or from the in-built software glossary (app version).

Results: Test and retest correlations showed that the app version performed better than the paper version of the questionnaire. Paper ($r(303)=.81$, $p<.001$, 95%CI [.77, .85]); App ($r(413)=.84$, $p<.001$, 95%CI [.79, .89]). Fisher's r to z transformation found the difference in the correlations to be statistically significant, $Z=-2.97$, $p<.01$. Similarly, Cronbach's alpha in both conditions was very high (app: $\alpha=.92$; paper: $\alpha=.87$). Such a high Cronbach's alpha indicates there may be item redundancy. Ordinarily this would lead to a possible removal of highly correlated items, however the primary aim of the current study is a comparison of app delivery method over a pen-and-paper mode and therefore outside the parameters of this paper. This will be considered in the discussion. Fisher's r to z transformation found the difference in the correlations to be statistically significant [$Z=-3.69$, $p<.01$]. A confirmatory factor analysis [2] supported the three-factor solution (individual, relational and contextual) and reported a good model fit ($\chi^2(15, N=541) = 27.6$, $p=0.24$).

Conclusions:

ALEX, an avatar with an integrated voice guide, increased reliability when measuring resilience compared to a paper version with teacher assistance. The CFA reports similar structure using the avatar when compared against the original validation.

Keywords: Resilience; Psychometrics; App-administration; CyberPsychology

Introduction

Resilience

Resilience has traditionally been conceptualised as an individual difference. For example, early research in the field showed that some children, even when exposed to a chaotic family life or early life stressors (e.g. bereavement) had surprisingly healthy behaviours, for example coping ability [3,4,5]. Indeed, a child with high levels of resilience will be able to overcome stressors to achieve a sense of well-being [6]. Furthermore, Panter-Brick and Leckman [7] in a review paper established a pathway between childhood resilience and adult well-being. However, as work on resilience has progressed it has become increasingly recognised that factors external to the child may also influence later personal and academic success [3,4,5]. Luthar, Lyman and Crossman [8] categorised subfactors of resilience into three themes labelled as “Attributes of the individual”, “Family influences” and “Wider social environments”. Ungar [9,10] further expanded on these categories to develop a dynamic concept of resilience that puts society at the centre of a child’s ability to develop resilience and coping strategies. Ungar’s *ecological model of resilience* is culturally sensitive and while it does accept that there is individual differences in coping, it argues that the environment surrounding the individual is crucial in providing appropriate resources. For example, while Ungar’s definition and subsequent measurement includes differential aspects of the ability to maintain friendships, it also measures whether the young person has been provided with the tools to do so. Ungar further suggests that resilience definitions should reflect both ontological and ecological variability, and therefore states the following:

“In the context of exposure to significant adversity, resilience is both the capacity of individuals to navigate their way to the psychological, social, cultural, and physical resources that sustain their well-being, and their capacity individually and collectively to negotiate for these resources to be provided and experienced in culturally meaningful ways (Ungar [11])”

In Scotland (the setting for the present study), pupils are currently supported via guidance teachers within a framework set by the Government (GIRFEC = Getting It Right For Every Child), and well-being is conceptualized within SHANARRI. SHANARRI has 8 indicators of well-being (Safe, Healthy, Active, Nurtured, Achieving, Respected, Responsible, Included) [12,13]. Guidance teachers lead the pastoral support for pupils of all ages, generally with approximately 200-250 pupils within their care, and with whom they will have Personal and Social learning classes each week, plus additional support if required [14]. It is within this setting that well-being, resilience and SHANARRI are measured. While there is a positive perception by pupils and parents of the support offered by guidance teachers, this is not consistent with a large minority of parents who argue that the system does not support their child [15]. The challenge for schools across Scotland is the government-led initiative in which they are expected to assess the risks and vulnerability of each child [16]. Clearly this should be easier to accomplish with an app that can measure resilience and well-being easily while engaging each pupil. Furthermore, the system is under strain as funding decreases, with the education system reducing the number of guidance teachers [17,18].

Psychometric measurement using apps

Ungar and Liebenberg [1,2] developed a scale of resilience that reflected this definition of resilience and was expressed in three factors (individual, relational, contextual). Sample items are “I cooperate

with people around me” (individual), and “my caregivers watch me closely” (relational). The questionnaire is designed to be used as a verbally administered questionnaire, conducted by a professional within the setting, with responses measured on a Likert scale from 1-7. However this is time-consuming and difficult to administer on an individual basis to large groups of pupils requiring assessment. . Further studies have changed verbal administration of the questionnaire to a more traditional paper based version to widen participation [19]. However, this obviously loses the verbal aspect of the questionnaire which Ungar [11] argues increases participants’ understanding. Therefore, an alternative to personal administration with each child is to use software that allows questions to be read if the participant requires it.

The current study seeks to address the issue of scalability while retaining the verbal aspect and reducing the need for competent reading skills. A further advantage is the benefit of software-based data collection which current research indicates reduces chances of incorrect or missing input and therefore increases validity and reliability [20]. Furthermore, there is evidence that internal consistency and concurrent validity are retained when moving to an app-based questionnaire [21,22]. Importantly, app-based scales have consistently been shown to have higher completion rates amongst studies included in a large scale meta-analysis [23]. However, it cannot be assumed that transferring a paper version to an app version will automatically carry over psychometric properties, though there is growing evidence that the transfer to computer-based measures does not result in a loss of psychometric properties [24]. However, this is transference of psychometric properties is by no means universal, for example, when transferring pen-and-paper psychometric questionnaires Booth-Kewley et al [25] found that a level of disinhibition crept in to measures regarding such topics as alcohol consumption and risky sexual behaviours. It is therefore still necessary to validate the development of a software-based app. It is of crucial importance that this is undertaken when the design of the app departs from the original scale administration format, as in the current study where an avatar is used to deliver the items. Traditionally, data collection online was designed to closely mimic paper questionnaires, however recently research has explored non-human interaction (Bot) with humans and their tendency to disclose, with evidence that self-disclosure increases with the use of non-human interviewees [26].

Present study

Our love of smartphones has been explained by various theories ranging from Bowlby’s attachment theory, addiction-based models, and emotional needs theories [27,28,29]. Indeed, it has been suggested that even larger portable technology, such as laptops, can be seen to be an extension of our identity and selves, given that we store memories through photographs and access social media on them [30]. For the present study these identity processes and dynamics are identified as being drivers in the adolescent relationship with their technological companions which may be seen as an extension of “self” [31,32]. Furthermore, adolescents have been described as a population which is hard to reach for research purposes, and therefore a smartphone app such as the one tested in the current paper should increase usability [33,34]. It is proposed that the interaction of the above dynamics will encourage honesty in this population and therefore increase the reliability of the questionnaire, as has been found in other studies exploring issues of well-being in hard-to-reach populations [35]. ‘Avatar as a researcher’ is an emerging concept and early studies have shown increased trust and openness thus increasing the reliability and confidence in data when discussing sensitive topics [36]. Identification with avatars and robots occurs with both humanoid and non-humanoid avatars. For example, even computer-driven triangle shapes are perceived to have intentionality [37,38]. Therefore it is expected that this study will see improved reliability, increased completion rates, and similar psychometric properties retained following validity analysis, in the app-based delivery. Additionally, the study aims to validate the use of the CYRM-28 amongst a

Scottish population.



Methods

App Development

Feedback on a number of avatar designs were gathered from 30 professionals, including social workers, educational psychologists and teachers at the 2015 *Pathways to Resilience* Conference. The outcome of the discussions was to avoid humanoid-looking avatars of similar ages to the participants, and to opt for one that would be considered gender neutral. ALEX has facial elements that move (eyes and mouth), and uses the speech-to-text engines of the device that is running the app. ALEX moves and bounces in response to screen touches. Further focus groups with young people confirmed that ALEX was user-friendly, approachable, and liked by a wide range of ages of both sexes. Participants in the app group were asked to complete a usability questionnaire following the resilience questionnaire.

Design

Recruitment was carried out in schools who agreed to take part in trials. Information sheets were sent to parents electronically and parents could access a website about the research and agree to participate via online surveys. A cross-sectional design was used aimed at comparing the performances of pen-and-paper to that of an app-based CYRM-28 scale [1]. Two schools included all of their pupils, and classes were randomly designated as either app versus paper with age groups represented in each group. All groups were presented with the scale twice, with a two-week retest design. Data collection was completed in PSE (Personal and Social Education) classes, and took approximately 10 minutes for the majority of the students. This was preceded by a short explanation regarding the administration of the scale and a reminder of their ethical rights. A guidance teacher and a member of the data collection team were present during the session. As with the original CYRM-28, participants could request further information and clarification from the researcher regarding the item statements (paper version) or an in-built glossary which could be accessed when the pupil highlighted a word or phrase. All research took place during the second term of the academic year (January to March 2017). A third school took part in one app-based data collection during the Summer term (July 2017) under the same conditions as described above, but further participation was prevented due to exams. This data is included only in the CFA.

Participants

The participants were 714 students from two North-East Scotland mixed sex schools, aged 11-17 (males=354 (M=14.3, SD=2.42; females =360 (M=14.6, SD=2.37)). Areas in Scotland are divided into five broad groupings of deprivation (1 being most deprived through to 5, least deprived) and are reported as Scottish Index of Multiple Deprivation (<https://www2.gov.scot/Topics/Statistics/SIMD>). School 1 (N=403) includes an area of affluence and the majority of pupils fall into bands 4 and 5 (relative high SES according to the Government's deprivation bands). School two (N=311) is in an urban setting classed as a high deprivation area (all pupils are classed as being in the top two levels of deprivation). The final school draws from a wide range of SES bands. All three schools are comprehensives and therefore mixed ability schools with sixth forms for pupils aged 16-18. The schools used mixed ability groups and each of the schools have approximately similar numbers on the roll.

Materials

The app version ran on Kindle Fires (HD) which were disconnected from the internet, and other software was unable to be accessed. The app presents the questions via the ALEX avatar. ALEX is gender neutral and is displayed in diagram 1 below, along with a typical question. As with the paper version the students were required to respond on a 1-7 Likert scale (strongly disagree to strongly agree), giving a possible data range of 28-196, with a higher score indicating stronger resilience. The app version has a computerized voice which is able to read the question to the participant, and a glossary of terms which are available. These had been tested by adolescents who had trialed the software and had indicated where they thought help would be required. In the pen-and-paper version, help was given if requested by the participant at the time, and adults provided the same answers as given by the pre-determined glossary. There were no reports of pupils asking questions outside of this set. The scale has previously been found to have good reliability scores (Individual: $\alpha = .803$; Relational: $\alpha = .833$; Contextual: $\alpha = .794$), and adequate validity following exploratory and confirmatory analyses [1]. The project received ethical approval from Liverpool Hope University Ethics board (S040417 SFREC 001), and students were required to read a short participation information sheet or screen following a short verbal reminder of their right to withdraw from the research. Parents had provided informed consent to their children's participation. Demographic information and data regarding the usability of the app was collected.

Statistical analysis

For demographic descriptive statistics only results from time 1 were included. All data met parametric assumptions. Items in the app condition were grouped and calculated to form three factors according to a-priori theory developed by Liebenberg and Ungar [2]. The first factor (individual) was composed of 11 items which were further conceptualised as personal skills, peer support and social skills. The second factor of relationship with caregiver included 7 items divided into physical and psychological care. The final factor was labelled as contextual and had 3 sub-factors (educational, spiritual and cultural).

Data from twelve respondents was removed prior to a CFA, following identification as multivariate outliers using the Mahalanobis Distance (MD) method. AMOS 24 was used to complete the CFA using a Maximum Likelihood Model.

Results

Usability results

262 of the pupils took part in the usability questionnaire. The majority of the participants rated the app as easy to very easy to use (87.4%), compared to those who rated it hard or very hard (4.4%). Additionally, users were positive about their experience regarding interaction with ALEX. However, participants were moderately negative with the voice that read the instructions, with 31% stating that it needed to be changed. They were also encouraged to leave comments regarding improvements; in this field the most common suggestion was to include a game.

Assessment results

Descriptive statistics for resilience are reported in Table 1. These data show that males and females reported similar scores, and suggesting there is little difference in resilience across schools. Resilience scores decreased with age, with the youngest pupils aged 11 reporting higher levels ($M=113.05$, $SD=11.85$) than those aged 16 plus ($M=103.50$, $SD=15.10$). A Pearson's correlation indicated a significant relationship between age and resilience, ($r=.81$, $p=.006$, $95\%CI [.02, 2.73]$).

Table 1. Summary of the scores for each sample including means, SD and confidence intervals.

Sample size		Mean		SD		Confidence Intervals at 95%	
S1 ^a	S2 ^b	S1	S2	S1	S2	S1	S2

Paper Total

	82	126	107.85	104.22	13.66	11.64	104.08-110.09	102.17-106.27
Male								
	36	50	108.06	103.06	12.93	10.52	103.68-112.24	100.04-106.08
Female								
	45	76	106.53	105.01	14.41	12.38	102.20-110.86	102.19-107.84
App Total								
	234	183	107.45	105.95	13.71	13.33	105.69-109.21	104.01-107.90
Male								
	135	97	107.65	106.38	13.69	14.00	105.30-110.02	103.54-109.22
Female								
	99	84	107.57	105.90	13.65	12.57	104.84-110.29	103.17-108.63

^a S1=School 1 (Deprivation group = 4,5; ^bS2=School 2 (Deprivation group = 1, 2)

There was no difference between the schools in terms of resilience ($M=107.24$, $SD=12.87$) than school 2 ($M = 105.79$, $SD = 13.15$) ($t(720)=1.38$, $p=.18$). In the paper version scores on CYRM-28 ranged from 63 to 131 ($M=106.98$, $SD=13.51$), however in the app version the equivalent results were 56 -135 ($M=106.79$, $SD=13.62$). An independent samples t-test was conducted between the two conditions and reported no significant difference ($t(720)=-.632$, $P =.53$, 95%CI [-2.55, 1.31]).

Psychometric properties

Cronbach's alpha in both conditions was very high (app: $\alpha=.92$; paper: $\alpha=.87$). Fisher's r to z transformation found the difference in the correlations to be statistically significant [$Z=-3.69$, $p <.01$]. Test-retest results (Pearson's correlations) were significant in both conditions, although the app version was shown to increase reliability: Paper ($r(303)=.81$, $p<.001$, 95%CI [.77, .85]); App ($r(413)=.84$, $p <.001$, 95%CI [.79, .89]). As SPSS was used to calculate the confidence intervals with a linear regression model, z-scores were used to calculate confidence intervals. Fisher's r to z transformation found the difference in the correlations to be statistically significant [$Z=-2.97$, $p <.01$]. Additionally, ICC (2,1) estimates and their 95% confident intervals were calculated using SPSS (SPSS Inc, Chicago, IL), the absolute-agreement, single rater model indicates that the reliability of the app version of the questionnaire was similar to the paper version is as indicated in Table 2.

Table 2: Results of ICC Calculation in SPSS using absolute-agreement, single rater Model.

Intraclass	95% CI	F Test With True Value 0
------------	--------	--------------------------

		Correlation						
Single			Lower	Upper	Value	df1	df2	Sig
Measures	App	.842	.812	.868	11.689	416	416	.000
	Paper	.810	.783	.834	9.526	721	721	.000

The three-factor structure of the 28-item CYRM-28, based on the model confirmed by Liebenberg and Unger [2], was estimated using a CFA with the Time 1 dataset in Amos 24. A maximum-likelihood estimation CFA model was found to be parsimonious, however the significant chi-square result indicates that the model did not adequately fit the data, ($\chi^2 (15, N= 541) = 27.6, p=0.24$). As large sample sizes can increase the likelihood of significant chi-square results, other indices of model fit are of particular interest. Table 3 includes a range of fit indices, all of which are within acceptable parameters.

Table 3: Model fit summary for App version of CYRM - 28 Confirmatory Factor Analysis

	X2	Df	P	GFI	CMIN	CFI	RMSEA
Original model							
	43.8	17	>.01	.94	43.78	.98	0.54
Second model							
	27.59	15	.24	.98	27.59	.99	.39

Modification indices were examined, and several items were found to have significant shared error variance, including: Relational (Physical) and Contextual (Spiritual); Individual (Personal) and Individual (Peer). An exploration of the items included in each of these factors for multicollinearity between the items suggested that no item was so redundant with another item that it could be dropped (e1-e2, Tolerance = 1.00, VIF=1.00; e4-e8, Tolerance = 1.00, VIF=1.00). As the shared error variance between all of these pairs of items was conceptually consistent with the domain assessed, a final model was re-specified to free these correlated errors. This model was found to fit the data moderately well, and increased goodness of fit ($\chi^2 (15, N= 541) = 27.6, p =0.24$); further details of fit can be seen in Table 2. The final confirmatory factor analytic model of the CYRM - 28 (Figure 1) indicated that the items were strongly correlated within factors rather than across factors, this replicates the findings from the original validity study [2]. Diagram 2 shows the error-covariances added to improve the model goodness of fit; each of these were low ($r=.12$ and $r=-.15$).

Discussion

Principal Results

The aim of the study was to establish the adequacy of an app version of a previously validated paper administration of a scale to measure resilience. The app and the paper versions of the scale presented the text of the items using Likert scales. The paper version allowed pupils to ask staff for support whilst in the app version this was built into the device. The results indicated that the app had significantly better reliability in a test-retest analysis and had significantly higher internal consistency, as measured by the Cronbach's alpha score. Scores across the demographic groups between paper and app did not differ, indicating that the app version matches the paper version CYRM-28 when measuring resilience. Finally, the study supports the use of the CYRM-28 in a Scottish youth population (11-18).

Comparison with Prior Work

Ungar had previously identified that resilience was not simply a function of the individual, but that environmental influences were also important [9]. The CFA reflected this understanding of resilience, and further confirmed Liebenberg and Ungar earlier reported three-factor solution (individual, family relationships and contextual). Furthermore, the CYRM-28 was designed to be used with the support of an adult professional (teacher or social worker) [2], and while this ensures that young people have understood the statements, it is not cost effective and therefore is of use only to small groups of children who have been identified as vulnerable. Additionally, as discussed in the Introduction, the pastoral system within Scottish schools is increasingly under strain. The current study provided evidence that a sizable percentage of children would not seek support from their guidance teachers. The purpose of the present study was to develop a low-cost scalable version of the questionnaire which depends on an avatar to support understanding, and encourages openness in adolescents. As discussed by Palmier-Claus, the app increased reliability shown by its high internal consistency, and in addition participants were more likely to provide similar responses across time periods when using the app version [40]. Research had previously indicated that the use of the avatar in the app would be a positive experience, and this has been replicated in the present study [41]. The students who completed the supplementary usability questions were generally positive about the avatar. It can be assumed that while app usage was time limited, the participants were able to develop a relationship of trust with ALEX and therefore were open in their responses.

Limitations

The current study sought to explore how effective an avatar was in connecting with young people and collecting data about their home-lives and feelings. The findings showed that the app performed well at this level of data collection and a proof of concept has been met. However, for ethical reasons it was decided to test this on a general population of young people, rather than adolescences who have been identified as vulnerable. Furthermore, while it can be argued that resilience is more

observable in people who are facing trauma or difficult situations, the CYRM-28 has previously been used in general populations [1,19]. Nonetheless, further research that includes vulnerable participants would be warranted.

The final version of the app was designed to allow the participant as well as the professional to access information about the pupil. While it is important to develop highly reliable but easy to administer assessments, it is important that the results are of use to the teacher or social worker in aiding the support of pupils. In the current study, the reports were only available to guidance teachers, and were for research purposes only. It is possible that knowledge of this had an impact on the participants' answers. However both groups (app and paper) were exposed to this variable. Furthermore, pupils were asked in the usability questions about whether they had thought this knowledge had affected their answer, with the majority stating that it had not. Additionally, the app will be used in a setting in which reports will be available to experts such as teachers, educational psychologists, and social workers. It was important that this was built-in to the trial. Parents had consented to reports being used in future studies about usability of reports, and both groups of pupils were informed of this prior to the study as part of the assent process.

Research is therefore currently being undertaken to explore how professionals utilize feedback from an app, but another question not answered here is how the young people themselves react to instant feedback on an aspect of their psychological life. Additionally, a discussion around the use of the app within a broader health and social education setting should be developed. The authors strongly suggest that the app would be well-suited in ongoing curricula designed around assessing and developing aspects of well-being. Education practitioners and social workers should be involved in developing good practice in relation to the use of such apps. It is recommended that this forms part of a conversation between guidance teachers and young people, rather than the end result of an assessment. To that end, future research should consider how assessment apps can incorporate the ability for the participant to communicate with their guidance teachers; this feature is of particular interest given the findings in the current study on the reluctance of pupils to approach their teachers.

Conclusions

The app technology utilized in the current study has shown strong reliability and validity in the measurement of resilience in young adult populations. The current findings demonstrate the efficacy of moving the CYRM-28 'gold-standard' measure of resilience to an online app-based platform. Benefits of avatar-led questioning in relation to young people's understanding of resilience are evident, however future work should address how technology can be effectively integrated into existing practitioner-led support services within schools.

Multimedia appendices

Files have been archived at <https://osf.io/kr6g9/>

Acknowledgements

APPA-Wellbeing.com who conceptualized and designed the smartphone app.

Conflicts of Interest

None declared

Abbreviations

CYRM-28: Child and youth resilience measure

GIRFEC: Getting it right for every child

SHANARRI: Safe, Healthy, Active, Nurtured, Achieving, Respected, Responsible, Independent.

References

1. Ungar, M., & Liebenberg, L. (2011). Assessing resilience across cultures using mixed methods: Construction of the child and youth resilience measure. *Journal of Mixed Methods Research*, 5(2):126-149. Doi: 10.1177/1558689811400607
2. Liebenberg, L, Ungar, M., & Vijver, F (2012). Validation of the child and youth resilience measure-28 (CYRM-28) among Canadian youth. *Research on social work practice*, 22(2): 219-226. Doi: 10.1177/1049731511428619
3. Garmezy, N, & Streitman, S (1974). Children at risk: The search for the antecedents of schizophrenia: I. Conceptual models and research methods. *Schizophrenia Bulletin*: 1(8), 14. Doi: 10.1093/schbul/1.8.14
4. Ong, A D, Bergeman, C S, Bisconti, T L, & Wallace, K A. (2006). Psychological resilience, positive emotions, and successful adaptation to stress in later life. *Journal of personality and social psychology*: 91(4): 730. Doi: 10.1037/0022-3514.91.4.730
5. Masten, A S. (2014). Global perspectives on resilience in children and youth. *Child development*, 85(1): 6-20. Doi: 10.1111/cdev.12205
6. Panter-Brick, C., & Leckman, J. F. (2013). Editorial commentary: resilience in child development—interconnected pathways to wellbeing. *Journal of child psychology and psychiatry*, 54(4): 333-336. Doi:10.1111/jcpp.12057
7. Luthar, S. S., Lyman, E. L., & Crossman, E. J. (2014). Resilience and positive psychology. In *Handbook of developmental psychopathology* (pp. 125-140). Springer US. Doi: 10.1007/978-1-4614-9608-3_7,
8. Ungar, M. (2004). A constructionist discourse on resilience: Multiple contexts, multiple realities among at-risk children and youth. *Youth & society*, 35(3): 341-365. Doi: 10.1177/0044118X03257030
9. Ungar, M. (2008). Resilience across cultures. *The British Journal of Social Work*, 38(2): 218-235. Doi: doi.org/10.1093/bjsw/bcl343
10. Ungar, M. (2011). Community resilience for youth and families: Facilitative physical and social capital in contexts of adversity. *Children and Youth Services Review*, 33(9), 1742-1748. Doi: 10.1016/j.chilyouth.2011.04.027
11. The Scottish Government, Children and Young People Act (2014) <http://www.gov.scot/Topics/People/Young-People/gettingitright/wellbeing>. Archived at <http://www.webcitation.org/6yiutudZw>
12. Daniel, B., Scott, J., Burgess, C., & Mulley, K. (2016). Noticing and Helping Neglected Children in Scotland:'sometimes it's just too hard to talk'. *Research Policy and Planning*, 32(1), 11-23.
13. The Scottish Government (2005). *Supporting pupils, A Study of guidance and pupil support in Scottish schools*. <http://www.gov.scot/Publications/2005/02/20693/52522>. Archived at <http://www.webcitation.org/6zPOXIiBj>
14. Black, C., Eunson, J., Murray, L., Zubairi, S. S., & Bowen, L. (2017). Behaviour in Scottish Schools Research 2016. Archived at <http://www.webcitation.org/6zPVH8SHf>
15. Stoddart, E. (2015). The Named Person: surveillance and the wellbeing of children and young people in Scotland. *Surveillance & Society*, 13(1): 102. ISSN: 1477-7487

16. Scottish Secondary teachers association (2017). http://www.parliament.scot/S5_Education/General%20Documents/20170317SSTAAsnSubmission.pdf. Archived at <http://www.webcitation.org/6yivWMBx5>
17. Green, C. (2017). <https://inews.co.uk/news/education/number-additional-support-teachers-scotland-sinks-lowest-level-since-2007/>. Archived at <http://www.webcitation.org/6yivkEepy>
18. Abualkibash, S. K., & Lera Rodríguez, M. J. (2015). Psychological resilience among Palestinian school students: An exploratory study in the West Bank. *International Humanities Studies*, 2(3): 1-20. ISSN: 2311-7796
19. Erbe, D., Eichert, H. C., Rietz, C., & Ebert, D. (2016). Interformat reliability of the patient health questionnaire: Validation of the computerized version of the PHQ-9. *Internet Interventions*, 5, 1-4. Doi: 10.1016/j.invent.2016.06.006
20. Faurholt-Jepsen, M., Frost, M., Vinberg, M., Christensen, E. M., Bardram, J. E., & Kessing, L. V. (2014). Smartphone data as objective measures of bipolar disorder symptoms. *Psychiatry research*, 217(1), 124-127. Doi: 10.1016/j.psychres.2014.03.009
21. Erbe, D., Eichert, H. C., Rietz, C., & Ebert, D. (2016). Interformat reliability of the patient health questionnaire: Validation of the computerized version of the PHQ-9. *Internet Interventions*, 5, 1-4. Doi: [10.1016/j.invent.2016.06.006](https://doi.org/10.1016/j.invent.2016.06.006)
22. Faurholt-Jepsen, M., Frost, M., Vinberg, M., Christensen, E. M., Bardram, J. E., & Kessing, L. V. (2014). Smartphone data as objective measures of bipolar disorder symptoms. *Psychiatry research*, 217(1), 124-127. Doi: [10.1016/j.psychres.2014.03.009](https://doi.org/10.1016/j.psychres.2014.03.009)
23. Bush, N. E., Skopp, N., Smolenski, D., Crumpton, R., & Fairall, J. (2013). Behavioral screening measures delivered with a smartphone app: psychometric properties and user preference. *The Journal of nervous and mental disease*, 201(11), 991-995. Doi: 10.1097/NMD.0000000000000039
24. Marcano-Belisario, J. S., Gupta, A. K., O'Donoghue, J., Morrison, C., & Car, J. (2016). Tablet computers for implementing NICE antenatal mental health guidelines: protocol of a feasibility study. *BMJ open*, 6(1), e009930. Doi: [10.1136/bmjopen-2015-009930](https://doi.org/10.1136/bmjopen-2015-009930)
25. Alfonsson, S., Maathz, P., & Hursti, T. (2014). Interformat reliability of digital psychiatric self-report questionnaires: a systematic review. *Journal of medical Internet research*, 16(12). Doi: [10.2196/jmir.3395](https://doi.org/10.2196/jmir.3395)
26. Booth-Kewley, S., Larson, G. E., & Miyoshi, D. K. (2007). Social desirability effects on computerized and paper-and-pencil questionnaires. *Computers in Human Behavior*, 23(1), 463-477. Doi: [10.1016/j.chb.2004.10.020](https://doi.org/10.1016/j.chb.2004.10.020)
27. Hasler, B. S., Tuchman, P., & Friedman, D. (2013). Virtual research assistants: Replacing human interviewers by automated avatars in virtual worlds. *Computers in Human Behavior*, 29(4), 1608-1616. Doi: [10.1016/j.chb.2013.01.004](https://doi.org/10.1016/j.chb.2013.01.004)
28. Thorsteinsson, G., & Page, T. (2014). User attachment to smartphones and design guidelines. *International Journal of Mobile Learning and Organisation*, 8(3-4), 201-215. Doi: 10.1504/IJMLO.2014.067020
29. Balakrishnan, V., & Raj, R. G. (2012). Exploring the relationship between urbanized Malaysian youth and their mobile phones: A quantitative approach. *Telematics and Informatics*, 29(3), 263-272. Doi: [10.1016/j.tele.2011.11.001](https://doi.org/10.1016/j.tele.2011.11.001)
30. Hassenzahl, M., Diefenbach, S., & Göritz, A. (2010). Needs, affect, and interactive products—Facets of user experience. *Interacting with computers*, 22(5), 353-362. Doi: [10.1016/j.intcom.2010.04.002](https://doi.org/10.1016/j.intcom.2010.04.002)
31. Waugh, M. (2017). 'My laptop is an extension of my memory and self': Post-Internet identity, virtual intimacy and digital queering in online popular music. *Popular Music*, 36(2), 233-251. Doi: 10.1017/S0261143017000083
32. Balakrishnan, V., & Raj, R. G. (2012). Exploring the relationship between urbanized Malaysian youth and their mobile phones: A quantitative approach. *Telematics and*

- Informatics, 29(3), 263-272. Doi: [10.1016/j.tele.2011.11.001](https://doi.org/10.1016/j.tele.2011.11.001)
33. Dresler-Hawke, E., & Mansvelt, J. (2008). Mobile phones: Enhancing social communication in young adult's lives. In Presentation at the Australian and New Zealand Marketing Academy Conference (pp. 1-7).
 34. Park, B. K., & Calamaro, C. (2013). A systematic review of social networking sites: Innovative platforms for health research targeting adolescents and young adults. *Journal of Nursing Scholarship*, 45(3), 256-264. Doi: [10.1111/jnu.12032](https://doi.org/10.1111/jnu.12032)
 35. Jones, L., Saksvig, B. I., Grieser, M., & Young, D. R. (2012). Recruiting adolescent girls into a follow-up study: benefits of using a social networking website. *Contemporary clinical trials*, 33(2), 268-272. Doi: [10.1016/j.cct.2011.10.011](https://doi.org/10.1016/j.cct.2011.10.011)
 36. Schnall, E., & Schnall, D. (2017). Positive Psychology in Jewish Education: Gratitude in the School and Synagogue Classroom. *Religious Education*, 112(2), 160-171. Doi: [10.1080/00344087.2016.1224002](https://doi.org/10.1080/00344087.2016.1224002)
 37. Pickard, M. D., Roster, C. A., & Chen, Y. (2016). Revealing sensitive information in personal interviews: Is self-disclosure easier with humans or avatars and under what conditions?. *Computers in Human Behavior*, 65, 23-30. Doi: [10.1016/j.chb.2016.08.004](https://doi.org/10.1016/j.chb.2016.08.004)
 38. Müller, Barbara CN, et al. "When triangles become human: action co-representation for objects." *Interaction Studies* 16.1 (2015): 54-67.)
 39. Zwickel, J. (2009). Agency attribution and visuospatial perspective taking. *Psychonomic Bulletin & Review*, 16(6), 1089-1093. Doi: [10.3758/PBR.16.6.1089](https://doi.org/10.3758/PBR.16.6.1089)
 40. Palmier-Claus, J.E., Ainsworth, J., Machin, M., Barrowclough, C., Dunn, G., Barkus, E., Rogers, A., Wykes, T., Kapur, S., Buchan, I. and Salter, E., (2012). The feasibility and validity of ambulatory self-report of psychotic symptoms using a smartphone software application. *BMC psychiatry*, 12(1). Doi: [10.1186/1471-244X-12-172](https://doi.org/10.1186/1471-244X-12-172)
 41. Pickard, M.D., Roster, C.A. and Chen, Y., 2016. Revealing sensitive information in personal interviews: Is self-disclosure easier with humans or avatars and under what conditions?. *Computers in Human Behavior*, 65. Doi: [10.1016/j.chb.2016.08.004](https://doi.org/10.1016/j.chb.2016.08.004)