Assessing the usability of complex psychosocial interventions: The Intervention Usability Scale

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Abstract

Background: Usability—the extent to which an intervention can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction—may be a key determinant of implementation success. However, few instruments have been developed to measure the design quality of complex health interventions (i.e., those with several interacting components). This study evaluated the structural validity of the Intervention Usability Scale (IUS), an adapted version of the well-established System Usability Scale (SUS) for digital technologies, to measure the usability of a leading complex psychosocial intervention, Motivational Interviewing (MI), for behavioral health service delivery in primary care. Prior SUS studies have found both one- and two-factor solutions, both of which were examined in this study of the IUS.

Method: A survey administered to 136 medical professionals from 11 primary-care sites collected demographic information and IUS ratings for MI, the evidence-based psychosocial intervention that primary-care providers reported using most often for behavioral health service delivery. Factor analyses replicated procedures used in prior research on the SUS.

Results: Analyses indicated that a two-factor solution (with “usable” and “learnable” subscales) best fit the data, accounting for 54.1% of the variance. Inter-item reliabilities for the total score, usable subscale, and learnable subscale were $\alpha = 0.83$, $\alpha = 0.84$, and $\alpha = 0.67$, respectively.

Conclusion: This study provides evidence for a two-factor IUS structure consistent with some prior research, as well as acceptable reliability. Implications for implementation research evaluating the usability of complex health interventions are discussed, including the potential for future comparisons across multiple interventions and provider types, as well as the use of the IUS to evaluate the relationship between usability and implementation outcomes such as feasibility.

Plain language abstract: The ease with which evidence-based psychosocial interventions (EBPIs) can be readily adopted and used by service providers is a key predictor of implementation success, but very little implementation research has attended to intervention usability. No quantitative instruments exist to evaluate the usability of complex health interventions, such as the EBPIs that are commonly used to integrate mental and behavioral health services into primary care. This article describes the evaluation of the first quantitative instrument for assessing the usability of complex health interventions and found that its factor structure replicated some research with the original version of the instrument, a scale developed to assess the usability of digital systems.

Keywords

complex health interventions, psychosocial interventions, mental health, usability, human-centered design, primary care

Although complex health interventions (CHIs)—those with several interacting components—are common in contemporary health care worldwide (Campbell et al., 2007;raig et al., 2013), clinicians often face considerable challenges implementing these interventions due to their

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design complexity (Greenhalgh et al., 2004; Perez Jolles et al., 2019). For this reason, intervention usability—the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction (International Organization for Standardization [ISO], 1998)—has been identified as a key “upstream” determinant of implementation (Lyon & Bruns, 2019). This is particularly true in mental and behavioral health, where most effective practices are complex evidence-based psychosocial interventions (EBPIs; Institute of Medicine [IoM], 2015).

In contrast to standard perceptual implementation outcomes such as acceptability, appropriateness, and feasibility, usability is largely a characteristic of the intervention. Lyon, Brewer, and Areán (2020) recently articulated a spectrum of contextual dependence for these four overlapping but distinct constructs, spanning from usability (the most contextually independent) to feasibility (the most contextually dependent). As an intra-intervention implementation determinant, usability is theorized to predict both perceptual (e.g., feasibility) and behavioral (e.g., adoption, fidelity, and sustainment) implementation outcomes. However, despite the existence of over a hundred instruments available to assess standard implementation outcomes (Lewis, Fischer, et al., 2015), no measures exist to evaluate CHI usability or other aspects of design quality (Lewis, Stanick, et al., 2015). This limited instrumentation has inhibited empirical study of the construct, including examination of the relationships between usability and perceptual implementation outcomes.

Frequently, EBPIs are delivered in integrated or non-specialty care settings (e.g., primary care and schools) that differ markedly from the contexts where they were originally developed. For instance, mismatches between EBPI design and the constraints of primary care make intervention fidelity and patient outcomes difficult to sustain (Alexopoulos et al., 2016; Areán et al., 2008). Despite being critical to implementation, aspects of intervention design quality, such as usability, have been insufficiently assessed in primary care and other non-specialty contexts (Lyon et al., 2019).

**Human-centered design and usability**

Human-centered design (HCD) reflects an approach and set of methods for creating and refining systems so that they are usable and useful for their stakeholders. HCD is also closely related to the fields of human-computer interaction, user experience, and human factors (ISO, 2019; Norman & Draper, 1986; Rubin & Chisnell, 2008). Relevant to our research aims, each of these fields includes a focus on usability and provides methods to evaluate and improve the extent to which people can reliably use a system to achieve their goals, without error, safely, and with an enjoyable experience (Dumas et al., 1999; Nielsen, 1994). Usability is a key aspect in the design and refinement of CHIs (Burchett et al., 2018; Harte et al., 2017; Horsky et al., 2012), and EBPIs in particular (Lyon et al., 2019; Lyon, Koerner, & Chung, 2020).

**System Usability Scale**

Originally designed for assessing digital systems, the System Usability Scale (SUS) is among the most widely applied usability instruments (Sauro & Lewis, 2009) and has been found to be significantly related to task success in both laboratory and field studies (Kortum & Peres, 2014). Some applications of the SUS have even extended beyond digital products to technologies such as automatic teller machines and microwave ovens (Kortum & Bangor, 2013). Brooke (1986) initially developed the 10-item scale as a brief and reliable instrument to allow comparisons among products and across versions of a product. Bangor et al. (2008) evaluated 2,324 SUS questionnaires and found high internal reliability (a = .91) and good sensitivity and concurrent validity. Although the instrument was originally considered unidimensional, Sauro and Lewis (2009) evaluated the SUS factor structure using 2,648 questionnaires assessing products such as computer hardware, software, and websites. They identified an 8-item “Usable” subscale and a 2-item “Learnable” subscale, a finding which provoked several replication studies (Kortum & Sorber, 2015; Lewis et al., 2013; Lewis, Brown, & Mayes, 2015; Lewis, Utesch, & Maher, 2015; Sauro & Lewis, 2011), including one analyzing more than 9,000 surveys (Lewis & Sauro, 2017). These studies did not replicate the initial findings. Although most studies found a two-factor solution, factors were defined by whether the item was positively worded or negatively worded, which Lewis and Sauro (2017) interpreted as practically unidimensional. This study replicates these factor analyses, but using a different population (health care professionals instead of consumers) and different target (EBPIs instead of computer hardware/software).

**Current aims**

In light of the criticality of CHI usability, and the paucity of psychometrically sound instruments for its evaluation, we revised the SUS to evaluate EBPI usability. This study assessed the revised instrument’s structural validity using confirmatory factor analytic methods. This study was carried out with primary-care providers, given the importance of primary care for the delivery of contemporary mental health services worldwide (Centers for Medicare & Medicaid Services, 2018; World Health Organization Regional Office for Europe, 2016) and the likelihood that many traditional EBPIs may demonstrate problematic usability in that novel context. The Intervention Usability Scale (IUS) was evaluated using primary-care providers’ ratings of Motivational Interviewing (MI), a client-centered and directive approach designed to help service recipients resolve ambivalence and build motivation to change (Miller...
& Rollnick, 2012). MI has a strong evidence base, including in primary care (Hettema et al., 2005; VanBuskirk & Wetherell, 2014), but its usability has never been assessed.

**Method**

**Participants**

Table 1 provides sample demographics. The study sample consisted of 136 medical providers who selected MI as the intervention they delivered most often (see Procedures). A slight majority (56.6%) of participants self-reported their gender as female; most participants were white (86.0%); and the median age was between 30 and 39.

**Procedures**

The data in this study were collected as a component of a larger survey completed by the WWAMI (Washington, Wyoming, Alaska, Montana, Idaho) region Practice and Research Network (WPRN)—a group of primary-care clinics committed to conducting practical research—in January 2019. At the time of the survey, WPRN clinics were spread across 25 diverse parent organizations in both urban and rural communities. The survey was originally conducted for quality improvement purposes. As a result, participation was not incentivized and providers were not required to provide informed consent. This study’s analyses were approved by the authors’ Institutional Review Board. The full survey consisted of questions in four areas: (1) clinician role/demographics, (2) perspectives on behavioral health in primary care, (3) anxiety treatment, and (4) provider burnout/resilience. Survey completion took approximately 10 minutes.

All WPRN member organizations \( n = 25 \) were invited to participate. Consistent with standard practices in the WPRN, staff and faculty held webinars with WPRN clinics and a preview of the full survey was distributed to build engagement and secure leadership approval. Eleven clinic sites chose to participate. The survey was distributed via the REDCap (Harris et al., 2009) digital system by clinic champions to 491 providers representing three categories of primary-care clinicians: medical providers (MD/DO, PA, NP), behavioral health providers (social workers, licensed addiction counselors, psychologists, marriage, and family therapists), and clinical pharmacists. Participation was voluntary and no incentives were provided. The overall survey response rate was 56.8\% \( (n = 279) \). There were 205 (73.4\%) participants qualified to answer the IUS questions because they reported using at least one of six identified behavioral health interventions (see Measures). MI was chosen by the overwhelming majority of respondents \( n = 172, 83.9\% \), and of those, most were medical providers \( n = 136, 79.1\% \). Therefore, we selected only medical providers who chose MI as their primary behavioral health intervention to include in this study.

**Measures**

Survey of commonly used behavioral health interventions. As a component of the larger survey, respondents were asked to select which intervention they provided most frequently from a list of evidence-based behavioral health interventions known to be commonly used in the WRPN (including cognitive behavioral therapy, behavioral activation, and MI, among others). That intervention served as the referent for the IUS.

IUS. The 10-item SUS (Brooke, 1986) was adapted to create the IUS (Lyon, 2016; Lyon, Koerner, & Chung, 2020). The term “system” was replaced with “intervention” in each item, but no other modifications were made to maintain consistency with the SUS operationalization of usability. Items are rated on a Likert-type scale from 0 (strongly disagree) to 4 (strongly agree), with half of the items reverse-scored. The total score was calculated by multiplying the sum of these scores by 2.5 (possible range: 0–100).

**Analyses**

To allow for direct comparability of studies, we replicated prior procedures. To replicate Sauro and Lewis (2009), we used principal axis factoring (a.k.a., common factor analysis) and, to replicate Lewis and Sauro (2017), we used principal components and unweighted least squares factor analysis to examine the factor structure of the IUS and evaluate possible subscales. All analyses used varimax rotation. We then assessed scale correlations and internal consistency for each subscale and the total score. We compared IUS descriptive statistics with prior research on the SUS.

**Results**

**Item descriptives and correlations**

Scores on IUS items included the full range (0–4) for all items besides item 4 (range: 0–3), item 5 (range: 1–4), and item 9 (range: 1–4). The mean scores for items ranged from 0.88 to 3.04; median scores were 3 for all regularly scored items and 1 for all reverse-scored items. See Table 2 for more detail on individual item descriptive statistics. Inter-item correlation absolute values (half of the IUS items are reverse scored) ranged from 0.05 to 0.64. Five pairs of items were not significantly correlated: items 1 and 6, items 1 and 7, items 1 and 10, items 6 and 9, and items 6 and 10. See Table 3 for full item correlation results.

**IUS factor structure**

Examining the point of inflection on a scree plot indicated that a two-factor solution best fit the data. Factor 1 had an eigenvalue of 4.31, therefore accounting for 43.1\% of the variance, and Factor 2 had an eigenvalue of 1.1, accounting for 11.0\% of the variance, for a total of 54.1\% of variance.
accounted for in the two-factor solution. For all three approaches to analysis, items 1, 2, 3, 5, 6, 7, 8, and 9 loaded onto the first factor, whereas items 4 and 10 loaded onto the second. See Table 4 for the rotated component matrix. The item-factor alignment was nearly identical to that of Sauro and Lewis (2009), which found a two-factor structure but inconsistent with studies that followed (J. R. Lewis & Sauro, 2017). Therefore, we named these factors the same as in the 2009 study; “Usable” and “Learnable.” To place the Usable and Learnable scores on a comparable 0 to 100 scale as the Overall IUS score, we multiplied their summed score contributions by 3.125 and 12.50, respectively.

Scale correlations

The correlations between the subscales and the Overall IUS score were \( r = .970 \) for Usable \( (p < .001) \) and \( r = .667 \) for Learnable \( (p < .001) \). The strong scale-to-total correlation for Usable was expected, given that 8 out of 10 items were included in this subscale. The correlation between Usable and Learnable was moderate at \( r = .467 \) \( (p < .001) \).

Reliability/internal consistency

The overall IUS items had good internal consistency \( (\alpha = .83) \). Coefficient alphas for Usable and Learnable were \( \alpha = .84 \) and \( \alpha = .67 \), respectively. Only two items loaded onto Learnable, contributing to its low alpha. The Learnable subscale was slightly lower than the typical minimum standard of .70 (Landauer, 1997; Nunnally, 1978).

Distribution of IUS subscale scores

Table 5 shows descriptive statistics on distributions of scores on the IUS, alongside a comparison with prior SUS data. Of note, the current sample had significantly higher overall scores \( (r = 3.22; p = .001) \) and Usable scores \( (r = 4.11; p < .001) \) on average, whereas the 2009 SUS study had slightly, non-significantly higher Learnable scores \( (r = .65; p = .52) \).

Table 1. Study sample demographics.

|              | N   | %  |
|--------------|-----|----|
| Age          |     |    |
| 18–29        | 37  | 27.2|
| 30–39        | 57  | 41.9|
| 40–49        | 20  | 14.7|
| 50–59        | 12  | 8.8 |
| 60–69        | 9   | 6.6 |
| Missing      | 1   | 0.7 |
| Gender (self-reported) |     |    |
| Female/woman | 77  | 56.6|
| Male/man     | 53  | 39.0|
| Genderqueer/non-binary | 2  | 1.5 |
| Missing      | 4   | 2.9 |
| Race/ethnicity a |     |    |
| American Indian/Alaska Native | 4   | 2.9 |
| Asian        | 12  | 8.8 |
| Black/African American | 1  | 0.7 |
| Hispanic/Latinx | 1  | 0.7 |
| Native Hawaiian/Pacific Islander | 1  | 0.7 |
| White        | 117 | 86.0|
| Other        | 3   | 2.2 |
| Degree(s) held a |     |    |
| MD           | 117 | 86.0|
| DO           | 10  | 7.4 |
| NP           | 5   | 3.7 |
| PA           | 3   | 2.2 |
| MPH          | 11  | 5.4 |
| MS/MA        | 5   | 3.7 |
| BS/BA        | 41  | 30.1|
| Other        | 2   | 1.5 |
| Years in practice |     |    |
| 0–5          | 15  | 11.0|
| 6–10         | 11  | 8.1 |
| 11–20        | 17  | 12.5|
| 21–30        | 9   | 6.6 |
| 31 or more   | 78  | 5.9 |
| Missing      | 60  | 44.1|

Note. N = 136.

\( ^a \)Racial/ethnic categories and degrees held are not mutually exclusive.

Table 2. IUS Individual Item Descriptives for Motivational Interviewing (MI).

| Item | Min | Max | Median | Mean | SD  |
|------|-----|-----|--------|------|-----|
| 1. I like to use MI frequently. | 0   | 4   | 3      | 3.04 | 0.73 |
| 2. I find MI unnecessarily complex. a | 0   | 4   | 1      | 1.13 | 0.78 |
| 3. I think MI is easy to use. | 0   | 4   | 3      | 2.54 | 0.90 |
| 4. I need the support of an expert consultant to be able to use MI. a | 0   | 3   | 1      | 0.88 | 0.80 |
| 5. I find the various components of MI are well integrated. | 1   | 4   | 3      | 2.72 | 0.73 |
| 6. I think there is too much inconsistency in MI. a | 0   | 4   | 1      | 1.19 | 0.81 |
| 7. I would imagine that most people would learn to use MI very quickly. | 0   | 4   | 3      | 2.38 | 0.97 |
| 8. I find MI very cumbersome to use. a | 0   | 4   | 1      | 1.11 | 0.88 |
| 9. I feel very confident using MI. | 1   | 4   | 3      | 2.55 | 0.82 |
| 10. I needed to learn a lot of things before I could get going with MI. a | 0   | 4   | 1      | 1.43 | 0.92 |

Note. N = 136 for all items.

For all items, 0 = strongly disagree, 1 = disagree; 2 = neither agree nor disagree; 3 = agree; 4 = strongly agree.

\( ^a \)Items 2, 4, 6, 8, and 10 are reverse scored.
Table 3. Item Correlations.

|                    | 1. I like to use MI frequently. | 2. I find MI unnecessarily complex. | 3. I think MI is easy to use. | 4. I need the support of an expert consultant to be able to use MI. | 5. I find the various components of MI are well integrated. | 6. I think there is too much inconsistency in MI. | 7. I would imagine that most people would learn to use MI very quickly. | 8. I find MI very cumbersome to use. | 9. I feel very confident using MI. | 10. I needed to learn a lot of things before I could get going with MI. |
|--------------------|---------------------------------|-----------------------------------|-------------------------------|-----------------------------------------------------------------|-------------------------------------------------------------|------------------------------------------|----------------------------------------------------------------|----------------------------------|---------------------------------|----------------------------------|
| 1. I like to use MI frequently. | –                               | –                                 | –                            | –                                                               | –                                                           | –                                        | –                                                            | –                                | –                               | –                                |
| 2. I find MI unnecessarily complex. | –0.37***                      | –                                 | –                            | –                                                               | –                                                           | –                                        | –                                                            | –                                | –                               | –                                |
| 3. I think MI is easy to use. | 0.30***                        | –0.52***                          | –                            | –                                                               | –                                                           | –                                        | –                                                            | –                                | –                               | –                                |
| 4. I need the support of an expert consultant to be able to use MI. | –0.28**                       | 0.40***                           | –0.38***                     | –                                                               | –                                                           | –                                        | –                                                            | –                                | –                               | –                                |
| 5. I find the various components of MI are well integrated. | 0.33***                        | –0.42***                          | 0.51***                      | –0.34***                                                        | –                                                           | –                                        | –                                                            | –                                | –                               | –                                |
| 6. I think there is too much inconsistency in MI. | –0.05                          | 0.40***                           | –0.26**                      | 0.31***                                                         | –0.37***                                                    | –                                        | –                                                            | –                                | –                               | –                                |
| 7. I would imagine that most people would learn to use MI very quickly. | 0.10                           | –0.41***                          | 0.58***                      | –0.28**                                                         | 0.33***                                                     | –0.19**                                              | –                                                            | –                                | –                               | –                                |
| 8. I find MI very cumbersome to use. | –0.35***                      | 0.64***                           | –0.56***                     | 0.35***                                                         | –0.38***                                                    | 0.48***                                               | –0.48***                                    | –                                | –                               | –                                |
| 9. I feel very confident using MI. | 0.45***                        | –0.41***                          | 0.56***                      | –0.46***                                                        | 0.43***                                                     | –0.16                                                 | 0.47***                                      | –0.44***                         | –                               | –                                |
| 10. I needed to learn a lot of things before I could get going with MI. | –0.10                          | 0.20*                             | –0.18*                       | 0.50***                                                         | –0.21*                                                      | 0.15                                                  | –0.27***                                     | 0.25**                           | –0.29***                        | –                                |

Note. N = 136.

*Significant at p < .05; ** Significant at p < .01; *** Significant at p < .001.
Implementation Research and Practice

Discussion

No psychometrically sound instruments exist to evaluate the usability of CHIs. Our study of the IUS revealed a factor structure that was nearly identical to Sauro and Lewis (2009). However, our results differed from subsequent studies (Kortum & Sorber, 2015; J. R. Lewis, Brown, & Mayes, 2015; J. R. Lewis et al., 2013; J. R. Lewis & Sauro, 2017; Lewis, Utesch, & Maher, 2015; Sauro & Lewis, 2011). The moderate correlation between the subscales indicates that the measure can be used as a total scale score, as well as decomposed into Usable and Learnable subscales. The overall IUS score for MI was 68.70, which was slightly below the SUS cutoff of 70 for “acceptable” (Bangor et al., 2008). However, until additional research is conducted with the IUS, it is unknown the extent to which IUS cutoffs translated to CHIs.

Future research should apply the IUS to better understand factors that contribute to high and low scores and the relationships between those scores and related constructs. First, applications with a broader range of EBPI types are indicated to confirm the current results, and these investigations are likely to reveal EBPI qualities that result in higher and lower scores (e.g., EBPI complexity). Second, the IUS should be applied with additional service provider and service recipient populations with a range of experience in the interventions evaluated. Prior research with both the SUS and the IUS suggests that greater experience with products or expertise in domains can result in higher scores (Lyon, Koerner, & Chung, 2020; McLellan et al., 2012; Sauro, 2011). Third, initial evidence for the structural validity of the IUS creates opportunities to evaluate the relationships between usability and perceptual implementation outcomes (e.g., acceptability and feasibility) using established measures for those constructs (e.g., Weiner et al., 2017). Fourth, there may be opportunities to improve the IUS itself, such as targeted item development to enhance the robustness of the two-item Learnable subscale or revised wording including exploration of the utility of including

Table 4. Rotated Component Matrices for three exploratory structure analyses.

| Item                                                                 | Principal axis |                                                   | Principal components | Unweighted least squares |
|---------------------------------------------------------------------|----------------|---------------------------------------------------|----------------------|-------------------------|
|                                                                     | Factor 1       | Factor 2                                          | Factor 1             | Factor 2                | Factor 1             | Factor 2             |
| 1. I like to use MI frequently.                                      | 0.383          | -0.210                                           | 0.412                | -0.293                  | 0.387                | -0.200               |
| 2. I find MI unnecessarily complex.                                  | -0.702         | 0.234                                            | -0.771               | 0.182                   | -0.698               | 0.238                |
| 3. I think MI is easy to use.                                        | 0.769          | -0.160                                           | 0.785                | -0.178                  | 0.766                | -0.164               |
| 4. I need the support of an expert consultant to be able to use MI.   | -0.273         | 0.843                                            | -0.305               | 0.773                   | -0.237               | 0.970                |
| 5. I find the various components of MI are well integrated.          | 0.567          | -0.225                                           | 0.649                | -0.205                  | 0.572                | -0.213               |
| 6. I think there is too much inconsistency in MI.                    | -0.402         | 0.192                                            | -0.561               | 0.041                   | -0.398               | 0.198                |
| 7. I would imagine that most people would learn to use MI very quickly. | 0.585          | -0.169                                           | 0.622                | -0.218                  | 0.592                | -0.156               |
| 8. I find MI very cumbersome to use.                                 | -0.748         | 0.191                                            | -0.797               | 0.160                   | -0.748               | 0.189                |
| 9. I feel very confident using MI.                                   | 0.578          | -0.366                                           | 0.568                | -0.486                  | 0.589                | -0.341               |
| 10. I needed to learn a lot of things before I could get going with MI.| -0.159         | 0.535                                            | -0.028               | 0.867                   | -0.185               | 0.469                |

Note. N = 136.

Table 5. Comparison with Prior System Usability Scale Data.

| Statistic            | Lewis & Sauro SUS (comparison sample) | Current data set |
|----------------------|---------------------------------------|------------------|
|                      | Overall | Usable | Learnable | Overall | Usable | Learnable |
| N                    | 324     | 324    | 324       | 136     | 136    | 136       |
| Mean                 | 62.10   | 59.40  | 72.70     | 68.70*  | 68.15**| 71.14     |
| Variance             | 494.38  | 531.54 | 674.47    | 183.29  | 203.40 | 346.10    |
| Standard deviation   | 22.24   | 23.06  | 25.97     | 13.54   | 14.26  | 18.60     |
| Standard error       | 1.24    | 1.28   | 1.44      | 1.17    | 1.23   | 1.60      |
| Skewness             | -.42    | -.38   | -.80      | -.08    | -.16   | -.39      |
| Kurtosis             | N/A     | N/A    | N/A       | -.20    | -.09   | -.30      |

Note. * Significantly different from comparison sample at p = .01; ** Significantly different from comparison sample at p = .001.
specific examples of EBPIs that demonstrate high or low usability. Finally, future research also should assess the extent to which differences in implementation supports (e.g., training and consultation) impact experiences of EBPI usability.

Limitations

This study had several limitations. First, it occurred only in primary care with one user group and may be difficult to generalize to other contexts. Although the WPRN represents a wide variety of types of health care systems, clinic sizes, and geography (and is broadly representative of primary care clinics in the region), sampling within the WPRN was non-systematic and may have yielded a sample that was more engaged with, or had positive attitudes toward, behavioral health services in general or EBPIs in particular. Second, due to a survey programming error, we did not obtain consistent data about the amount of training respondents had received for MI.

Conclusions and next steps

Overall, the adapted IUS demonstrated good psychometric quality and a structure consistent with some prior research. Overall, intervention usability has been conceptualized as a key determinant of both perceptual (e.g., appropriateness and feasibility) and behavioral (e.g., fidelity) implementation outcomes, as well as patient outcomes (Lyon & Bruns, 2019). Application of the IUS to a broader range of EBPIs, settings, and professional roles would allow this proposition to be explicitly tested.

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References

Alexopoulos, G. S., Rauer, P. J., Gunning, F., Kiosses, D. N., Kanellopoulos, D., Pollari, C., Banerjee, S., . . . Arean, P. A. (2016). Engage therapy: Behavioral activation and improvement of late-life major depression. American Journal of Geriatric Psychiatry, 24(4), 320–326. https://doi.org/10.1016/j.jagp.2015.11.006
Arein, P. A., Ayalon, L., Jin, C., McCulloch, C. E., Linkins, K., Chen, H., . . . Estes, C. (2008). Integrated specialty mental health care among older minorities improves access but not outcomes: Results of the PRISMe study. International Journal of Geriatric Psychiatry: A Journal of the Psychiatry of Late Life and Allied Sciences, 23(10), 1086–1092. https://doi.org/10.1002/gps.2100
Bangor, A., Kortum, P. T., & Miller, J. T. (2008). An empirical evaluation of the System Usability Scale. International Journal of Human-Computer Interaction, 24(6), 574–594. https://doi.org/10.1080/10447310802205776
Brooke, J. (1996). SUS: A quick and dirty usability scale. In P. W. Jordan, B. Thomas, I. L. McClelland, & B. Weerdmester (Eds.), Usability evaluation in industry (pp. 189–194). CRC Press. London.
Burchett, H. E. D., Blanchard, L., Kneale, D., & Thomas, J. (2018). Assessing the applicability of public health intervention evaluations from one setting to another: A methodological study of the usability and usefulness of assessment tools and frameworks. Health Research Policy and Systems, 16(1), 88. https://doi.org/10.1186/s12961-018-0364-3
Campbell, N. C., Murray, E., Darbyshire, J., Emery, J., Farmer, A., Griffiths, F., . . . Kinmonth, A. L. (2007). Designing and evaluating complex interventions to improve health care. British Medical Journal, 334(7591), 455–459. https://doi.org/10.1136/bmj.39108.379965.be
Centers for Medicare & Medicaid Services. (2018). Behavioral health integration services booklet. https://www.cms.gov/Outreach-and-Education/Medicare-Learning-Network-MLN/MLNProducts/Downloads/BehavioralHealthIntegration.pdf
Craig, P., Dieppe, P., Macintyre, S., Michie, S., Nazareth, I., & Petticrew, M. (2013). Developing and evaluating complex interventions: The new Medical Research Council guidance. International Journal of Nursing Studies, 50(5), 585–587. https://doi.org/10.1016/j.ijnurstu.2012.09.010
Dumas, J. S., Dumas, J. S., & Redish, J. (1999). A practical guide to usability testing. Intellect Books.
Greenhalgh, T., Robert, G., Macfarlane, F., Bate, P., & Kyriakidou, O. (2004). Diffusion of innovations in service organizations: Systematic review and recommendations. The Milbank Quarterly, 82(4), 581–629. https://doi.org/10.1111/j.0887-378x.2004.00325.x
Harris, P. A., Taylor, R., Thielke, R., Payne, J., Gonzalez, N., & Conde, J. G. (2009). Research electronic data capture (REDCap)-A metadata-driven methodology and workflow process for providing translational research informatics sup-
port. *Journal of Biomedical Informatics, 42*(2), 377–381. https://doi.org/10.1016/j.jbi.2008.08.010

Harte, R., Glynn, L., Rodríguez-Molinero, A., Baker, P. M., Scharf, T., Quinan, L. R., & ÓLaighin, G. (2017). A human-centered design methodology to enhance the usability, human factors, and user experience of connected health systems: A three-phase methodology. *JMIR Human Factors, 4*(1), e8. https://doi.org/10.2196/humanfactors.5443

Hettema, J., Steele, J., & Miller, W. R. (2005). Motivational interviewing. *Annual Review of Clinical Psychology, 1*, 91–111. https://doi.org/10.1146/annurev.clinpsych.1.102803.143833

Horsky, J., Schiff, G. D., Johnston, D., Mercincavage, L., Bell, D., & Middleton, B. (2012). Interface design principles for usable decision support: A targeted review of best practices for clinical prescribing interventions. *Journal of Biomedical Informatics, 45*(6), 1202–1216. https://doi.org/10.1016/j.jbi.2012.09.002

Institute of Medicine. (2015). *Psychosocial interventions for mental and substance use disorders: A framework for establishing evidence-based standards*. National Academies Press.

International Organization for Standardization. (1998). Ergonomic requirements for office work with visual display terminals (VDTs)—Part 11: Guidance on usability. https://www.iso.org/standard/16883.html

International Organization for Standardization. (2019). 9241–210: Ergonomics of human system interaction—Part 210: Human-centered design for interactive systems. https://www.iso.org/standard/77520.html

Kortum, P., & Peres, S. C. (2014). The relationship between system effectiveness and subjective usability scores using the System Usability Scale. *International Journal of Human-Computer Interaction, 30*(7), 575–584. https://doi.org/10.1080/10447318.2014.904177

Kortum, P., & Sorber, M. (2015). Measuring the usability of mobile applications for phones and tablets. *International Journal of Human-Computer Interaction, 31*(8), 518–529. https://doi.org/10.1080/10447318.2015.1064658

Kortum, P. T., & Bangor, A. (2013). Usability ratings for everyday products measured with the System Usability Scale. *International Journal of Human-Computer Interaction, 29*(2), 67–76. https://doi.org/10.1080/10447318.2012.681221

Landauer, T. (1997). Behavioral research methods in human-computer interaction. In *Handbook of human-computer interaction* (pp. 203–227). https://doi.org/10.1016/B978-044481862-1.50075-3

Lewis, C. C., Fischer, S., Weiner, B. J., Stanick, C., Kim, M., & Martinez, R. G. (2015). Outcomes for implementation science: An enhanced systematic review of instruments using evidence-based rating criteria. *Implementation Science, 10*(1), 155. https://doi.org/10.1186/s13012-015-0342-x

Lewis, C. C., Stanick, C. F., Martineau, R. G., Weiner, B. J., Kim, M., Barwick, M., & Comtois, K. A. (2015). The society for implementation research collaboration instrument review project: A methodology to promote rigorous evaluation. *Implementation Science, 10*(1), 2. https://doi.org/10.1186/s13012-014-0193-x

Lewis, J. R., Brown, J., & Mayes, D. K. (2015). Psychometric evaluation of the EMO and the SUS in the context of a large-sample unmoderated usability study. *International Journal of Human-Computer Interaction, 31*(8), 545–553. https://doi.org/10.1080/10447318.2015.1064665

Lewis, J. R., & Sauro, J. (2017). Revisiting the factor structure of the System Usability Scale. *Journal of Usability Studies, 12*, 183–192. https://uxpajournal.org/revisit-factor-structure-system-usability-scale/

Lewis, J. R., Utesch, B. S., & Maher, D. E. (2013). UMUX—LITE—When there’s no time for the SUS. In *Conference on human factors in computing systems—Proceedings* (pp. 2099–2102). https://doi.org/10.1145/2470654.2481287

Lewis, J. R., Utesch, B. S., & Maher, D. E. (2015). Measuring perceived usability: The SUS, UMUX-LITE, and AltUsability. *International Journal of Human-Computer Interaction, 31*(8), 496–505. https://doi.org/10.1080/10447318.2015.1064654

Lyon, A. R. (2016). *Intervention Usability Scale (IUS)*. University of Washington.

Lyon, A. R., Brewer, S. K., & Areán, P. A. (2020). Leveraging human-centered design to implement modern psychological science: Return on an early investment. *American Psychologist, 75*, 1067–1079. http://doi.org/10.1037/amp0000652

Lyon, A. R., & Bruns, E. J. (2019). User—centered redesign of evidence—based psychosocial interventions to enhance implementation—hospitalable soil or better Seeds? *JAMA Psychiatry, 76*(1), 3–4. https://doi.org/10.1001/jamapsychiatry.2018.3060

Lyon, A. R., Koerner, K., & Chung, J. (2020). Usability evaluation for evidence-based psychosocial interventions (USE-EBPI): A methodology for assessing complex intervention implementability. *Implementation Research and Practice, 1*, 1–17. https://doi.org/10.1177%2F2633489520932924

Lyon, A. R., Munson, S. A., Renn, B. N., Atkins, D. C., Pullmann, M. D., Friedman, E., & Areán, P. A. (2019). Use of human-centered design to improve implementation of evidence-based psychotherapies in low-resource communities: Protocol for Studies Applying a Framework to Assess Usability. *JMIR Research Protocols, 8*(10), e14990. https://doi.org/10.2196/14990

McEwan, S., Muddimer, A., & Peres, S. C. (2012). The effect of experience on System Usability Scale ratings. *Journal of Usability Studies, 7*(2), 56–67. http://uxpajournal.org/the-effect-of-experience-on-system-usability-scale-ratings/

Miller, W. R., & Rollnick, S. (2012). *Motivational interviewing: Helping people change*. Guilford Press.

Nielsen, J. (1994). *Usability engineering*. Morgan Kaufmann.

Norman, D. A., & Draper, S. W. (1986). *User centered system design: new perspectives on human-computer interaction*. Lawrence Erlbaum Associates.

Nunnally, J. C. (1978). *Psychometric theory*. McGraw-Hill.

Perez Jolles, M., Lengnick-Hall, R., & Mittman, B. S. (2019). Core functions and forms of complex health interventions: A patient-centered medical home Illustration. *Journal of General Internal Medicine, 34*(6), 1032–1038. https://doi.org/10.1007/s11606-018-4818-7

Rubin, J., & Chinsell, D. (2008). *Handbook of usability testing: How to plan, design, and conduct effective tests*. Wiley.
Sauro, J. (2011). Does prior experience affect perceptions of usability? https://measuringu.com/prior-exposure/

Sauro, J., & Lewis, J. R. (2009, April 4–9). Correlations among prototypical usability metrics: Evidence for the construct of usability. In Proceedings of the 27th international conference on human factors in computing systems (pp. 1609–1618). ACM Press. https://doi.org/10.1145/1518701.1518947

Sauro, J., & Lewis, J. R. (2011). When designing usability questionnaires, does it hurt to be positive? In Conference on human factors in computing systems—Proceedings (pp. 2215–2223). https://doi.org/10.1145/1978942.1979266

VanBuskirk, K. A., & Wetherell, J. L. (2014). Motivational interviewing with primary care populations: A systematic review and meta-analysis. Journal of Behavioral Medicine, 37(4), 768–780. https://doi.org/10.1007%2Fs10865-013-9527-4

Weiner, B. J., Lewis, C. C., Stanick, C., Powell, B. J., Dorsey, C. N., Clary, A. S., . . . Halko, H. (2017). Psychometric assessment of three newly developed implementation outcome measures. Implementation Science, 12(1), 1–12. https://doi.org/10.1186/s13012-017-0635-3

World Health Organization Regional Office for Europe. (2016). Integrated care models: An overview Working document. http://www.euro.who.int/pubrequest