An Examination of the Psychometric Structure of the Multidimensional Pain Inventory

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Factor analyses to create the Multidimensional Pain Inventory (MPI) warrant further examination due to small sample size, the use of separate factor analyses for each MPI section, and lack of evidence for the replicability of the factor model. The present study randomly assigned 972 respondents to one of three samples. Study 1 used data from Sample 1 (n = 452) to examine the replicability of the MPI factor structure reported by Kerns, Turk, and Rudy (1985), and to measure the internal consistencies of MPI scales. In Study 2, confirmatory factor analyses using Sample 2 data (n = 267) verified a revised MPI factor structure that was generated in Study 1; cross-validation was achieved using data from Sample 3 (n = 253). The revised MPI model differed from the original model in its number of scales and pattern of scale loadings. Recommendations for the refinement of the MPI are proposed. © 2001 John Wiley & Sons, Inc. J Clin Psychol 57: 765–783, 2001.

Keywords: chronic pain; Multidimensional Pain Inventory; factor analysis; cross-validation

This study is based on the doctoral dissertation of Julie A. Deisinger under the direction of Jeffrey E. Cassisi. The authors would like to thank members of the dissertation committee, including Robert Schleser, Charles Merbitz, and Susan Feinberg, as well as several anonymous reviewers, for their helpful comments. They would also like to extend their appreciation to Joanne Tsoutsouris, who assisted with the initial phase of data entry. Correspondence concerning this article should be addressed to: Julie A. Deisinger, Psychology Department, Saint Xavier University, 3700 West 103rd Street, Chicago, IL, 60655.
Self-report measures of pain provide both clinicians and researchers with valuable clinical information about various features of the pain experience. Kerns, Turk, and Rudy (1985) created one such measure, the Multidimensional Pain Inventory (MPI; cf. Rudy, 1989), to assess multiple aspects of psychosocial functioning in chronic pain patients. Since its development, the MPI frequently has been used in studies of chronic pain populations (e.g., Beck, Chase, Berisford, & Taegtmeyer, 1992; Etscheidt, Steger, & Braverman, 1995; Flor, Kerns, & Turk, 1987; Jensen, Nygren, Gamberale, Goldie, & Westerholm, 1994; Lockett & Campbell, 1992; Toomey, Hernandez, Gittelman, & Hulka, 1993; Walter & Brannon, 1991). Some researchers (e.g., Bradley, Haile, & Jaworski, 1992; Tyrer, 1992) have recommended it as the single best instrument for multidimensional assessment of chronic pain.

The MPI consists of three sections, each containing subscales that were derived using factor-analytic techniques. Kerns et al. (1985) performed a confirmatory factor analysis (CFA) of Section I and verified five subscales: Interference, Support, Pain Severity, Self-control, and Negative Mood. Next, they employed exploratory factor analyses (EFAs) to derive subscales for Sections II and III. They used principal axis factoring as the factor extraction method, and performed both orthogonal and oblique rotations to simplify the factor structure. Section II, which measures significant others’ responses to patients’ chronic pain, yielded three factors: Punishing Responses, Solicitous Responses, and Distracting Responses. Section III contained four factors related to patients’ activity levels: Household Chores, Outdoor Work, Activities Away from Home, and Social Activities.

In the process of developing the MPI, an exploratory factor analysis of all MPI items was not conducted. Kerns et al. (1985) did a CFA of Section I, followed by separate EFAs of Sections II and III. They explained this approach by noting that confirmatory techniques are suitable for use with a priori scales. However, another rationale might have been preferable for the following reason. During the development of any psychometric instrument, relationships between questionnaire items initially are unknown. Thus, an EFA using all MPI items is needed to elucidate these relationships.

A limitation of the Kerns et al. (1985) study is that its sample ($n = 120$) was too small to permit an EFA of the entire instrument. Although the authors created each MPI section based on theoretical constructs presumed relevant to chronic pain, concerns still can be raised about the generalizability of these factors. Factors derived from small samples have limited generalizability to other samples due to greater fluctuation in between-variable correlations (Tinsley & Tinsley, 1987). Furthermore, a minimum of five observations per item generally is recommended for an EFA (Tinsley & Tinsley, 1987). This criterion was not met for Section I of the MPI, which consisted of 28 items. Finally, adequacy of sample size for use in factor analysis should be justified empirically, e.g., through the use of Bartlett’s test of sphericity or the Kaiser–Meyer–Olkin measure of sampling adequacy (Norusis, 1993).

Another limitation of the Kerns et al. (1985) study is that its sample did not meet commonly accepted criteria for the application of CFA. Such analyses typically should include either of the following: at least 10 times as many observations as variables, or a minimum of 200 observations (Floyd & Widaman, 1995; Lowe, Walker, & MacCallum, 1991).

Since the MPI was devised, two studies have attempted to examine the replicability of its factor structure. Bernstein, Jaremko, and Hinkley (1995) examined the MPI factor structure with a confirmatory factor-analytic technique called the method of oblique multiple groups (cf. Nunnally & Bernstein, 1994). Using data from 194 chronic pain patients, each section of the MPI was analyzed to determine the amount of variance that was...
accounted for by its component scales. That study differed from the factor model reported by Kerns et al. (1985) in two respects. Bernstein et al. (1995) reported that the Activities Away from Home and Social Activities scales overlapped, as did the scales for Solicitous Responses and Distracting Responses. Otherwise, their results appeared to support the original MPI model.

In a more recent study, Riley, Zawacki, Robinson, and Geisser (1999) performed both exploratory and confirmatory factor analyses on each section of the MPI. Results of their exploratory factor analyses, using data from 472 chronic-pain patients, varied somewhat from the structure described by Kerns et al. (1985). Riley et al. (1999) found that the Self-control and Negative Affect scales from Section I loaded onto a single factor. They also noted that items 12, 13, and 19 from Section I, as well as items 3 and 6 from Section II, loaded strongly on more than one scale. In addition, they reported that the Activities Away from Home and Social Activities scales from Section III loaded together, replicating the findings of Bernstein et al. (1995).

Riley et al. (1999) used data from a separate sample of 346 chronic pain patients for their confirmatory factor analyses to compare the original Kerns et al. (1985) model, the Bernstein et al. (1995) model, and an empirical model they had created by dropping those items that had loaded on more than one factor in their exploratory analyses. They obtained a model for Section I that was a better fit than either the Kerns et al. (1985) model or the Bernstein et al. (1995) model by allowing cross-loadings between Item 10 of the Support scale and both the Pain Severity and Life Interference scales. For Section III, they achieved the best fit by allowing cross-loadings between Item 10 of the Outdoor Work scale and the three other scales in this section. Despite the changes noted, however, Riley et al. (1999) concluded that the original model created by Kerns et al. (1985) was an adequate representation of the MPI’s psychometric structure.

Both of these studies included larger samples than the one used by Kerns et al. (1985); however, all three of the previous studies analyzed the original 52-item version of the MPI, rather than the current 61-item version (Rudy, 1989) that is used widely. Another limitation shared by the Bernstein et al. (1995) and Riley et al. (1999) study is that both of these studies separately factor analyzed each section of the MPI. Furthermore, both studies used only Kaiser’s criterion to determine the proper number of factors to extract. Although this method frequently is employed, additional criteria (e.g., scree plots, percentage of variance accounted for by each factor) also should be considered when deciding on a factor solution (Floyd & Widaman, 1995; Tinsley & Tinsley, 1987). Yet another drawback of Bernstein et al. (1995) was its failure to utilize structural equation modeling, the preferred technique when examining the goodness of fit for a given factor model (Fassinger, 1987; Floyd & Widaman, 1995).

An important oversight in these studies is the lack of evidence concerning the stability of the MPI factor structure. Smith and McCarthy (1995) emphasized that the factor solution of an assessment instrument should be replicated using an independent sample to insure that the solution is not merely a function of the sample used to create the instrument. This issue was recognized by Riley et al. (1999), who did use separate samples for their exploratory and confirmatory factor analyses. However, they identified noteworthy differences in gender composition and pain duration across their two samples as potential weaknesses of their study. Furthermore, they neglected to cross-validate their empirical model using data from a third sample of patients.

A final psychometric issue that needs further study is the reliability and consistency of the MPI scales. According to Kerns et al. (1985), the internal consistencies of MPI scales ranged from 0.70 to 0.90. However, several of these scales consist of only three or four items. Brevity in a self-report instrument is desirable in order to avoid respondents’
fatigue or inattention; however, internal consistency may be compromised if too few items are used (Lyman, 1986).

The present studies sought to address the limitations discussed above. Main objectives of Study 1 included: (1) examining the replicability of the MPI factor structure that was reported originally by Kerns et al. (1985), and (2) measuring the internal consistencies of MPI scales. In Study 2, primary goals involved: (1) verifying the factor structure of the MPI that was generated in Study 1, and (2) cross-validating the MPI factor structure using an independent sample.

**Study 1**

**Method**

**Participants.** Archival MPI data, originally gathered from 1989 to 1995, were obtained from three chronic pain treatment centers in Chicago. Participants were a heterogeneous group of chronic pain patients who completed Version 2.1 of the MPI (Rudy, 1989) as part of a pre-treatment pain assessment at these facilities. The exclusionary criterion consisted of failure to respond to three or more items. As a result, 283 respondents were excluded from further analyses. The use of this criterion was deemed appropriate because, as noted earlier, some MPI scales consist of only three items. Had protocols missing three or more items been included in the analyses, score totals for some MPI scales might have been affected. For protocols with only one or two missing items, item means were calculated by gender and substituted accordingly (cf. Brown, 1994). The final database contained 972 respondents. Demographic information from the questionnaires included gender, age, duration of pain, and site of pain.

A random split-sample procedure (Anastasi, 1988), using *SPSS for Windows*, Release 6.0 (Norusis, 1993), generated three demographically equivalent samples. A larger percentage of respondents (n = 452) was allocated to the first sample in order to meet sample size requirements for EFA. The remaining participants were divided into two roughly equal samples. Data from the second sample (n = 267) were subjected to CFA, and data from the third sample (n = 253) were reserved for cross-validation. The latter two sets of analyses will be discussed in Study 2.

Sample 1 contained 199 male and 250 female respondents; three individuals failed to disclose their gender. They had a mean age of 41.73 years (SD = 11.88), and reported a mean duration of pain equal to 40.20 months (SD = 64.91). Sample 2 consisted of 117 males and 149 females, with one respondent of unknown gender. Their mean age was 41.32 years (SD = 11.33), and their mean duration of pain equaled 48.93 months (SD = 67.26). In Sample 3, there were 124 males, 124 females, and 5 individuals who failed to disclose their gender. Mean age for these respondents was 42.11 years (SD = 11.92), and mean pain duration was 45.43 months (SD = 68.68). The back was the modal site of pain in all three samples, with 39.5% of the respondents reporting back pain. The legs and shoulders/arms were the other most-frequently reported sites of pain with 20.8% and 18.6% of participants, respectively, indicating difficulties in these areas.

χ² tests were used to examine the equivalence of the samples with regard to data source (i.e., number of participants from each of the three treatment centers), gender, and site of pain. Results were nonsignificant (all p’s > .10), indicating that the samples were equivalent across these measures. One-way analyses of variance were performed to compare the samples for equivalence according to age and reported duration of pain. Again, nonsignificant results were obtained (all p’s > .10), demonstrating that the samples were equivalent for these characteristics.
Procedures and Data Analysis. A series of factor analyses (see Table 1) systematically examined the original factor structure of the MPI. Bartlett’s test of sphericity (BTS) and the Kaiser–Meyer–Olkin measure of sampling adequacy (KMO) were used to check whether the data were appropriate for factor analyses. The number of factors to be extracted during EFAs was determined by examining Kaiser’s criterion, Cattell’s (1966) scree test, and the percentage of variance accounted for by each factor (Tinsley & Tinsley, 1987). Principal axis factoring was used as the factor extraction method, since this extraction method was used by Kerns et al. (1985).

Following an EFA of all 61 MPI items, both orthogonal and oblique rotations were performed to determine the best factor solution for the entire instrument. An EFA of all MPI items identified three revised sections, or latent factors. The items comprising each latent factor differed somewhat from items found in each of the original MPI sections. An a priori decision was made to perform orthogonal rotations following EFAs for each of the latent factors to create independent scales for each factor. The use of orthogonal rotation assured that the resulting scales were nonoverlapping (cf. Golden, Sawicki, & Franzen, 1990).

Results

Exploratory Factor Analysis of All MPI Items. Table 1 gives an overview of the results of Study 1. Exploratory factor analysis (EFA) was performed on respondents’ raw scores for all 61 items of the MPI (BTS = 12479.02, p < .00001; KMO = .88). Twenty-nine eigenvalues greater than one emerged; however, a scree plot implied that three underlying factors were sufficient. In addition, only the first three factors each accounted for ≥5% of the total variance: 18.2%, 8.0%, and 5.9%, respectively.

Two more EFAs were conducted, specifying three factors for extraction. One of these analyses was followed by orthogonal (varimax) rotation, while the other was followed by oblique (direct oblimin) rotation. Both of the rotated solutions yielded an identical pattern of factor loadings. However, the oblique solution appeared to conform more closely to accepted criteria for simple structure because it contained more nonsignificant loadings that approached a value of zero (Dillon & Goldstein, 1984). Also, although Factors Two and Three appeared uncorrelated with each other (r = 0.00), modest correlations were observed between Factors One and Two (r = .11) and between Factors One and Three (r = −.35). These correlations indicated that neither too few nor too many factors were extracted. The three factors extracted in the EFA accounted for a cumulative percentage of variance equal to 31.2%. The pattern matrix for the oblique factor solution appears in Table 2.

Factor loadings with an absolute value of ≥0.30 were used to define the three latent constructs identified by the analyses (cf. Hair, Anderson, & Tatham, 1987). Items that did not load significantly on any factor were excluded from further analyses. In cases where an item loaded significantly on more than one factor, it was assigned to the factor on which it loaded most strongly.

The first factor contained significant loadings from 25 items and was characterized best as a Suffering factor. It contained 22 of the 28 items from the original Section I of the MPI, such as “Rate the level of your pain at the present moment,” “On the average, how severe has your pain been during the last week?,” and “How much suffering do you experience because of your pain?” In addition, three items from Section II loaded on this factor; these were from the original Punishing Responses scale (e.g., “Gets angry with me”).

Thirteen items loaded on the second latent factor. It appeared to be a Social Support factor, generally corresponding to the original Section II of the MPI. Items loading on
Table 1
Summary of Study 1 Results

<table>
<thead>
<tr>
<th>Step</th>
<th>Type of Analysis</th>
<th>Purpose</th>
<th>Scope of Analysis</th>
<th>Sample</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>EFA of Original MPI</td>
<td>Replicate MPI Factor Structure</td>
<td>All MPI Items</td>
<td>1</td>
<td>Identified 3 Revised MPI Latent Factors: Suffering, Social Support, &amp; Activity; Compositions of Latent Factors Differ from Original MPI Sections</td>
</tr>
<tr>
<td>2</td>
<td>EFA of Suffering Factor</td>
<td>Create New MPI Scales</td>
<td>Items Loading on Suffering Factor in Step 1</td>
<td>1</td>
<td>After Discarding 7 Items, Identified 3 Reliable Suffering Scales: Interference, Punishing Responses, &amp; Pain Severity</td>
</tr>
<tr>
<td>3</td>
<td>EFA of Social Support Factor</td>
<td>Create New MPI Scales</td>
<td>Items Loading on Social Support Factor in Step 1</td>
<td>1</td>
<td>After Discarding 1 Item, Identified 3 Reliable Social Support Scales: Support, Solicitous Responses, &amp; Distracting Responses</td>
</tr>
<tr>
<td>4</td>
<td>EFA of Activity Factor</td>
<td>Create New MPI Scales</td>
<td>Items Loading on Activity Factor in Step 1</td>
<td>1</td>
<td>Identified 3 Activity Scales: Recreation, Household Chores, &amp; Outdoor Work</td>
</tr>
<tr>
<td>5</td>
<td>Cronbach’s α</td>
<td>Internal Consistency of Revised MPI Scales</td>
<td>Items Assigned to Each Revised MPI Scale</td>
<td>1</td>
<td>α Values Range from 0.74 to 0.90</td>
</tr>
</tbody>
</table>

Note. EFA = exploratory factor analysis; MPI = Multidimensional Pain Inventory; Sample 1 n = 452.
this factor came primarily from the original Solicitous Responses and Distracting Responses scales (e.g., “Asks me what he/she can do to help”; “Talks to me about something else to take my mind off the pain”). However, three additional items came from the original Support scale of Section I [e.g., “How supportive or helpful is your spouse (significant other) to you in relation to your pain?”].

The third factor was clearly an Activity factor, comprised of all 19 items from Section III of the MPI. Examples of items loading on this factor include “Go grocery shopping,” “Take a trip,” and “Work on a needed household repair.”
Exploratory Factor Analyses of Empirically Derived MPI Factors. The preceding EFA of all MPI items yielded three latent factors: Suffering, Social Support, and Activity. Each of these factors was subjected to another EFA to create new MPI scales. These analyses explored whether the original MPI scales would be replicated in the present sample.\(^1\) For all subsequent analyses in Study 1, BTS and KMO values indicated that these data were appropriate for EFA (for BTS, all \(p\)'s < .0001; all KMO's ≥ 0.86). The number of scales that were specified for each factor was determined based on Kaiser's criterion, scree plots, and the percentage of variance accounted for by each scale. An item that loaded on more than one scale was assigned to the scale on which it loaded most strongly. The compositions of the revised MPI scales are described in Table 3.

Examination of Table 3 reveals that several MPI items that loaded on the Suffering factor during the initial factor analysis of the entire instrument were excluded during the process of creating revised MPI scales. Only three scales, rather than five, were identified for this factor. An initial EFA of the Suffering factor included a fourth scale that was a composite of the two original MPI scales entitled Affective Distress and Life Control. However, the internal consistency of this fourth scale was extremely poor (Cronbach’s \(\alpha = 0.26\)) and did not improve with the deletion of any single item. Therefore, the seven items from this scale were deleted (cf. Hair et al., 1987), and the EFA was repeated on the remaining 18 items of the Suffering factor to yield the scales indicated in Table 3.

A similar problem arose during the EFA of the Social Support factor. The internal consistency of the scale corresponding to the original Support scale was only 0.54. Item-by-item analysis indicated that internal consistency would be improved greatly with the deletion of Item 1 from Section II of the MPI. This item asks whether significant others respond to patients’ pain by ignoring them. Cronbach’s \(\alpha\) for the revised Support scale, minus Item 1 of Section II, was 0.81.

The three scales comprising the Suffering factor accounted for 52.7% of the total variance in the data. The first scale, Interference, was composed of the same items as the

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\(^1\)Factor matrices for EFAs of revised MPI sections are available from the first author upon request.
original Interference scale (Kerns et al., 1985). The second scale, Punishing Responses, retained three of the four items from the original Punishing Responses scale in Section II of the MPI. The third scale, Pain Severity, contained the three items comprising the original Pain Severity scale, as well as an item from Section I concerning pain interference during sleep.

Table 3 lists three scales for the Social Support factor, which accounted for 49.9% of the total variance. The first scale demonstrated significant loadings on items that dealt with significant others’ attentiveness to patients’ pain. It contained the same three items as the original MPI scale called Support, plus an additional item (Item 2) from MPI Section II concerning significant others’ offers of help to pain patients. The name Support was retained for this scale. The second scale, Solicitous Responses, retained five of the six items contained on the original Solicitous Responses scale. The third scale, Distracting Responses, contained three of the four items on the original scale of the same name.

In contrast to the original MPI model, only three scales, rather than four, were found for the Activity factor, accounting for 43.3% of the total variance. The first scale appeared to be a Recreation scale. It combined the original MPI scales for Activities Away from Home and Social Activities, and added an item that assessed frequency of sexual activity. The value of Cronbach’s α for this scale was 0.80. The second and third scales were identical in composition to the Household Chores and Outdoor Work scales created by Kerns et al. (1985).

Internal consistency values were calculated for the original MPI scales, as well as for the revised MPI scales that were derived empirically based on the factor analyses described above. The obtained reliabilities for the original MPI scales generally were within the expected range. Values for Cronbach’s α ranged from 0.64 on Scale 11 (Activities Away from Home) to 0.89 on Scale 2 (Interference). Reliabilities for the nine revised scales were good to excellent, ranging from 0.74 to 0.90.

Discussion

This study examined the psychometric structure of a widely used self-report instrument, the Multidimensional Pain Inventory (MPI). Multidimensional Pain Inventory responses from a large, heterogeneous sample of chronic pain patients were subjected to a series of exploratory factor analyses. Results indicate that the original description of the MPI factor structure needs to be modified. The current findings provide a more parsimonious factor model for this instrument.

An EFA of all 61 MPI items identified three latent factors that generally corresponded to the three original sections of the MPI. These factors were shown to be moderately correlated. As noted earlier, an inverse correlation was noted between the Suffering and Activity factors \((r = -.35)\), and a positive relationship was found between the Suffering and Social Support factors \((r = .11)\). Such relationships between factors have not been reported previously. The modest absolute values of the correlations suggest that the proper number of factors was identified.

The first construct underlying the MPI could be regarded as a Suffering factor, in keeping with Fordyce’s (1988) definition of suffering as “an affective or emotional response in the central nervous system, triggered by nociception or (sic) other aversive events, such as loss of a loved one, fear, or threat” (p. 278). The Pain Severity scale relates to nociception; the Interference and Punishing Responses scales concern emotional responses to pain that are elicited by aversive events.
Although the original Section II could be considered a Social Support factor, the scales comprising the empirically derived factor differ from those originally contained in Section II. The Support scale from MPI Section I loaded with scales from Section II. In addition, the Punishing Responses scale from Section II loaded significantly on the Suffering factor.

The original Section III of the MPI appears analogous to the empirically derived Activity factor. All of the MPI items that originally formed this section were retained in the present study, although some items were combined in new ways.

The second purpose of this study was to examine the internal consistencies of MPI scales in a large sample. All of the 12 original MPI scales possessed adequate-to-good internal consistency. Yet, four MPI scales were not retained in their original form during subsequent exploratory factor analyses.

Findings of the present study replicated those reported by Riley et al. (1999) regarding the Affective Distress and Life Control scales. The items for those scales loaded together, forming a single scale that was eliminated from subsequent analyses due to poor internal consistency. Because the factor structure of the MPI was improved by the deletion of those items, it appears that the Affective Distress and Life Control scales should not be used to measure psychological distress. Both of these issues conceptually are important in understanding the chronic pain experience. However, results of the present study indicate that these two constructs may not be measured adequately by the MPI.

The original scales for Social Activities and Activities Away from Home also loaded on a single scale; however, this newly formed Recreation scale demonstrated a higher degree of internal consistency than either of its component scales. The new Recreation scale also included an item assessing frequency of sexual activity, which previously was not incorporated in the MPI scoring system. The findings of the present study are similar to those of Naliboff, Cohen, Swanson, Bonebakker, and McArthur (1985), which identified recreation as an important topic to consider when assessing activity levels of chronic-pain patients. In addition, they replicate the results of Bernstein et al. (1995) and Riley et al. (1999), both of which reported that these scales tended to load together during factor analysis.

When the MPI was factor analyzed in its entirety, less than one-third of the total variance in the instrument was accounted for by its three sections. In addition, the scales from the Social Support and Activity factors accounted for less than half of their total variance. Scales from the Suffering factor did only slightly better, accounting for roughly 53% of their variance.

No information was given in the original description of the MPI concerning the amount of total variance accounted for by all items. That information also was not reported for MPI Section I (cf. Bernstein et al., 1995). Kerns et al. (1985) did state that 83.0% and 76.1% of variance was accounted for by Sections II and III, respectively. Results of the present study differ from earlier findings and suggest that less of the variance is accounted for than previously was believed.

Even with the creation of new sections (i.e., factors) composed of revised MPI scales, the amount of variance accounted for by each factor was generally ≤50%. Hair et al. (1987) suggested that, in the social sciences, a factor solution typically is deemed satisfactory when it accounts for at least 60% of the total variance. The results of the present study suggest that the content homogeneity of the MPI is somewhat inadequate. According to Golden et al. (1990), the results of a factor analysis depend on the nature of the items included in the analysis. Thus, it seems that the factorial purity of the MPI could be improved by the creation of new items that better represent the pain characteristics being assessed. Such changes also might increase the clinical utility of this instrument.
Study 2

Method

Participants. As described earlier, participants were a heterogeneous group of chronic pain patients who completed the MPI during a pre-treatment pain assessment. Data from respondents in Sample 2 were used during confirmatory factor analyses. Sample 3 data were used to cross-validate the revised MPI factor model that was generated through the previous analyses.

Procedures and Data Analysis. Confirmatory factor analysis (CFA) is a statistical technique to verify, or disprove, hypothetical relationships between constructs that are identified through exploratory factor analysis (Joreskog & Sorbom, 1988). In the present study, an initial CFA measured the adequacy of the original MPI model. Next, CFAs were conducted using three MPI latent factors that were identified by an exploratory factor analysis of all MPI items in Study 1. The first and second sets of analyses were conducted using MPI data from Sample 2 \( (n = 267) \). The third analysis, a CFA using data from Sample 3 \( (n = 253) \), was a cross-validation of the respecified model that was created during the second set of analyses. All CFAs were performed using the LISREL 7 module (Joreskog & Sorbom, 1988) of SPSS for Windows, Release 6.0 (Norusis, 1993).

The adequacy of each model initially was examined using the \( \chi^2 \) statistic for goodness-of-fit (Joreskog & Sorbom, 1988), with a nonsignificant result suggesting that the model correctly described relationships between observed variables (cf. Kerns et al., 1985). Yet, because the \( \chi^2 \) statistic is sensitive to large sample size, the possibility of a Type I error also increases (Fassinger, 1987). To address this problem, five additional measures were included to determine the viability of each model: the \( \chi^2/df \) estimate, the Goodness of Fit Index (GFI), the Adjusted Goodness of Fit Index (AGFI), the Root Mean Square Residual (RMSR), and the maximum modification index (MI).

A well-fitting model will yield a \( \chi^2/df \) ratio of \( \leq 3.0 \) (Kline, 1998; Lee & Robbins, 1995). Values for the GFI and AGFI should be \( \geq 0.90 \) in order to demonstrate a good fit between the observed data and the proposed model (Fassinger, 1987; Kline, 1998). In addition, if the proposed model accounts for the majority of the variance in the data, the value of the RMSR should closely approximate zero (Fassinger, 1987; Kline, 1998). Finally, an MI value of \( \leq 9.0 \) suggests that all significant paths between variables have been included in the model (Fassinger, 1987).

Results

Confirmatory Factor Analysis of Original MPI Model. Table 4 summarizes the findings of Study 2. Using data from Sample 2 \( (n = 267) \), a confirmatory factor analysis (CFA) was performed to verify the measurement model of the MPI that originally was proposed by Kerns et al. (1985). Figure 1 gives a pictorial representation of the original MPI model. Original MPI scales were allowed to load on the factors (i.e., sections) to which they previously were assigned. Otherwise, the three latent factors (Sections I, II, and III), 12 MPI scales, and error terms for the scales were assumed to be uncorrelated. To maintain consistency across subsequent analyses, a decision was made to use mean item–score totals for the 12 scales, rather than mean scale \( T \)-scores, as the observed variables in the model.

A correlation matrix for the 12 mean item–score totals was created. This matrix, as well as standard deviations for the 12 totals, were entered into LISREL 7 (Joreskog & Sorbom, 1988). The correlation matrix then was subjected to the maximum-likelihood
<table>
<thead>
<tr>
<th>Step</th>
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<th>Purpose</th>
<th>Scope of Analysis</th>
<th>Sample</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CFA of Original MPI Model</td>
<td>Examine for Goodness of Fit</td>
<td>3 Original MPI Sections, 12 Original MPI Scales</td>
<td>2</td>
<td>Inadequate Fit</td>
</tr>
<tr>
<td>2</td>
<td>CFA of Revised MPI Model, Based on EFA from Study 1</td>
<td>Examine for Goodness of Fit</td>
<td>3 MPI Latent Factors, 9 Revised MPI Scales</td>
<td>2</td>
<td>Improved Fit, but Still Inadequate</td>
</tr>
<tr>
<td>3</td>
<td>Exploratory Use of LISREL</td>
<td>Respecify Model to Improve Fit</td>
<td>3 MPI Latent Factors, 9 Revised MPI Scales</td>
<td>2</td>
<td>Good Fit</td>
</tr>
<tr>
<td>4</td>
<td>CFA of Respecified MPI Model, Based on Results of Step 3 from Study 2</td>
<td>Cross-validation</td>
<td>3 MPI Latent Factors, 9 Revised MPI Scales</td>
<td>3</td>
<td>Cross-validation Achieved</td>
</tr>
</tbody>
</table>

*Note. CFA = confirmatory factor analysis; MPI = Multidimensional Pain Inventory; Sample 2 \(n = 267\); Sample 3 \(n = 253\).*
method of parameter estimation (cf. Lee & Robbins, 1995; Rahim & Magner, 1995). Goodness-of-fit indices for the original MPI model were the following: $\chi^2 (51, n = 267) = 326.27, p < .001$; $\chi^2/df = 6.40$; GFI = 0.843; AGFI = 0.760; RMSR = 0.131; maximum MI = 62.58.

Figure 1. Original MPI model.

2 Correlation matrices, standard deviations, and maximum likelihood estimates of LISREL parameters that were used in CFAs of the original and revised MPI models can be obtained by contacting the first author.
The maximum MI for the original model indicated that a crossloading should have been specified between Scale 5 (Support) and Section II of the MPI. A crossloading represents a correlation between a measured variable (in this case, an MPI scale) and a latent factor other than the factor presumably being measured by that variable. Results of the initial CFA, based on the Kerns et al. (1985) model, pointed to a relationship between the Support scale from MPI Section I and the latent factor represented by MPI Section II.

An unexpected problem arose during this analysis. The maximum likelihood matrix of error terms for the original model did not achieve positive definite status; a negative value was obtained on the error term for the Solicitous Responses scale. According to Joreskog and Sorbom (1988, p. 211), such a finding indicates that the model is incorrect.

**Confirmatory Factor Analyses of Revised MPI Model.** These results suggested that the model proposed by Kerns et al. (1985) was inadequate. Therefore, another CFA was performed on Sample 2 data, using three latent factors and nine revised scales that were generated empirically through an EFA in Study 1. A correlation matrix and standard deviations for the means of the nine scale item-score totals were used to create a new model. Each revised MPI scale was permitted to load only on the factor to which it belonged, according to the findings of Study 1. Thus, the revised scales entitled Interference, Punishing Responses, and Pain Severity were specified as loading on the Suffering Factor. The Support, Solicitous Responses, and Distracting Responses scales were allowed to load on the Social Support Factor. Finally, the scales for Recreation, Household Chores, and Outdoor Work were permitted to load on the Activity Factor. Otherwise, the three latent factors, nine scales, and error terms were assumed uncorrelated. The maximum-likelihood method again was used to estimate relationships between parameters. Goodness-of-fit indices for the empirically generated model were as follows: $\chi^2(24, n = 267) = 93.47, p < .001, \chi^2/df = 3.89, GFI = 0.929, AGFI = 0.867, RMSR = 0.084$, maximum MI = 19.99. All matrices in the revised model achieved positive definite status. The maximum MI suggested that a crossloading should have been specified between the Punishing Responses scale and the Social Support factor.

Although the empirical model was an improvement over the model proposed by the authors of the MPI, it did not meet criteria for a truly well-fitting model. Modification indices suggested ways to adjust the model in order to improve the fit. At this point, LISREL was used in an exploratory fashion.

Through a series of CFAs, the empirical model was adjusted based on the modification indices that followed each analysis. Each respecification allowed a correlation between two previously uncorrelated parameters. The change in $\chi^2$ value was examined following each adjustment until a nonsignificant difference was obtained. Four CFAs were required to achieve this result. A crossloading now was permitted between the Suffering factor and the Recreation scale. In addition, crossloadings were allowed between the Social Support factor and the scales for Punishing Responses, Recreation, and Household Chores. Goodness-of-fit indices for the respecified model included the following: $\chi^2(20, n = 267) = 51.80 (p = .000), \chi^2/df = 2.59, GFI = 0.958, AGFI = 0.906, RMSR = 0.043$, maximum MI = 3.29. All matrices were positive definite.

The $\phi$ matrix generated during CFA indicated weak relationships between the three latent factors. This result supports the findings of the earlier EFA, in which an oblique solution was found to best describe the observed data.

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3The respecification table for the revised MPI model is available through the first author.
Cross-validation of Revised MPI Model. Data from Sample 3 \((n = 253)\) were used in a confirmatory factor analysis to cross-validate the respecified model that was derived using Sample 2 data. As before, a correlation matrix and standard deviations from the means of the nine scale item-score totals were entered into the LISREL program. Each revised scale was allowed to load on its appropriate factor. Other parameters were assumed uncorrelated with the following exceptions: crossloadings were specified between the Suffering factor and the Recreation scale, and between the Social Support factor and the Punishing Responses, Recreation, and Household Chores scales.

The resulting goodness-of-fit indices for the cross-validation were as follows: \(\chi^2(20, n = 253) = 41.04, p = .004; \chi^2/df = 2.05; \text{GFI} = 0.966; \text{AGFI} = 0.923; \text{RSMR} = 0.050; \text{maximum MI} = 8.75\). All matrices were positive definite. These results demonstrate that cross-validation was achieved. The cross-validated model, representing the psychometric structure of the MPI, is depicted in Figure 2. As shown in Figure 2, moderate relationships between latent factors again were observed.

Discussion

Study 2 examined the adequacy of the factor model that originally was reported for the Multidimensional Pain Inventory. MPI responses from two large, heterogeneous, demographically equivalent samples of chronic pain patients were subjected to a series of confirmatory factor analyses.

The cross-validated MPI model differed in several respects from the MPI factor structure described by Kerns et al. (1985). In the revised model, two of the original MPI scales (Affective Distress and Life Control) were eliminated. Two other scales, Social Activities and Activities Away from Home, combined to form a single scale. Differences between the original and revised MPI models also can be seen in the pattern of scale loadings on MPI factors. This study indicates that the Punishing Responses scale, originally assumed to belong to Section II of the MPI, fits better with the Suffering factor (analogous to MPI Section I). In addition, the Support scale from MPI Section I more appropriately belongs to the Social Support factor (corresponding to MPI Section II).

The demonstration of cross-validation for the new model of the MPI is an important component of this study. Cross-validation presents evidence that the newly derived factor structure is stable and not merely an artifact of a particular group of respondents (Golden et al., 1990; Smith & McCarthy, 1995). Fassinger (1987) noted that, although cross-validation should be the final step when testing the adequacy of a model, it rarely is performed due to lack of participant availability. The large sample that initially was available for this research afforded the opportunity to develop a new MPI model using one group of respondents, and to test the model on another group.

General Discussion

The limitations of factor analysis should be kept in mind when considering the findings of these studies. Latent factors are nothing more than theoretical constructs derived using a particular set of questionnaire items. Other questionnaires, or other assessment methods, may lead to the identification of different constructs associated with chronic pain (Gamsa, 1994). Similarly, the proper use of LISREL strongly depends on sound, a priori theoretical assumptions. It is possible that, using these data with different conceptualizations about the psychological components of chronic pain, other factor models might fit equally well (cf. Dillon & Goldstein, 1984).
Another limitation of these studies is the restricted amount of information about demographic variables. Because archival data were used in this study, demographic information that was not recorded directly on the MPI protocols generally was unavailable. The current version of the MPI (Rudy, 1989) provides space for respondents to indicate their gender, age, site of pain, and duration of pain. Other variables that may be relevant to chronic pain, such as ethnicity, marital status, and socioeconomic status (cf. Clark & Yang, 1983; Craig, Prkacin, & Grunau, 1992; Gamsa, 1994; Golden et al., 1990; Kerns et al., 1990; Sue, 1991), are not assessed by this instrument. Failure to include a question about marital status particularly is surprising, as Section II of the MPI deals with significant others' behaviors toward chronic pain patients.

A final limitation that should be mentioned is the exclusion of 23% of the original database, due to missing responses for three or more MPI items. Different results might have been obtained had these additional data been included in the analyses.

Figure 2. Cross-validated revised MPI model.
Despite these limitations, the findings of these studies reveal differences from the previously reported factor structure of the MPI. Several recommendations for future research can be made. First, future studies of the MPI should include more detailed descriptions of participants so as to explore whether demographic differences have any impact on its psychometric structure (cf. Rohling, Binder, & Langhinrichsen-Rohling, 1995). To make such analyses possible, the present version of the MPI will need to be modified by including questions about respondents’ racial, marital, and socioeconomic status.

Second, further refinement of the MPI appears warranted based on the present findings. Items from the Affective Distress and Life Control scales should either be eliminated or revised to form scales that are more valid. Also, new items should be created and added to very brief scales (e.g., Punishing Responses, presently composed of only three items) to improve scale reliability.

Third, summary scores need to be created for the revised MPI factors. The MPI in its present form includes a summary scale for Section III only. A thirteenth scale, entitled General Activity Level, is a composite of the four scales contained in Section III. The value of the General Activity Level is calculated by averaging the raw scores for the Household Chores, Outdoor Work, Activities Away from Home, and Social Activities scales. However, no comparable summary scores exist for Sections I and II of the MPI.

Study 2 demonstrated that the empirically derived Activity factor, with its revised scales, produces a better fit for MPI data than the original Section III of the MPI. Therefore, a new composite score should be created for the Activity factor based on the information obtained from the revised Activity scales. Summary scores likewise should be created for the Suffering and Social Support factors. Using a composite score for the Suffering factor would be preferable to relying on the Affective Distress and Life Control scales currently included in the MPI.

A final problem with the MPI in its present format concerns the lack of validity scales. The current instrument does not include a method to detect response bias. Using the MPI computer program (Rudy, 1989, p. 33), random or exaggerated responding might be classified as an “anomalous” profile. However, Rudy (1989) also recognized that some valid but unusual profiles might be misclassified as anomalous. A recent study (Bruehl, Lofland, Sherman, & Carlson, 1998) presented a preliminary, empirically derived scale to correct this oversight.

Although the current version of the MPI provides valuable information about psychosocial aspects of pain, its utility could be enhanced through alterations to account for the findings of this study. As new items, scales, and summary scores are added to the MPI, further studies will be needed to identify changes in the psychometric structure of this questionnaire. Modifications also will be needed in the MPI computer-scoring program (Rudy, 1989) to reflect changes in the structure of the instrument. Finally, the revised model of the MPI needs to be tested clinically to determine whether the revised scales permit more accurate classification of chronic pain patients.

References


