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The meaning and measurement of self-complexity

Eshkol Rafaeli-Mor[a]*, Ian H. Gotlib[b], William Revelle[a]

[a]Psychology Department, Northwestern University, Swift Hall 102, 2029 Sheridan Road, Evanston, IL 60208-52710, USA
[b]Stanford University, USA

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Abstract

The self-complexity (SC) theory is a structural model of self-knowledge that suggests individual differences in the complexity of knowledge about the self are predictive of emotional stability and reactivity to stress. Various studies have identified problems concerning the consistency, reliability and validity of the often used measure of SC, the dimensionality statistic (H; Scott, 1969). Addressing these issues, the present study proposes 2 alternative measures of the components of SC and examines psychometric properties of these measures. Results of this study indicate a lack of a general factor underlying the dimensionality statistic. In addition, they offer support for the benefit of distinguishing between 2 components of self-complexity: quantity of self-aspects and overlap among them. © 1999 Elsevier Science Ltd. All rights reserved.

1. Introduction

The self has long been of great interest to psychologists, first appearing prominently in the writings of James (1890). James distinguished between two notions: "the self as known" and "the self as knower", which he, respectively, termed "the me" and "the I". Recently, James's terms have been 'translated' into modern cognitive terms (Linville & Carlston, 1994); the notion of 'known self' is conceptualized as the *declarative knowledge* we have about ourselves, whereas the notion of 'the knower self' is conceptualized as *procedural knowledge* that directs our actions, thoughts and feelings. The analysis of the cognitive-informational nature of the self (e.g. Klein & Loftus, 1993) falls mostly within the realm of declarative self-knowledge (Linville & Carlston, 1994), with studies focusing on the content and the structure of this knowledge. Thus, from the pioneering work of Kelly (1955) to more recent social-cognitive studies of the self (e.g. Markus & Wurf, 1987; Klein & Loftus, 1993), the self has been discussed as the organized set of knowledge that is acquired by each person about himself or herself.

Investigation of any knowledge structure or set naturally includes attention to the content of

*Corresponding author. E-mail: eshkol@nwu.edu

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this set. Accordingly, research on the self as a knowledge structure first examined the content of self-knowledge (Markus & Wurf, 1987). Studies of the cognitive content of the self explore the declarative or the evaluative components of the self-concept (Campbell et al., 1996). One example of a focus on cognitive content is the attention given to the positive or negative valence of self-knowledge; this focus has been central for investigators examining the construct of self-esteem (e.g. Rosenberg, 1965). Another example is the focus on the specific beliefs about one self that may differentiate depressed and non-depressed individuals (e.g. Beck, Rush, Shaw & Emery, 1979).

Until two decades ago, the empirical study of the self was limited to questions concerning content. This content focus was due to the prevailing view of the self-concept as unitary (e.g. Rogers, 1951; Allport, 1955). This view gave rise to a large body of research examining self-esteem "..which assumed that people have a single, global self-concept about which they feel good or bad" (Linville & Carlston, 1994). Newer alternative structural models of the self draw on the general trends within psychology (e.g. Markus & Wurf, 1987) and sociology (e.g. Thoits, 1983) that see the self as multi-faceted rather than as unitary. Although psychologists (e.g. James, 1890; Kelly, 1955) and symbolic interactionists (e.g. Mead, 1934) have long favored such a multi-faceted approach, it was only with the advent of social-cognitive theory and methodology that the empirical study of a multi-dimensional self began (cf. Markus & Wurf, 1987). Consequently, self researchers began attending not only to the content of the knowledge but also to its structure, exploring self-knowledge as the multi-faceted set of information it is assumed to be.

Studies of structural properties of the self "... refer to how the knowledge components or specific self-beliefs are organized" (Campbell et al., 1996, p. 141). The last decade has brought a host of proposed structural characteristics of self-knowledge, and of studies examining these characteristics. For example, Linville (1985, 1987) coined the term *self-complexity* (SC), which she operationalized as the dimensionality underlying the self-concept. Showers (1992) discussed the property of *compartmentalization*, or the degree to which one uses partitioning of differently valenced self-knowledge into distinct categories. Donahue, Robins, Roberts and John (1993) have examined the integration of self-dimensions. Finally, Higgins and his colleagues (e.g. Higgins, Bond, Klein & Strauman, 1986; Strauman & Higgins, 1987) have explored *self-discrepancies*, or the degree to which the real-self diverges from the ideal-self or the ought-self.

In accord with a social-cognitive view of the self (Markus & Wurf, 1987), Linville's (1985) model of SC assumes that the self is composed of multiple aspects. These aspects can include social roles, relationships, goals, future and past selves and so on. The SC model posits that there are individual differences in the number of such self-aspects. It also posits individual differences in the extent to which each of these self-aspects overlaps with other self-aspects with respect to content or characteristics. Thus, Linville's SC model suggests that there are individual differences in both the number of self-aspects and the degree to which they overlap.

Linville's earlier work on in-group heterogeneity and out-group homogeneity (e.g. Linville & Jones, 1980; Linville, 1982) led her to conclude that complex (i.e. heterogeneous) concepts evoke more moderate affective reactions or evaluative judgments, whereas concepts that are more simplistic (i.e. homogeneous) evoke evaluations and reactions that are more extreme. For example, Linville (1982) found that the extremity of ratings of both favorable and unfavorable vignettes about an elderly target was significantly and negatively correlated with the complexity of the rater's concept of 'elderly males'. In two subsequent influential papers, Linville (1985, 1987) offered evidence for the existence of this type of complexity effect in the field of self-knowledge or self-concept. In a two-week mood-diary study, Linville (1985) found that participants whose self-concept was more complex did not differ from participants whose self-concept was less complex with respect to average mood rating, but did differ in the variance of their moods: participants who were higher in self-complexity had less variable moods.

Linville (1985, 1987) suggested that these effects of complexity on mood or affective extremity could be explained by two emotional mechanisms that stem from individual differences in complexity. Specifically, these mechanisms reflect the two components of SC: *quantity* of self-aspects and *overlap* among them. First, Linville (1985) assumed that when a person experiences a stressful event, it affects the self-aspect that is most pertinent to the stressor. She argued that for a person with numerous self-aspects (high *quantity*), the affected self-aspect is but one of many aspects and, therefore, that a relatively small proportion of the 'total' self is affected. In contrast, a stressor will affect a great proportion of the self in persons who have fewer aspects in their self-concept. Thus, greater quantity is one mechanism that moderates the impact of stressors.

Individuals can also differ in the degree to which they maintain distinctions among their various self-aspects. Linville (1987, p. 664) posited that higher overlap (and thus, lesser distinction) allows for a spill-over effect: "feelings and inferences associated with the originally activated self-aspect spill over and color feelings and inferences regarding associated self-aspects". A stressor that affects one self-aspect will initiate a process of spill-over of activation to overlapping self-aspects; it cannot do so, however, if no overlapping aspects exist. Thus, little or no overlap is a second moderator of the impact of stressors. Defining SC as the confluence of high quantity of self-aspects and low overlap among them, Linville (1987) suggested that SC serves as a buffer against stress-related illness and depression. Indeed, she proposed its antithesis, *self-simplicity*, as a diathesis for such ailments or disorders.

Linville (1985, 1987) operationalized the SC construct using a trait-sorting task. In this task, participants are instructed to sort a set of trait words into meaningful categories or groups, such that each group consists of those traits that are descriptive of the participant in some aspect of his or her life. The choice of categories is therefore idiosyncratic, as is each individual's sorting of the traits into these categories. An individual's SC score (SC-D) is then computed using the dimensionality statistic, H (Attneave, 1959; Scott, 1969; see Appendix A for a detailed explanation of this measure). Scott proposed this statistic as a measure of the number of dimensions a person uses to describe a knowledge domain, in this case the domain of one's knowledge about oneself.

Several studies have used SC-D to test the predictions of the Linville (1987) SC theory. In particular, studies have investigated the role of self-simplicity, or low SC, as a possible diathesis for stress-related depression. Because of the two mechanisms discussed above, the proportion of aspects that are affected by a stressor and the magnitude of the spill-over of activation among the aspects, SC theory posits that individuals who are more complex should be buffered against strong reactivity to stress. In contrast, individuals who have a cognitively simpler concept of themselves should exhibit more extreme reactions to stressors or negative events.

Although the Linville (1985) mood diary study demonstrated the cognitive simplicity–affective extremity effect, it was her subsequent study (Linville, 1987), adopting the more appropriate prospective panel design (cf. Barnett & Gotlib, 1988), that gave the most support to SC theory. The study found the hypothesized buffering effect of SC; the impact of an accumulation of stressors on stress-related physical and psychological distress, controlling for earlier symptoms, was moderated by high levels of self-concept dimensionality (Linville, 1987). Other investigators (e.g. Dixon & Baumeister, 1991; Niedenthal, Setterlund & Wherry, 1992; Kalthoff & Neimeyer, 1993, study 1) have reached similar conclusions regarding the predictive validity of dimensionality. (Note that two other studies by Kalthoff and Neimeyer (1992, studies 2 and 3) failed to support Linville's claims when using conceptually similar methodologies).

Nevertheless, several attempts to replicate the Linville (1987) findings have failed to support the conclusion that low SC is a diathesis for depression. These studies have identified limitations in the validity, the reliability, or the internal consistency of the SC construct as it has been operationalized by Linville. For example, the validity of Linville's SC-D measure and of the SC construct were called into question by the findings of both Koenig (1989) and Hershberger (1990). Using prospective panel designs similar to that used by Linville (1987), these studies failed to find the buffering effect of SC on the level of depressive symptoms experienced after exposure to a stressor. Such failures to replicate raise questions concerning the predictive validity of self-simplicity as a diathesis for depression.

The reliability of SC-D has been challenged by the findings of several studies. Salovey (1992) has shown SC-D to be susceptible to both negative and positive affective states. In addition, Salovey explicitly used SC-D as a measure of the (temporary) state of self-focused attention. Showers (1992) found the SC-D score to vary with different compositions of the trait-word lists supplied to the participant, in the same self-descriptive sorting task conducted by Linville (1985, 1987). Hence, the Linville (1985) SC-D measure may simply be unreliable, reflecting fluctuations of mood or of self-focused attention (Salovey, 1992) rather than assessing a stable individual difference in the structure of self-knowledge. Although Linville (1987) herself reported a relative temporal stability (test–retest $r = 0.7$), these studies raise concerns about Linville's claims of dispositional individual differences on the SC construct.

Last and most detrimental are the findings of several studies that call into question the internal consistency of the Linville (1987) measure, SC-D, and the degree to which it actually reflects a single latent property (i.e. the complexity of the self-concept structure). Contrary to Linville's claim of such a single latent property, several investigators have found poor internal consistency for SC-D and have argued for the existence of at least two latent factors. For example, Woolfolk, Novolany, Gara, Allen & Polino (1995) found the dimensionality of positive self-knowledge to differ from that of negative self-knowledge. In their study, measures of 'positive-SC' and 'negative-SC' were computed, each reflecting the dimensionality of knowledge of one valence while ignoring the information of the other valence. The two measures were found to play different roles in participants' reactivity to stress. In fact, Woolfolk et al. found the complexity of negative knowledge to be positively, not negatively, related to affective extremity. (Woolfolk et al. also found strong effects of word-list composition on positive SC but not on negative SC; this can be seen as additional evidence for poor reliability and poor internal consistency of this measure.) In a similar vein, Morgan and Janoff-Bulman (1994) reported that only the complexity of positive knowledge buffered stress. In sum, it seems the assumptions that structure and content are orthogonal and, specifically, that the valence of the content is unrelated to complexity, have not been supported by a number of studies that have used SC-D.

The findings of poor internal consistency are particularly harmful to SC theory because the existence of a general factor underlying SC is central to Linville's (1985, 1987) other tenets. Other models of structural properties of the self (e.g. *compartmentalization*, Showers, 1992; *self-discrepancies*, Strauman & Higgins, 1987) posit an interaction between the actual knowledge and the way it is structured, and do not maintain that structural features have an effect on mood that is independent of content. In contrast, SC theory divorces structure from content altogether. Linville (1987) hypothesizes that complex structure as measured by SC-D, buffers strong affective reaction, regardless of the actual traits used, and regardless of the traits' valences. Yet as demonstrated by Woolfolk et al. (1995), among others, valence might have a strong impact on levels of SC. It is conceivable that other features of the knowledge (apart from valence) may affect the structure of the self-concept or at least interact with it.

The present study examined two issues. First, it provided an analysis of the internal consistency of SC-D. Second, the present study proposed two alternative measures of the mechanisms posited by SC theory and compared these alternative measures with SC-D. An explicit evaluation of the internal consistency of SC-D was deemed appropriate for several reasons. First, there have been no explicit reports of internal consistency estimates in the published SC literature. Second, as noted above, some of the replication attempts (e.g. Woolfolk et al., 1995, studies 1 and 5) have indicated a poor internal consistency; nevertheless, none of these studies discuss this phenomenon in psychometric terms. Even the clearest analysis to date of the internal nature of SC-D (the one carried out by Woolfolk et al., 1995) stops short of providing a detailed analysis of internal consistency and reports only the data regarding discrepancies between positive SC and negative SC. The third rationale for an internal consistency analysis of SC-D involves the poor showing of SC studies utilizing that measure, with respect to both reliability and predictive validity. Predictive validity for a purportedly unitary construct depends (among other factors) on internal consistency (Nunnally & Bernstein, 1994). An analysis of the internal consistency might help in the construction of alternative measures with which a greater validity would be achieved. Finally, and most importantly, an analysis of the internal consistency of the SC-D measure is a test of SC theory itself. Such a test will be able to examine the Linville (1985, 1987) assertion concerning the orthogonal effects of content and structure within the self-concept and, in particular, the orthogonality of the effects of valence and of complexity.

SC theory (Linville, 1987) states that the complexity of the self-concept, irrespective of the specific content, plays a unique role in affect and judgment. If SC-D is a valid measure of structure (irrespective of content), its internal consistency should be high. Given the results of the studies described above, the first hypothesis of the present study was that internal consistency of this measure would be poor. In particular, the findings of Woolfolk et al. (1995) were expected to be replicated: the valence of self-knowledge was expected to hinder the internal consistency of the SC-D measure.

Although this first hypothesis examined the choice of the SC-D statistic suggested by SC theory (Linville, 1985), it did not directly explore the hypotheses of that theory. A second purpose of this study was to propose two alternative measures, both obtained from the same self-descriptive sorting task, and each reflecting one of the components of the SC construct, the quantity of self-aspects and the overlap among them. These two measures were obtained for comparison with the dimensionality measure used by Linville. They are seen as reflective of the two underlying processes which are thought to account for the self-complexity moderation effects. The quantity measure has been used in previous studies (e.g. Linville, 1985, 1987). The overlap, reflecting the 'spill-over' process, was new to this study. The inclusion of these two measures together allowed us to examine the interrelation of the two component processes and to provide measures for tests of the interaction of the numerosity of aspects with the overlap among them.

Inter-correlations between the two component measures and the SC-D statistic were computed, and the internal consistency of the two component measures were compared to that of the SC-D statistic. It was hypothesized that the correlations of SC-D with the more specific measures of the underlying components (quantity and overlap of self-aspects) would not fit Linville's (1985, 1987) assumptions. It was also hypothesized that both specific measures would have greater internal consistencies than would SC-D.

2. Method

2.1. Overview

As part of a larger study aimed at identifying interpersonal and cognitive correlates of SC, data were collected from students at Northwestern University. Each participant completed a self-descriptive trait sorting task (from Linville, 1985), as well as several questionnaires assessing constructs not relevant to the present study (attachment status, perceived childhood parenting and self-efficacy).

2.2. Participants

122 Northwestern University undergraduate students (62 females) enrolled in an Introductory Psychology course participated in the study as partial fulfillment of the research requirement.

2.3 Measures

2.3.1. Self-descriptive sorting task

The SC task was based on that used by Linville (1985, 1987), with some minor variations. Participants were given a packet of 44 randomly ordered card-stock cards, each printed with a trait adjective derived from pre-testing, 10 blank cards and a two-sided recording sheet with blank columns[1]. Trait words were obtained in a pre-testing procedure and were selected to include markers of the Big-5 personality dimensions (Goldberg, 1992), as well as constructs that fall outside of that framework. The final list was composed of 23 positively valenced adjectives and 21 negatively valenced adjectives. Participants were asked to sort the cards into meaningful groups, so that each group is descriptive of an aspect of their life. The descriptive groups were recorded in the blank columns of the recording sheet. Participants were asked to provide a label for each group, but could note a general description of the type of aspect if they did not wish to provide the specific meaning of a group. No limit was placed on the number of groups or on the number of cards (i.e. traits) within each group, although that number could not exceed the total number of adjectives (i.e. 44). Participants were informed that an adjective could be used once, several times (in different groups) or not at all. The blank cards were used for repetition of traits. The

[1] To obtain the word list, for information about the pre-testing procedure and for further details about the self-descriptive sorting task, contact E.R-M. (first author).

participants were allowed 25 min to complete the task. Rather than using the Linville (1985, 1987) trait list, which we found lacking in several respects, a newly developed trait list was used in this study. Our list of 44 adjectives differed from the original in having a better balance between positive and negative traits, in being larger (and therefore a more reliable sample of the entire trait lexicon) and in utilizing the recent developments in lexical trait theories (e.g. Goldberg, 1992) which allowed us to ensure the presence of markers for all Big-5 dimensions. Conceptually, however, self-complexity as an individual difference characteristic of self-knowledge, should not be sensitive to content variation in the task used to measure it.

The alternative measures of the quantity of self-aspects (NASPECTS) and of their overlap (OL), as well as the Linville (1985) dimensionality measure (SC-D) were computed from the data generated by this task. SC-D is a measure of the number of independent attributes underlying the trait-sort (Scott, 1969; Linville, 1987; see Appendix A for a more detailed explanation of SC-D). NASPECTS is simply the number of groups formed by the participant from the packet of cards. OL is the average overlap between two groups, over all possible pairs of trait-groups (see Appendix B for a more detailed explanation of OL).

2.4. Procedure

Participants completed the study in groups of one to five, seated at individual desks. For all participants, the SC-D measure was administered first, with the other questionnaires (not relevant to this study) following in random order.

3. Results

3.1. Measures of structure

Three measures of structural properties, SC-D, NASPECTS and OL, were computed for each participant using the results of the trait sorting task. As noted above, SC-D is a measure of dimensionality (Scott, 1969) that has been used by Linville (1987) to represent SC as a whole. The scores on SC-D in the present study ($M = 2.80$, S.D. $= 0.58$) were comparable to those reported by Linville (1987). NASPECTS and OL are two alternative measures designed to represent the two components of SC: quantity of self aspects and overlap among these aspects. NASPECTS is operationalized simply as the number of trait groups formed by the participant in the trait sorting. The scores on NASPECTS in the present study ($M = 5.74$, S.D. $= 2.10$) were comparable to the figures of what Linville reported as "... the number of feature groups created in the self-complexity sorting task" (Linville, 1987, p. 668)[2]. OL is the average overlap between two groups, over all

[2] The score of one participant proved to be a bivariate outlier, with NASPECTS of 17 and OL of 0.01. The analyses of the study were subsequently conducted with and without that person's scores. The pattern of intercorrelations, partial correlations, and internal consistencies obtained in the two analyses were similar. Therefore, the reported analyses are those for the whole sample, including the outlier.

Table 1
Intercorrelations among self-complexity measures ($N = 121$)

Measure	1	2	3
(1) SC-D	–	0.71***	0.24**
(2) NASPECTS		–	−0.21*
(3) OL			–

SC-D = the Linville (1985) self-concept dimensionality measure. NASPECTS = number of self-aspects. OL = overlap among self aspects.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

possible pairs of groups. In the present study this measure had a mean of 0.13 and a standard deviation of 0.12[3].

3.2. Inter-correlations

Zero-order correlations (reported in Table 1) indicated that SC-D was positively related to NASPECTS. This is consistent with the Linville (1987) expectation that numerosity of roles contributes to SC. Importantly, it is similar in magnitude to an earlier report by Linville (1987) of the correlation of these two variables ($r = 0.72$). SC-D was also positively related to OL. This is contrary to Linville's expectation that overlap will detract from SC. Finally, NASPECTS was negatively correlated with OL. To ascertain if the relation of OL to SC-D remains positive even when controlling for NASPECTS, a simultaneous multiple regression analysis was conducted with OL and NASPECTS as predictors and SC-D as the dependent variable. Both OL and NASPECTS uniquely and positively contributed to the variance in SC-D, above and beyond the effect of the other statistic (OL: $\beta = 0.41$, $T = 7.53$, $p < 0.0001$; NASPECTS: $\beta = 0.80$, $T = 14.60$, $p < 0.0001$).

3.3. Internal consistencies

One common way to assess internal consistency uses the Cronbach (1951) coefficient alpha (α). However, due to the nature of the trait-sorting task and particularly to the fact that it is not an aggregate of items in the conventional sense of a scale, it is impossible to compute an α reliability estimate for this task. Both the total scale score variance and individual item variances are necessary for a computation of α. Unfortunately, since the self-descriptive trait sorting task is not composed of discrete items that can be used in such an analysis, there is no total-scale score as such. More

[3] A possible measurement concern was the presence of a scaling ('floor') effect in the OL measure. This pattern is expected however, since OL scores vary from none to some overlap and cannot accept negative values. The scaling effect may cause an attenuation of the bivariate correlations of OL with the other two measures (NASPECTS and SC-D). A visual inspection of the bivariate scatter plot supports this claim, at least with regard to SC-D. Therefore, had there been no floor effect, the positive relationship between OL and SC-D is likely to have been even stronger.

importantly, coefficient α is actually a poor estimate of the general factor saturation of a test (Cronbach, 1951; Revelle, 1979). Although coefficient α is a lower bound of the common variance in a measure, it is also an upper bound of the general (or first) source of variance, which is of greater interest here.

Revelle (1979) has suggested an alternative measure of factorial homogeneity, which he dubbed coefficient beta (β). This estimate is obtained by computing the 'worst split-half reliability'; i.e. the reliability computed when splitting a scale into two, such that the covariance of the two halves is minimized. As Revelle pointed out, β is a better estimate of general factor variance, but a poor estimate of common factor variance, while α excels at estimating common factor, but not general factor variance. Since the interest of this study is in the general (first) factor variance of the measure, the internal consistency estimates will be obtained using Revelle's β.

To test the internal consistency of each of the three structural measures, a set of split-half reliability estimates was obtained. Split-half procedures for the trait-sorting task were conducted as follows: instead of using a participant's full trait sorting for computing SC-D, NASPECTS and OL, only a subset of traits (e.g. the 22 odd-numbered traits) are used. In effect, any traits that do not belong to a specific *split* or half are eliminated temporarily from the participant's trait sorting. Consequently, the number of traits utilized decreases, as may the number of self-aspects into which they have been grouped. The relevant measures (SC-D, NASPECTS and OL) are then computed on this reduced trait-sort. For example, the NASPECTS measure is simply the number of aspects (groups) that the participant had formed with the limited set of trait-words. The split-half correlation of each of the 3 measures is obtained by correlating the score on that measure within one subset of traits with the respective score within the other half of the traits. This split-half correlation is then stepped up by the Spearman–Brown formula (Pedhazur & Schmelkin, 1991) to obtain a split-half reliability estimate.

Two types of divisions of traits were conducted. In the first type, the traits were split randomly, but both positive and negative traits were maintained in each of the subsets (12 positive and 11 negative traits in one subset, 11 positive and 10 negative traits in the other). Three random splits of this sort were conducted; the internal consistency analyses of SC-D, NASPECTS and OL in all three of these splits yielded similar results. For all three splits the split-half correlation of NASPECTS was highest ($r = 0.95$–0.97, $p < 0.001$), followed by OL ($r = 0.82$–0.86, $p < 0.001$) and SC-D ($r = 0.74$–0.78, $p < 0.001$) (see Table 2 for the associated reliability estimates). Thus, with two smaller and ostensibly parallel forms of the sorting task (maintaining a comparable balance of positive and negative traits), the split-half reliability of all three structural properties is acceptable (Nunnally & Bernstein, 1994), with NASPECTS and OL showing greater split-half reliability.

In Revelle's (1979) terms, the above partitions of the traits can be thought of as examples of 'good splits'. By maintaining the balance of positive and negative trait words in each half, the valence (which has been previously shown to be a source of internal inconsistency; e.g. Woolfolk et al., 1995) is controlled from attenuating the correlations and the reliability estimates. However, as Revelle has noted, a better estimate of the general factor variance in a measure is the reliability estimate obtained from the worst split-half. Any correlation between the two least-similar portions of a test indicates the existence of a shared source of variance, even for the least similar portions (and consequently, for all portions of the scale).

The branding of a specific splitting of the traits as 'the worst one' is an empirical task. However, even for the limited case in which the two halves of the self-descriptive sorting instrument are equal

Table 2
Split-half reliability estimates of self-complexity measures ($N = 121$)

Measure	Split-half reliability estimates computed in three semi-random splittings	Split-half reliability estimates computed in the valenced splitting
(1) SC-D	0.85–0.88***	0.17^{ns}
(2) NASPECTS	0.97–0.98***	0.65***
(3) OL	0.90–0.92***	0.66***

SC-D = the Linville (1985) self-concept dimensionality measure. NASPECTS = number of self-aspects. OL = overlap among self aspects. Significance values based on split-half correlations.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, ns = non-significant.

in size (22 traits each), there are over 200 billion possible splits of the 44 traits. Performing an analytical worst-splitting is therefore computationally difficult and virtually impossible (Revelle, 1979). It is possible, however, to partition the traits according to some theoretically meaningful construct that is thought to differentiate among groups of these traits; in hypothesis-testing terms, this means that a failure to find internal consistency with such a split would lead to rejection of the consistency hypothesis, whereas a finding of internal consistency would only lead to a non-rejection of that hypothesis. In effect, such a theoretically-based ‘worst splitting’ provides an upper bound to the empirical worst split-half. The true β will be equal or lower in value to that found in such a theoretically-based split.

Thus, a second type of split-half reliability estimate was obtained by dividing the 44 traits into two subsets according to their valence, such that one subset was composed solely of the 23 positive traits while the other was comprised of the 21 negative traits. The theoretically worst split-half reliability estimate for SC-D, that based on a valenced split, was found not to differ from zero (split half $r = 0.09$, n.s.). In contrast, the same worst split-half estimates for both NASPECTS and OL were of moderate magnitude (split half $r = 0.48$ and 0.49, respectively, $p < 0.001$ for both). The split-half reliability estimates for this set and for the semi-random splitting are summarized in Table 2.

4. Discussion

The findings of this study support a measurement explanation of the problems in the consistency, reliability and validity surrounding self-complexity theory (Linville, 1985, 1987); they also suggest a measurement solution to these problems. The results indicate poor internal consistency and insufficient convergent validity for the frequently used dimensionality measure, SC-D. In turn, the study proposes two alternative measures of the components of SC and offers psychometric support for their use. In doing so, this study offers an adjustment of SC theory, one that maintains the premises posited by Linville, but that also attempts to explain findings that have questioned the theory’s reliability and validity (e.g. Hershberger, 1990; Showers, 1992; Woolfolk et al., 1995).

The results of the present study suggest that SC-D, Linville's (1985, 1987) dimensionality measure, is lacking in several respects. Linville posited that SC-D reflects both components of SC: the quantity of self-aspects and the distinction among them. Thus, a convergent validity analysis should find SC-D to be correlated positively with the number of self-aspects utilized and negatively with the overlap among these self-aspects. In contrast to this expectation, in the present study the SC-D measure was found to correlate strongly and in the predicted direction only with the quantity component of SC; it correlated with the second component, overlap, in a manner contrary to that suggested by Linville. SC-D was found to be correlated positively with the overlap measure. Thus, the existence of overlap among self-aspects in effect strengthens one's SC-D score instead of detracting from it as Linville argued that it should.

Although this finding may represent evidence against the claims of the SC model, further analysis reveals that what is problematic is not the model as much as its measurement. The weak but significant negative correlation between the measures of quantity and overlap supports this position and is consistent with the hypotheses of SC theory. A greater number of self-aspects was associated with somewhat lower overlap among these aspects. Thus, although the two constructs are mostly independent of each other, their correlation is in the predicted direction.

Therefore, a tentative conclusion is that, in keeping with Linville's (1985) SC theory, the use of measures that separately and independently reflect the two underlying components of quantity and overlap might actually be more informative than the use of the single dimensionality (SC-D) statistic. The latter measure does not seem to be a valid reflection of the components of SC that it purports to assess. This conclusion is further supported by the analysis of the internal consistency of the SC-D measure.

Internal consistency of the measurement of SC is assumed in Linville's (1985, 1987) model; the construct of SC is discussed by Linville as a unitary, structural construct that plays a unique part in the cognitive-emotional functioning of the self. Thus, SC theory would predict that a dimensionality (SC-D) score obtained from a subset of traits would correlate highly with that obtained from a different subset of traits, since the actual content of the traits being sorted should be orthogonal to the dimensionality of the trait sort. In other words, a split-half reliability estimate that partitions the traits according to their valence (which is a feature of their content, or identity) should not be smaller than an estimate obtained in a non-valenced split-half analysis. In contrast, other theorists and investigators have found SC to be sensitive to such a split (e.g. Morgan & Janoff-Bulman, 1994; Woolfolk et al., 1995). The present study replicated Woolfolk et al.'s findings regarding the poor consistency of the SC-D measure. Using the Revelle (1979) β estimate of general factor variance, the general factor variance of SC-D was found not to differ from zero. Again, this finding is consistent with the possibility that the SC construct should not be measured with the dimensionality statistic.

The analysis of the internal consistencies of the two alternative measures presented in this study suggests that the SC model should not be rejected outright. The two alternative structural measures, NASPECTS and OL, displayed robust internal consistency even when valence of the knowledge was considered. Using Revelle's (1979) β as an estimate of general factor variance and assuming that the valenced split is truly the worst one possible, the measure of self-aspects quantity (NASPECTS) appears to have a general factor underlying it that accounts for about 64% of its variance. The same is true of the measure of overlap among self-aspects (OL), in which 66% of the variance is accounted for by a general factor. These results support the existence of general factors underlying both NASPECTS and OL. Such factors, independent of content and valence, account for more than half of the variance in the two alternative measures.

It is important to note that a comparison of the internal consistency estimates obtained in the set of valenced-split analyses with those obtained in the set of non-valenced splits revealed that valence affects all three measures (SC-D, NASPECTS and OL). When these measures are examined separately within the positive subset and within the negative subset of traits, the correlation between the respective measures (positive and negative) is weaker than is the association between two random subsets (that cut across valence). A valenced-split eradicates Linville's SC-D measure, lowering the split-half reliability from the 0.85–0.87 range (in a random, balanced split) to a very low 0.17 (in a valenced split). This sensitivity of the SC-D measure to the valence of the traits being sorted indicates a lack of one general factor underlying the measure. In contrast, valence only partly attenuated the internal consistency estimates of the two alternative measures. For the measure of quantity of aspects, the split-half reliability dropped from the 0.97–0.98 range (in random, balanced splits) to a still reasonable 0.65 (in a valenced split). A similar pattern occurred with the OL measure (0.90–0.92 to 0.66, respectively). The substantial β reliability estimates of these two measures suggests the existence of a general factor that is content-free, or at least independent of valence, for both quantity and overlap of self-aspects. No such claim can be made for the measure of dimensionality (SC-D). The dimensionality of positive traits was essentially unrelated to that of negative traits in our data.

A closer inspection of SC-D offers one possible explanation for its poor internal consistency and convergent validity. SC-D and its predecessor, the *H* statistic, were originally developed in the context of information theory (Attneave, 1959). It was incorporated as a psychological concept within a multi-dimensional model of knowledge structures (Scott, 1969). As Scott pointed out, this measure reflects "..the number of 'dimensions-worth' of space utilized by the attributes with which a person comprehends the domain" (Scott, 1969, p. 263). Thus, it seems that SC-D is best suited for a multi-dimensional model. In contrast, the components of the SC model (quantity of self-aspects and overlap among them) reflect a categorical approach to self-knowledge. Both of the alternative measures suggested in this study assume a categorical nature: the quantity measure (NASPECTS) is a count of the categories used and the overlap measure (OL) reflects category similarities. The theoretical appropriateness of the alternative measures, but not of SC-D, may explain the psychometric differences among them.

It is of interest to note the relationship of Linville's (1985) choice of measure to the work of Scott (1969) and Kelly (1955). As Linville and Carlston (1994) point out, Kelly's notion of personal constructs anticipated theoretical aspects of the social-cognitive approach, but predated the adequate methodology to investigate them. Kelly pioneered the analysis of cognitive structure and its affective consequences and motivational correlates. Kelly, and later Scott, promoted a notion of individually different multi-dimensional spaces, composed of varying numbers of dimensions (or 'constructs'), with varying 'attribute articulation' (Scott, 1969, p. 266; compare to Kelly's 'zone of convenience'). The use of the SC-D measure seems congruent with these earlier approaches. However, Linville and Carlston's presentation of possible memory models of self-knowledge does not include a multi-dimensional approach to memory. Given Linville's use of SC-D and the frequent use of her instrument by others, the absence of such a possible model is problematic. It may be worthwhile to express the concept of SC theory in terms of a multi-dimensional model of self-knowledge and to use measures similar or identical to the SC-D measure within a test of this reformulated theory. In the meantime, however, it is possible that the incongruity between the dimensional measure and the categorical model underlying SC theory may be the cause of the poor performance of that measure.

Our analysis focused on the convergent validity and the internal consistency of self-complexity measures. An interesting point, not explored in our data, is that of temporal stability of these measures. The temporal stability of the dimensionality statistic has been explored previously (although the conclusions were not consistent; cf. Linville, 1987; Salovey, 1992). Our analysis of split-half reliability (Table 2), which is analogous to alternate form reliability, leads us to believe that all measures of self-complexity would show strong *temporal stability* as well, as long as the forms included both positive and negative valenced items. If the forms should differ in valence, we believe that only the NASPECTS and OL measures will show stability.

The present findings have three implications for SC theory and for the study of structural characteristics of self-knowledge in general. First, they provide support for the claims of SC theory regarding the existence of structural properties that are independent of content, while demonstrating that alternative measurement decisions may be called for: rather than a singular measure of dimensionality (SC-D; Linville, 1985), two alternative measures that assess the two components of SC, quantity and overlap of self-aspects, must be considered. Second, it is noteworthy that even the alternative measures of SC presented in this study appear to be sensitive to valence. This finding offers support for the attempts of such researchers as Showers (1992), Strauman and Higgins (1987) and others, to integrate within their models of the self-concept both features of content and properties of structure. Finally, it is important to observe that the face validity and the demonstrated reliability of the quantity and overlap measures do not provide assurance that the constructs they measure will prove to be valid in their roles as buffers or diathesis factors for affective extremity, as posited by Linville (1985). Nevertheless, the inclusion of these measures in studies that examine the claims of SC theory would permit a test of the buffering hypothesis, and would lift the burden of inconsistent and unreliable measurement. It is possible that further research utilizing these measures will support the predictive value of the structure of the self for issues concerning depression and emotional lability.

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Appendix 1: Computation of the SC-D statistic (from Linville, 1987)

This study used the dimensionality (SC-D) score, a measure based on the *H* index of dispersion derived from information theory (Attneave, 1959; Scott, 1969). The measure represents the number of independent attributes implicit in a participant's trait sort. It is defined by:

$$\text{SC-D} = \log_2 n - (\Sigma_i (n_i \log_2 n_i))/n$$

where n is the total number of traits used in the sort and n_i is the number of traits that appear in a particular unique group combination. To define a unique group combination, consider a trait that is sorted into group 1 and group 2 but no others. This trait is said to fall into the group combination 1–2. More generally, if a person only forms two groups, a given trait may fall into one of four possible group combinations: 1, 2, 1–2, or 'no group'. In this case, n_i in the formula can be interpreted as follows: n_1 = number of traits sorted only into group 1, n_2 = number of traits sorted only into group 2, n_3 = number of traits sorted group 1 and group 2 and n_4 = number of traits not sorted into any group.

Note that if the *i*th group combination has no traits in it, it is excluded from the formula.

Appendix B: Computation of the OL statistic

Overlap is defined as the average communality between all pairs of self-aspects. The OL measure reflects the Linville (1985) notion of 'spill-over' among one's self-aspects. To the degree a person maintains strong distinction between self-aspects, OL should be low. Greater communality (a large proportion of traits describing one aspect that also describe another aspect) is tantamount to high overlap or similarity and therefore strong spill-over.

Tversky (1977, p. 328) pointed out that similarity "should not be treated as a symmetric relation". In the study of the self-concept, this implies that overlap or spill-over between any two aspects can exist in both directions and should not be collapsed into a single measure for each pair. Thus, we defined OL using the following formula:

$$OL = (\Sigma_i(\Sigma_j C_{ij})/T_i)/n*(n-1)$$

where C is the number of common features in 2 aspects; T is the total number of features in the referent aspect; n is the total number of aspects in the person's sort and i and j vary from 1 to n (i and j unequal).

The pair-wise communality between a referent aspect and another aspect is the proportion of traits common to both aspects, within the total number of traits in the referent aspect. For simplicity's sake, let us consider a person who sorted 6 traits (numbered 1–6), into only 2 groups:

Group A: {1, 2, 3, 4, 5}
Group B: {5, 6}

The overlap between these two groups is due to one shared trait, (number 5). Thus, the proportions of the common traits to the total number of traits in each group is 1/5 and 1/2, respectively. OL is the average of these: $(1/5 + 1/2)/2 = 0.35$.

In the general case, such a pair-wise comparison is conducted between all combinations of two groups, and then averaged. For n aspects, there are $n*(n-1)$ such combinations. For example, the following participant formed 4 groups in her trait-sort:

Group A: {1, 2}
Group B: {1}
Group C: {1, 4, 5, 6}
Group D: {3}

There are (4*3) pair-wise comparisons: AB, AC, AD, BA, BC, BD, CA, CB, CD, DA, DB, DC.

The respective pair-wise overlaps are 0.5, 0.5, 0, 1, 1, 0, 0.25, 0.25, 0, 0, 0, 0. The average of these, OL, is therefore 0.292.

An interesting extension of this method could take into account the semantic similarity of some of the traits. Traits can be grouped, at least in part, as reflecting the Big-5 dimensions (Goldberg, 1992). Future studies could capitalize on these relationships to better assess pair-wise overlap, by including synonyms and not only identical matches in the computation of communality.

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