A Critical Review of the Literature on Kolb's Learning Style Inventory with Implications for Score Reliability.

Researchers identified 110 articles that used the LSI. Fifty-nine articles made no mention of reliability, and slightly fewer than a third of these reported reliability for the obtained scores appropriately. Findings indicate that continued use of the LSI should be considered questionable. Reliabilities can vary as researchers administer the instrument across different settings. Thus reliability generalization may be warranted to examine score reliability meta-analytically across studies. Based on the work of L. Vacha-Haase, this study discusses the possibility of examining the variance of measurement error across studies as part of the literature review. (Contains 2 tables and 68 references.) (Author/SLD)
A Critical review of the Literature on Kolb's Learning Style Inventory with Implications for Score Reliability

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Abstract
The Learning Style Inventory (LSI) is a commonly employed measure of learning styles based on Kolb's Experiential Learning Model. Nevertheless, the psychometric soundness of LSI scores has historically been critiqued. The present article reviews the literature and critically evaluates the psychometric properties of Kolb's original and revised versions of LSI. Reliabilities can vary as researchers administer the instrument across different settings. Thus, reliability generalization (RG) may be warranted to meta-analytically examine score reliability across studies. Based on Vacha-Haase (1998), this study will discuss the possibility of examining the variance of measurement error across studies as part of the literature review.
The study of individual learners’ preferences or styles is an appealing concept for educators (cf., De Bello, 1990). Many researchers make an *a priori* assumption that learning style is measurable (e.g., Cross, 1976; Keefe, 1979), and a number of theories and resulting instruments have been developed (De Bello, 1990). Researchers have used these theoretical frameworks and inventories in diverse disciplines and have attempted to correlate learning style or preference with many other variables (Geller, 1979).

**Kolb’s Experiential Learning Model (ELM)**

Historically, one of the more popular theoretical models of learning style has been Kolb’s (1976) ELM. The ELM depicts learning as a cyclic process involving four modes: (a) concrete experience (CE), (b) reflective observation (RO), (c) abstract conceptualization (AC), and (d) active experimentation (AE). According to the theory, the effective learner typically participates in new experiences (CE) and then reflects upon these experiences (RO) in order to develop informal theories (AC). Then, the learner uses these theories to make decisions or solve problems (AE).

Kolb (1976) further proposed that CE and AC, as well as RO and AE, represented polarized abilities that lie on different
Kolb's LSI

ends of a continuum. These two dimensions were also hypothesized to be orthogonal. Although the ideal learner integrates and utilizes all four abilities, the average learner favors one ability on each dimension. Consequently, from the combination of an individual's ability on abstractness over concreteness (AC-CE) and action over reflection (AE-RO), an individual is assigned to one of four learning styles: (a) Assimilator (AC and RO), (b) Converger (AC and AE), (c) Accommodator (CE and AE), or (d) Diverger (CE and RO). The reader is referred to Atkinson (1991), Kolb (1974, 1976, 1985), and Pickworth and Schoeman (2000) for broader discussions of the ELM.

The Learning Styles Inventory (LSI)

To operationalize his theory, Kolb (1976, 1985) developed the LSI as a measure of learning style, which enabled the classification of individuals into of the four dominant styles noted above. The LSI is one of the more commonly used instruments in this area continues to be employed in recent years (cf. Chou & Wang, 1999; Geiger & Boyle, 1992; Yuen & Lee, 1994).

Based largely on the work of Kolb himself, Geller (1979) noted that even early on:

The inventory has been used to examine relationship between
learning style and age (Kolb, 1971, 1976), sex (Kolb, 1976), educational level (Kolb, 1971, 1976), undergraduate major (Kolb, 1971, 1974, 1976), creativity (Kolb, 1976), personality (Kolb, 1976), occupation (Kolb, 1971, 1976), career choice (Kolb, 1976; Kolb & Fry, 1974; Plovnick, 1975; Sadler, Plovnick, & Snope, 1978; Wunderlich & Gjerde, 1978), career-choice influences (Plovnick, 1975; Wunderlich & Gjerde, 1978), approach to management education (Kolb, 1974), creating and maintaining an effective learning organization (Kolb, Rubin, & McIntyre, 1971), communication among different functional units in an organization (Kolb, 1974), and preference for a particular instructional method or learning situation (Kolb, 1976; Sadler, Plovnick, & Snope, 1978; Whitney & Caplan, 1978). (p. 556)

With a more recent revision of the LSI (Kolb, 1985), the inventory has enjoyed a relatively long tenure of use. However, as noted below, the LSI has also been severely criticized regarding its psychometric properties.

Original/revised versions of the LSI

The first formal version of the LSI appeared in 1976 (Kolb, 1976); the inventory was revised in 1985 (Kolb, 1985). The original LSI (1976) consisted of nine items of four words representing each experiential style. Respondents rank order their preferences concerning the four words in each row that
corresponded to Kolb’s four learning styles: CE, RO, AC, and AE. The original LSI used only six items in each column and three items per column served as distracters and were omitted from scoring.

The 1976 version was subject to psychometric critique that largely centered poor score reliability (see e.g., Geller, 1979; Wilson, 1986). Kolb (1985) therefore revised the format and scoring of the instrument, resulting in twelve rows of four sentence completion items that related to the four learning styles. Respondents again rank order their preferences on the four sentences in each row from 1 to 4. Unlike the prior version, all 12 items are used in scoring with no distracters. Further, each column represents a single style (i.e., CE, RO, AE, AC), leading some to suggest the risk of a response-set bias (Atkinson, 1988, 1989; Ruble & Stout, 1990, 1991; Sims, Veres, Watson, & Buckner, 1986; Veres, Sims, & Shake, 1987).

In spite of apparent face validity and frequency of use, both versions of the LSI have been attacked as regards the validity and reliability of their scores. Previous measurement studies have addressed several psychometric problems such as the use of ipsative scoring (cf. Merritt & Marshall, 1984), questionable factor structure (cf. Geiger, Boyle, & Pinto, 1992, 1993), response-set bias (cf. Ruble & Stout, 1994), and reliability and validity (cf. Atkinson, 1991).
Issues with ipsativity

Cattell (1944) coined the term "ipsative", referring to "measures that can be meaningfully interpreted intraindividually, as contrasted with 'normative' measures that can be interpreted interindividually" (Pedhazur & Schmelkin, 1991, p. 21). Essentially, ipsative measures require respondents to rank order responses, thus representing ordinal data that does not contain information regarding magnitude between observations. Both versions of the LSI use a rank order format for rating preferences for words (1976) or sentences (1985).

Importantly, the ranking is not an ordering of individuals on a trait (e.g., highest in concreteness, next, and so on), but rather is performed within the individual as respondents rank sets of items (i.e., CE, RO, AE, AC) from 1 to 4. Accordingly, responses to one item will necessarily be dependent on responses to other items in the set. Furthermore, the ipsative nature of this ranking creates artifactual negative correlations among measured attributes, because when a person ranks one attribute as 1, other attribute ranks must be higher than 1. Of course, the converse of this would be true as well, creating a situation where low scores on one attribute tend to correspond to higher scores on the other attribute. Table 1 provides a heuristic example (adapted from Cornwell and Dunlap [1994, p. 91]) of this problem for five subjects across the four scales in the LSI and...
illustrates the tendency for the negative interdependence of the correlations.

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INSERT TABLE 1 ABOUT HERE

Reliability Issues

Because ipsative scores are interdependent, they have limited value for many psychometric purposes. As noted, artifactual negative interdependence is a function of the scoring method. This limits the factorability of ipsative scores and can yield artificial bipolar factors, such as those proposed by Kolb (1976, 1985) (i.e., AC-CE and AE-RO). Accordingly, the validity of LSI scores has been questioned (Atkinson, 1991; Cornwell, Manfredo, & Dunlap, 1991; Ruble & Stout, 1994; Wilson, 1986). Cornwell and Dunlap (1994) and Hicks (1970) provide useful summaries of the limitations of ipsative scores.

Importantly, the 1976 LSI did not use all items in the final scoring due to the inclusion of distracters; the 1985 LSI scored all items. Some authors have therefore characterized the 1976 version as partially ipsative and the 1985 version as completely ipsative (cf. Ruble & Stout, 1994). Logically, the negative interdependence noted above would be most pronounced in fully ipsative data (Hicks, 1970).

The LSI has also been challenged on reliability grounds. Atkinson (1991), Geller (1979), Pickworth and Schoeman (2000),
Ruble and Stout (1990, 1994), Sims et al. (1986), and others have discussed the historical reliability of LSI scores for both versions. The notable number of published psychometric reviews speaks to both the wide use of the LSI and the debate surrounding its measurement quality.

The 1976 LSI appeared to yield scores with marginal internal consistency and poor test-retest reliability. Scores from the 1985 LSI appeared to have stronger, perhaps acceptable, internal consistency but continued to have poor, perhaps even worse, temporal stability. However, the interpretation of LSI score reliabilities is confounded with the ipsative nature of the scoring. Tenopyr (1988) demonstrated the artifactual reliability possible for multiple forced choice scales. Ruble and Stout (1994) further argued that the internal consistency improvement for 1985 LSI scores was inflated due to the fully ipsative nature of the scoring, as against the 1976 version which was only partially ipsative.

Another possible reason for reliability inflation in 1985 LSI scores is response bias (Atkinson, 1991; Sims et al., 1986; Wilson, 1986). For the LSI, response bias may be caused by the simplified scoring format for the same learning mode in the same column. Wilson (1986) examined this possibility with three different LSI versions: standard items, randomized items, and elaborated items. Wilson noted that the randomized and
elaborated versions produced less reliable scores than the standard version for both test-retest stability and internal consistency. He suggested that correlation for standard version might be inflated by response bias.

Validity Issues

Several studies have assessed construct validity of LSI scores using factor analysis. Factor analysis examines the internal structure of an instrument, which is relevant to the assessment of construct validity (Nunnally & Burstein, 1994; Thompson & Daniel, 1996). Kerlinger suggested that the misunderstanding of ipsative measures might lead to false interpretation of factor analysis. The ipsative format of the LSI can cause spurious negative correlations among the items and distort factor analysis results.

Kolb (1976b) proposed a bipolar two-factor structure in his ELM. Extant factor analytic studies provide confused results about these bipolar dimensions in the LSI. Given Kolb’s theory, factor analysis should not extract four distinct factors (i.e., one for each style) but two orthogonal factors (i.e., one for each dimension). The extraction of four distinct factors suggests that the learning abilities are independent. Unless the two bipolar factors are the result of spurious negative intercorrelations caused by ipsative scales, a two-factor
solution would support two bipolar dimensions of learning proposed by the ELM while four independent factors would not.

Certo and Lamb (1980) compared the ipsative scales with normative (Likert) scales in their study. The ipsative version provided a two-factor structure, but the normative version did not. Further, Merritt and Marshall (1984) found a four-factor structure with the normative instrument, rather than the two bipolar dimensions posited by the ELM. They concluded that the normative form supports construct validity of the LSI.

Cornwell, Manfredo, and Dunlap (1991) provided both two-factor and four-factor solutions, with results unsupportive of Kolb's two bipolar dimensions. Geiger, Boyle, and Pinto (1992) also provided two-factor and four-factor solutions. In the two-factor solution, CE and RO items tended to weight together, as did AC and AE items. In the four-factor solution,

Geiger, Boyle, and Pinto (1993) used the standard LSI (ipsative format) of the 1985 version and a modified version (normative format). In the two-factor structure, CE items and RO items tended to weight together, while AC items and AE items tended to weight together. In the four-factor structure, only the AC items weighted as a distinct factor. Their results did not support the hypothesized bipolar dimensions.

According to the bipolar assumptions of the ELM, the opposite scales (i.e., CE with AC and RO with AE) should have
strong negative correlations with each other and the orthogonal ("not-opposite") scales (i.e., CE with RO, AE with AC, CE with AE, and RO with AC) should have zero (or near zero) correlations. However, previous studies have observed negative correlations of a given style with other "non-opposite" styles (Highhouse & Doverspike, 1987; Ruble & Stout, 1990; Smith & Kolb, 1986). Thus, the pattern of intercorrelations of scores from the revised 1985 version of the LSI tends not to support the bipolar structure of the ELM.

Implications for Score Reliability

Although several reviews exist that examine the reliability of LSI scores, most reviews do not simultaneously address differences in score reliabilities from both versions of the LSI as well as other modified versions. Further, none of the reviews identified study features that may be predictive of reliability variation across studies. We therefore examined the extant literature using the LSI to characterize the variation of measurement error across administrations of the LSI.

Method

Sample of Articles

Searches of the ERIC and PsycINFO databases using the keywords "Learning Style Inventory" and "LSI" were conducted. Only published articles were retained which left 127 ERIC and 199 PsycINFO articles. After eliminating duplicates between the
databases, 290 articles remained, of which 174 were false hits (i.e., did not address the LSI) and 11 were theoretical. These were also eliminated leaving 105 articles. An additional five articles were added to this pool as a result of secondary identification of articles by backtracking references in the articles originally noted in the database searches. This left a final pool of 110 articles that employed the LSI. Each article was read and placed into one of several categories.

Fifty-nine (53.6%) articles made no mention of reliability. Fifteen (13.6%) articles "inducted" (Vacha-Haase, Kogan, & Thompson, 2000) reliabilities by citing coefficients from prior studies or the test manual. Two articles reported reliability for data in hand but not in a usable format (e.g., reported a range of coefficients). A little less than a third (n=34, 30.9%) of the articles appropriately reported reliability for the obtained scores. However, many of these articles reported multiple reliability estimates, leaving a sample of 206 internal consistency and 182 test-retest coefficients across the various subscales and dimensions of the LSI.

Reliability generalization

Reliability generalization (RG) is a meta-analytic technique to characterize (a) the measurement error variance for a given test across studies, (b) the amount of variability in reliability coefficients for given measures, and (c) the sources
of variability in reliability coefficients across studies (Vacha-Haase, 1998). The present paper only examined variability of reliability estimates across studies. Study features that are predictive of reliability variation are reported elsewhere (Henson & Hwang, in press).

Results and discussion

Descriptive statistics (see Table 2) indicated considerably larger mean coefficient alphas for the 1985 version scores as compared to scores on the original 1976 form. For test-retest reliability, however, the 1985 form scores performed slightly worse than those from the 1976 test, and 1985 revisions yielded scores that did much better. These findings are consistent with prior studies (cf. Atkinson, 1991; Geller, 1979; Pickworth & Schoeman, 2000; Ruble & Stout, 1990, 1994; Sims et al., 1986).

It is clear that the 1985 version of the LSI yielded more reliable scores as regards internal consistency. However, scores from the revision gave slightly lower test-retest coefficients. Thus, the apparent improvement in internal consistency was not matched by a corresponding improvement in temporal stability. As the standard deviations in Table 2 demonstrate, the measurement error possible in LSI scores can be considerable.

At a minimum, researchers ought to examine reliability for their LSI scores and interpret effects in light of reliability (Wilkinson & APA Task Force on Statistical Inference, 1999).
However, the lack of reliability in LSI scores is substantial enough to warrant either (a) discontinuation of use or (b) considerable revision of the instrument. Indeed, several authors have called for the abolition of the LSI due to its psychometric infirmities (see e.g., Atkinson, 1991; DeCoux, 1990; Ruble & Stout, 1994).

The current results, however, suggest that some promise may be found in studies (cf. Pickworth & Schoeman, 2000) revising the 1985 form in various ways (e.g., use of normative rather than ipsative scaling). The mean score reliabilities for the 1985 revisions (see Table 3) are marginal for internal consistency (although much improved over the 1976 form) and strong for temporal stability. Perhaps the future of the LSI lies with continued revision. The current results would indicate that the LSI's past is sufficiently storied to preclude future use, particularly when one considers that reliability is a necessary but insufficient condition for validity.

In sum, the current findings indicate that continued use of the LSI should be considered questionable at best. Despite prior psychometric reviews with similar outcomes (Atkinson, 1991; Ruble & Stout, 1990, 1994), the LSI has enjoyed continued use in the literature. As explained by Atkinson (1991):

Considering the popularity of the instrument, face validity may have been what has kept practitioners and researchers
returning to the LSI. While authors like Freedman and Stumpf (1980) acknowledged the face validity of the LSI, they proposed, as did others, that what meets the eye may be less than the beholder suspects. ...Continued
applications of the LSI-1985 seem warranted for dialogic, rather than diagnostic, purposes as long as the user is mindful and open about the instrument's apparent limitations. ...Heretofore, it seems face validity has been the saving grace of the LSI... (pp. 158-159, italics in original)

Unfortunately for the LSI, face validity is insufficient psychometric evidence for most applications.
References

References marked with an asterisk (*) were used in the review.


Hicks, L. E. (1970). Some properties of ipsative, normative, and


Inventory II. *Educational and Psychological Measurement*, 49, 227-233.


Improving the reliability of Kolb's revised Learning Style Inventory. *Educational and Psychological Measurement*, 51, 143-150.


Table 1

**Illustrative Responses and Scale Intercorrelations for Five Subjects on LSI Scales.**

<table>
<thead>
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<th>Subject No.</th>
<th>Ipssative Rankings</th>
<th>Correlations</th>
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<td>Scale</td>
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<td></td>
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<td>1.</td>
<td>1  2  3  4</td>
<td>CE  1.00</td>
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<tr>
<td>2.</td>
<td>2  1  4  3</td>
<td>RO  -.84  1.00</td>
</tr>
<tr>
<td>3.</td>
<td>3  1  2  4</td>
<td>AE  -.28  .00  1.00</td>
</tr>
<tr>
<td>4.</td>
<td>1  3  2  4</td>
<td>AC  .25  -.28  -.84  1.00</td>
</tr>
<tr>
<td>5.</td>
<td>1  3  4  2</td>
<td></td>
</tr>
</tbody>
</table>

Note. Subject responses are ranked, 1 to 4, across the four attributes.
Table 2

Descriptive Statistics for Coefficient alpha and Test-retest Reliabilities for Various Test Forms by LSI Subscale.

<table>
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<th>1976 version</th>
<th>1985 version</th>
<th>revised 1985 version</th>
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<td>.420</td>
<td>.809</td>
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<td>.090</td>
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<td><strong>Reflective Observation</strong></td>
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