

Rigidity of Thought and Behavior: 100 Years of Research

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ABSTRACT. Rigidity is one of the oldest psychological constructs, with systematic research dating back to the late 19th century. The authors review this research in an attempt to clarify the construct of rigidity and to investigate its correlates. Rigidity is described as a multidimensional construct encompassing the tendency to form and persevere in the use of mental and behavioral sets. A series of meta-analyses was performed based on three measures of behavioral rigidity: the Einstellung Water-Jar Task, the Wisconsin Card Sorting Task, and the motor–cognitive dimension of the Test of Behavioral Rigidity. The results indicated that rigidity is curvilinearly related to age, positively related to authoritarianism (particularly under stressful situations), and negatively related to intelligence; that men are more rigid than women; that obsessive–compulsiveness is positively related to rigidity; and that schizophrenics are more rigid than nonschizophrenic siblings and normal controls. Unresolved issues and gaps in the research are discussed.

Key words: mental set, perseveration, rigidity

THE CONSTRUCT OF RIGIDITY has a productive and venerable history in the field of psychology. Systematic research on rigidity can be traced back to the Gestalt psychologists of the late 19th and early 20th century (Cattell, 1946; Chown, 1959; Lankes, 1915; Luchins & Luchins, 1994; Müller & Schumann, 1898; Spearman, 1927; Stewin, 1983). An examination of the names associated with much of the early research on rigidity reads like an all-star roster: Raymond Cattell, Else Frenkel-Brunswik, William James, Kurt Lewin, Abraham Luchins, Milton Rokeach, Charles Spearman, and Louis Thurstone all made substantial contributions to the area. More than 100 years of systematic study of rigidity have produced a large body of research with some clear and established findings. However, controversies surrounding several fundamental aspects of rigidity remain.

Although the term *rigidity* may be somewhat out of vogue among personality and social psychologists today, we continue to see considerable interest in a range of highly related personality variables, such as flexibility, need for closure, and openness to experience. Indeed, every major personality inventory contains a dimension similar to rigidity. But what is rigidity? How is it measured? And what are the causes and correlates of resistance to change? For social psychologists, answers to these questions bear special importance. Social psychologists have always been interested in behavior change. As presented in the following review, rigidity is the tendency of an individual *not* to change. We believe that a conceptual clarification of rigidity, a summary of the tools for measuring rigidity, and an analysis of the correlates of rigidity will be useful for determining the state of knowledge about this important construct.

Despite the long history of research on rigidity, the construct continues to attract research from a variety of psychological disciplines (D'Aunno & Sutton, 1992; McKelvie, 1990). An examination of published research reveals that the term rigidity continues to be commonly used by psychological researchers. Indeed, between 1967 and 1998 the term rigidity was used in the abstracts or titles of 1,733 published articles contained in the PsycINFO database (revealed through a free-text search of WebSPIRS in 9/98 for the term rigidity). The term continues to be current; between 1990 and 1998 it was used in the abstracts of 494 published studies. A topical summary of these 494 articles is presented in Table 1. Each of the abstracts was coded for its focus: muscular rigidity, perceptual rigidity, attitudinal rigidity, behavioral rigidity, determinants of rigidity, rigidity as a predictor variable, rigidity of animal behavior, rigidity in organizational processes, or rigidity of measurement/theory. An examination of the types of studies within each of these categories revealed that the term was used by researchers in a variety of psychological subdisciplines, including

- Personality psychology (Viek, 1997)
- Social psychology (Gruber-Baldini, Schaie, & Willis, 1995; O'Connor & Dyce, 1997)
- Cognitive psychology (Alam & Saeeduzzafar, 1991)
- Counseling (Glover, 1994; Mahalik, Cournoyer, DeFranc, Cherry, & Napolitano, 1998)
- Developmental psychology (Chelune & Thompson, 1987; Everett, Thomas, Cote, Levesque, & Michaud, 1991)

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TABLE 1
Categorization of Studies Conducted
on Rigidity Between 1990 and 1998

Topic	Number of articles
Musculature rigidity	
(e.g., Parkinsons, Catatonia)	189
Rigidity in perception	39
Depth/motion	35
Rigidity of self-perception	4
Rigidity of attitudes	33
Culture	10
Gender role/identity	7
Attitudes toward science	5
Attitude change	4
Career attitudes	4
Political attitudes	3
Rigidity of behavior	63
Families and roles	19
Pathology and therapy	32
Problem solving	7
Learning	3
Brain injury	2
Determinants of rigidity	32
Age	6
Retardation	8
Schizophrenia	7
Experience	4
Autism	3
Stress	2
Obsessive-compulsive disorder	2
Rigidity as a predictor of:	78
Eating disorders	7
Depression/suicide	7
Delinquency	3
Coping	3
Health behavior (e.g., smoking)	4
Creativity	3
ADHD	3
Child abuse	3
Academic performance	3
Other	42
Animal behavior	5
Organizational processes	5
Measurement/theory	26
Other	24
Total	494

Note. Totals are in bold type.

- Educational psychology (Corder & Corder, 1974; Freeman, Sawyer, & Behnke, 1997)
- Mental retardation (Berkson, Gutermuth, & Baranek, 1995; Kreitler, Zigler, & Kreitler, 1990)
- Neuropsychology (Heinrichs, 1990)
- Organizational behavior (Miller, Droge, & Vickery, 1997; Rosman, Lubatkin, & O'Neill, 1994; VanAllen, 1994)
- Ethology (Toates, 1997)
- Psychopathology (Hellman, Morrison, & Abramowitz, 1987; Lennings, 1994; Rickelman & Houfek, 1995)
- Psychotherapy (Christoph & Li, 1985; Dare et al., 1995; Mizes & Christiano, 1995).

The construct of rigidity has attracted researchers from around the world, with recent articles on rigidity published by psychologists in Africa, China, Eastern Europe, India, Japan, Mexico, Pakistan, Russia, the United States, and Western Europe. Clearly the construct is alive and well in psychological research. In this article, we provide a working definition of rigidity, discuss measurement issues, review established findings using meta-analytic techniques (see Appendix), illuminate ambiguities in the research literature, and suggest directions for future research.

Chown's Review

One of the most comprehensive reviews of rigidity was provided in an often cited *Psychological Bulletin* article by Sheila Chown (1959) more than 40 years ago (see also Luchins & Luchins, 1959). At that time, Chown stated, "Few major topics in contemporary psychology appear to offer more promise than rigidity, and the amount of work reported on this subject has been increasing year by year" (p. 195). Her article focused on definitions of rigidity, rigidity tests, and experimental work involving rigidity. She concluded with three generalizations. First, she noted that at the time, a variety of instruments were available for measuring rigidity and that their commonalities were unclear. Second, she advocated a return to a physical model of rigidity, in which rigidity is defined as the ratio of environmental stress to structural strain. For example, the rigidity of a beam is measured as the amount of physical stress imposed on the beam divided by the amount of resistance to this stress. Finally, she noted that the empirical evidence suggested a multidimensional construct, but that little research had been conducted to identify the different aspects of rigidity.

Another theme noted by Chown was the distinction between the functional and structural approaches to rigidity, a distinction articulated in earlier articles by Kounin (1948) and Werner (1946). The structural approach viewed rigidity in terms of the amount of differentiation between "mental regions." A person with

highly defined and distinct regions was rigid, while a person with less clearly defined mental regions (i.e., more overlap between regions) was not rigid. A functional view of rigidity, in contrast, viewed it not as a tool for organizing information, but as a way of using information to solve problems. Although we no longer talk about rigidity as resulting from boundaries between mental regions, the distinction between the organization of information and the use of information in problem solving is a continuing theme in the research on rigidity. In the 42 years since Chown's review, researchers have addressed several of these points and uncovered new issues that need to be addressed.

Defining Rigidity

In her 1959 review, Chown noted that the construct of rigidity had proved difficult to define. Indeed, the term had been used to describe mental sets, extreme attitudes, ethnocentrism, stereotypy, lack of flexibility, perseveration, authoritarianism, and the inability to change habits. In her review, Chown failed to provide a coherent definition of rigidity, in part because there was no consensus among researchers. However, in light of the focal status given her review, this omission is a serious shortcoming.

Early approaches to the study of rigidity treated it as a unidimensional continuum ranging from rigid at one end to flexible at the other. The notion of rigidity as a unidimensional construct dates back to the late 1800s and was later articulated by Spearman (1927), who described it as "mental inertia" (Lankes, 1915; Pinard, 1932). Spearman is widely known for introducing the *g* factor, but it is not widely known that he also proposed a *p* factor (perseveration factor). According to Spearman, *g* consisted of the amount of mental energy available and *p* was the inertia of this energy. Prior to 1960, definitions for rigidity abounded. Examples include Goldstein's (1943) "adherence to a present performance in an inadequate way," Werner's (1946) "lack of variability in response," Rokeach's (1948) "inability to change one's set when the objective conditions demand it," and Buss's (1952) "resistance to shifting from old to new discriminations." In their comprehensive survey of the literature, Luchins and Luchins (1959) listed 34 factors identified in various studies, many of which were conceptually similar. And they ruefully noted that "one investigator seldom relates the factors he promulgates to those in other studies" (p. 94). Clearly, at the time of Chown's review there was no consensus as to how to define rigidity.

A useful development since 1959 has been Rokeach's *The Open and Closed Mind* (1960). Summarizing the wide range of approaches to the construct, Rokeach defined rigidity as a resistance to change in beliefs, attitudes, or personal habits. The usefulness of this definition is its multidimensional nature. Rigidity is not simply the perseveration of behavior on a behavioral task, but can be divided into cognitive, attitudinal, and behavioral components. Rokeach used the term *dogmatism* to refer to resistance to change in a person's belief system.

Rigidity refers to single beliefs (or habits), whereas dogmatism refers to a system of beliefs. Despite Rokeach's attempt to provide clarification, a 1967 summary of the literature reached a conclusion similar to Chown's: Leach (1967) stated, "A large amount of effort has been devoted to the study of rigidity . . . yet there is still little agreement as to its identity or its components" (p. 11).

Research in the last 42 years has by no means converged on a consensus regarding the nature of rigidity, partly, we think, because of the multidimensional nature of the construct. Our review of the last 100 years of the psychological literature does, however, suggest that a comprehensive definition of rigidity must contain several key elements. First, rigidity involves the formation of a mental or behavioral set (Chown, 1959; Rokeach, 1948; Sarmany-Schuller, 1994; Stewin, 1983; Vollhardt, 1990). By set, we mean a learned mental or behavioral pattern that forms through repeated experience in a given situation (Luchins, 1942; Luchins & Luchins, 1959, 1994). Mental sets are expectations about future events (including attitudes, beliefs, expectancies, and schemas), whereas behavioral sets are patterns of observable responses. Second, rigidity involves the perseveration of these sets. By perseveration we mean the continuation of the set in the face of pressure to change (Goldberg, 1986; Goldberg & Tucker, 1979; Luchins & Luchins, 1994; Sandson & Albert, 1984). Pressure to change can come from a variety of sources, including (a) the realization that the set is no longer effective, efficient, or appropriate for the current situation; or (b) pressure from an external agent indicating that change is desirable. We define rigidity as the tendency to develop and persevere in the use of mental or behavioral sets.

Thus, there are two steps in the rigidity process: set formation and set perseveration (Guetzkow, 1951; Taylor & McNemar, 1955). Presumably, these two steps are positively correlated such that a person who quickly forms a set is likely to persevere in its use (Luchins & Luchins, 1982). Similarly, a person who quickly forms a mental set should also be likely to quickly form a behavioral set. Note that our definition incorporates the distinction that researchers used to make between structural rigidity and functional rigidity. What we have referred to as the tendency to develop a set is similar to structural rigidity, and the tendency to persevere in the use of a set is similar to functional rigidity.

One important distinction is between perseveration and habit. A habit is a typical pattern of behavior—that is, a habit is a behavioral set. Habits are behavioral sets that occur largely without reflection. Examples of habits might include daily routines such as routes to work or (for U.S. drivers) driving on the right side of the road. In and of themselves, habits are not rigid; it is only when a behavioral pattern perseverates in the face of pressure to change that it meets our definition of rigidity. So, consider the case of a U.S. automobile driver who travels to England where it is customary to drive on the left side of the road. If, after several driving excursions, the driver is still unable (or unwilling) to adapt to the new prevailing rules of the road, then this would reflect rigidity.

Measuring Rigidity

Although our review of the literature suggests the emergence of some agreement on the definition of rigidity, it is not surprising given the multidimensional nature of the construct that no universally acknowledged and accepted ways to measure it exist. Further, there has been little research aimed at establishing the relationship among the existing techniques (Joshi, 1974). Many researchers, dissatisfied with the available instruments, create idiosyncratic measures of rigidity, reporting only minimal descriptions of the materials or procedures. Indeed, Chown's review identified 47 measures of rigidity, and since that time, many additional measures have been developed. More recently, some researchers have moved away from the term rigidity and instead have adopted labels such as personal need for structure, need for closure, openness, or flexibility. In the next section, we will briefly introduce 11 measures of rigidity divided into two categories: 7 questionnaire measures and 4 perseveration measures.

Questionnaire Measures of Rigidity

By far the most widely used procedure for measuring rigidity is to ask respondents to rate statements on a Likert-type scale. These scales are easily administered to many respondents simultaneously and have the advantage of providing estimates for internal reliability. In this section, we review seven questionnaire measures of constructs that assess either the tendency to form or persevere on the use of a mental or behavioral set.

Breskin Rigidity Test. The Breskin Rigidity Test is based on the Gestalt Laws of Prägnanz and measures individual differences in the tendency to form a perceptual set (Breskin, 1968, 1969; Breskin, Gorman, & Hochman, 1970; Breskin & Rich, 1971). Respondents are presented with pairs of images, one of which has "good form," the other of which does not. Respondents are asked to select the one that they prefer. Examples of item pairs from the scale include an equilateral triangle (good form) versus an isosceles triangle or a complete circle (good form) versus an incomplete circle.

Recent research with the scale has found it to be a good predictor of perceptual organization and to have good internal consistency (Beer, 1989; Cunningham, Ridley, & Campbell, 1988; Maltby & Lewis, 1996). However, several articles in the 1970s suggested that the term perceptual rigidity was a misnomer. In examining the relationship between the Breskin scale and performance on standard reversible figures tasks (like the Necker Cube or the Rubin Vase) that require a change in perceptual set, several studies found nonsignificant effects (Joshi, 1974; Primavera, Simon, & Hochman, 1974). Primavera et al. argued that the Breskin scale measures "obsessive cognitive rigidity" and not "perceptual rigidity." However, to date no published study has examined the link between

perceptual rigidity and other measures of rigidity, and at face value the term “perceptual rigidity” seems appropriate.

California Personality Inventory-Flexibility (CPI; Gough & Bradley, 1996). The flexibility subscale of the CPI was developed to measure rigidity–flexibility of personality that was unassociated with political ideology. The first version of the scale, known as the Gough Rigidity scale, was incorporated into the CPI in 1956. People scoring high on flexibility are described as imaginative, spontaneous, and able to adapt to change and the unexpected. They are also described as inconsistent and undependable. People who score low on the scale are described as serious, stubborn, and inflexible. Factor analyses of the 28 items have revealed a complex pattern. Gough and Bradley reported seven factors from a norm sample of 6,000 people. However, there is very little published research on the factors of the flexibility scale.

Intolerance of Ambiguity Scale. Budner (1962) defined intolerance of ambiguity as “the tendency to perceive ambiguous situations as sources of threat” and tolerance of ambiguity as “the tendency to perceive ambiguous situations as desirable” (p. 29). The 16-item scale measures individual differences in desire for certainty (Durrheim, 1995). However, the research literatures on rigidity and intolerance of ambiguity are so closely related that, quite often, the two constructs are treated as synonymous.

Need for Closure Scale (NFCS; Kruglanski, Webster, & Klem, 1993). The 42-item NFCS measures individual differences in preferences for order and structure and the abhorrence of disorder and chaos. The scale measures five correlated subsets labeled preference for structure, discomfort with ambiguity, decisiveness, predictability, and closed mindedness. Research by Kruglanski and his colleagues confirmed the five factor structure and demonstrated reasonable predictive ability. For instance, the scale distinguishes “artistic types” from “conventional types,” predicts individual differences in the tendency to show the primacy effect, is positively correlated with the tendency to commit the fundamental attribution error, and is positively correlated with resistance to persuasion. (Several items from the Personal Need for Structure Scale, described below, are included in the NFCS.)

Openness to experience. Openness to experience is one of the personality dimensions included in the Five-Factor Model of personality (McCrae, 1996; McCrae & Costa, 1996). Openness is a broad and general dimension that includes preference for novelty, cognitive complexity, and flexibility. In contrast, closedness is manifested in a preference for familiarity, simplicity, and closure.

Personal Need for Structure (PNS; Neuberg & Newsom, 1993, Study 3). Personal need for structure refers to individual differences in preference for cog-

nitive simplicity and structure. Measured with a 12-item scale, the PNS represents the degree to which people are motivated to structure their worlds in simple and unambiguous ways. Factor analyses of the scale have revealed two factors labeled Desire for Structure and Response to Lack of Structure. Research suggests that high PNS is associated with a greater tendency to stereotype (Neuberg & Newsom; Schaller, Boyd, Yohannes, & O'Brien, 1995), a greater tendency to categorize new information (Moskowitz, 1993), a tendency to form less complex categories for objects (Neuberg & Newsom, 1993, Study 3), and a tendency to develop mental sets under stressful conditions (Schultz & Searleman, 1998).

Test of Behavioral Rigidity (TBR). Schaie (1955), in a paper that was not cited in Chown's (1959) review, distinguished between "motor-cognitive flexibility," and "personality-perceptual flexibility." Schaie reported the results from a factor analysis of eight instruments that showed three distinct factors. The first is Psychomotor Speed, which refers to the speed with which a person responds to a familiar situation. Because this does not measure rigidity per se, results from this variable were not included in our review. The second factor identified by Schaie was the Personality-Perceptual component, which was defined as "ideational inertia" and measured with a series of true-false questions drawn from early self-report scales of mental flexibility (Schaie, Dutta, & Willis, 1991; Schaie & Parham, 1975). This factor reflects an individual's ability to adjust readily to new surroundings. More recently, this factor has been termed "attitudinal flexibility" (see Schaie, 1996). The third factor of rigidity that Schaie identified is Motor-Cognitive (discussed in the Measures of Perseverative Rigidity section that follows). Motor-Cognitive is a person's ability to shift without difficulty from one activity to another, the behavioral aspect of rigidity.

An 8-year longitudinal study of rigidity using covariance structural models found support for the identity of unique cognitive and behavioral factors (Schaie et al., 1991). Using latent variable analysis at each measurement period, Schaie et al. found a strong correlation ($r = .81$) between the cognitive and behavioral aspects of the scale. In addition, the study found a high degree of consistency across an 8-year span. Correlations between the latent factors across the 8-year period provided an assessment of their stability and were .98 for motor-cognitive flexibility and .80 for personality-perceptual flexibility.

Measures of Perseverative Rigidity

Although questionnaire measures of rigidity are by far the most commonly used assessment technique, they do not lend themselves to experimental methodology. In contrast, problem-solving measures can be administered under manipulated conditions using varied sequences of problems. We have defined rigidity as the tendency to develop and persevere in the use of a mental or behavioral

set. Problem-solving measures have focused almost exclusively on the perseveration aspect of rigidity (for an exception see Schultz & Searleman, 1998). The general paradigm is to ask participants to solve problems in which they discover a set solution and then to change the solution either explicitly by telling them to use a different solution or implicitly by giving them feedback that the set solution is no longer effective. Four measures of perseveration have been frequently used: the TBR, the Einstellung Water-Jar Task, the Wisconsin Card Sorting Task (WCST), and the Stroop task.

TBR. As mentioned earlier, the TBR (Schaie & Parham, 1975) contains both a questionnaire measure and a problem-solving measure of rigidity. The problem-solving measure, termed motor-cognitive rigidity, is assessed through two perseveration tasks: capitals and opposites. In the capitals task, respondents are asked to copy a paragraph containing words written in random lower-case and upper-case letters. After 2½ minutes, they are asked to copy the same paragraph, now using lower-case letters in place of capitals and using capitals for lower-case letters. Behavioral flexibility (the polar opposite of rigidity) is calculated as the number of correctly copied words in the straight copy task divided by the number of words correctly copied during the second task. A similar procedure is used in the opposites task, in which respondents are asked to think first of synonyms for words, then of antonyms, and finally of a randomly varied combination of synonyms and antonyms (Schaie & Parham, 1975). Note that scores on the TBR are calculated such that higher scores indicate less rigidity.

Einstellung Water-Jar Task. Made famous by Luchins (1942), the Einstellung Water-Jar Task asks participants to solve a series of paper-and-pencil problems in which they manipulate three hypothetical jugs of stated sizes in order to obtain a desired amount. For example, given jugs of size 60, 12, and 6 units, how could they be manipulated to obtain 30 units? One correct solution would be $60 - 12 - 12 - 6 = 30$. That is, if one fills the large jug, pours out 12 units twice and pours out 6 units once, then 30 units remain in the large jug. After solving a series of problems that can all be solved through the same solution pattern (large minus two medium minus one small), a set or Einstellung develops.

Once Einstellung has developed, rigidity is measured as the extent to which people persevere in their use of the set solution. Although there is no consensus about how best to measure this perseveration (Levitt, 1956), two methods have been commonly employed (Christie, 1993). The first involves the use of critical problems: problems that can be solved either through the set method or through a more direct, one-step solution. Rigidity is measured as the number of critical problems solved with the set method. A second commonly used technique is the extinction problem, which can be solved only with a short, one-step solution (e.g., medium minus small). Rigidity is either the number of extinction problems the participant fails to solve or the time required to solve one extinction problem.

Over the years, other less-known Einstellung measures have been developed that do not require mathematical ability. For instance, Cowen, Wiener, and Hess (1953) developed an alphabet maze task; Rees and Israel (1935) described an anagram problem-solving task; Cowen et al. (1953) reported a correlation of .42 between a water-jar and an alphabet maze Einstellung test. However, we cannot find any published articles that have used these tasks since the late 1950s.

WCST (Harris, 1998). The WCST is similar to the Water Jar task in that participants are asked to solve a series of problems, each of which can be solved through a set solution (Harris; Heaton, 1981). In the WCST participants are presented with a series of cards, each of which has one, two, three, or four colored shapes. Participants are asked to match the cards by either color, shape, or number in such a way as to discover the experimenter's matching rule. Cards are matched by placing them on stacks so that they match on one of these dimensions. The experimenter then says either "correct" or "incorrect" for each card. After a preset number of correct responses (usually 10), the experimenter changes the matching rule without telling the participant. The measure of rigidity is the number of perseverative matching responses the participant makes before discovering the new sorting rule. For example, if the matching rule was originally color and the participant had correctly matched 10 consecutive cards by color, the experimenter would then secretly change the matching rule to number and record the number of cards the participant continued to match by color (Axelrod, Greve, & Goldman, 1994; Heaton, 1981). A computerized version of this test has also been developed (Harris, 1988). For a discussion of reliability and validity see also O'Donnell, MacGregor, Dabrowski, Oestreicher, and Romero (1994) or Paolo, Axelrod, and Troster (1996).

Stroop Color-Word Interference Task (Stroop, 1935). The Stroop task has been used as a tool for studying attention, interference, cognitive structures, response competition, and at the level of individual differences, rigidity. The task requires shifting and maintaining a particular perceptual set while suppressing "a habitual response in favor of an unusual one" (Spree & Strauss, 1991, p. 52). This interference is analogous to the perseveration aspect of rigidity, and as such, the Stroop task reflects individual differences in the tendency to persevere in the use of a perceptual set. Some researchers (e.g., Graf, Uttl, & Tuokko, 1995) have referred to the individual difference on the Stroop task as "cognitive flexibility."

In the traditional Stroop task (Stroop, 1935), words for different colors are displayed and participants are asked to name the color of the ink in which the word is written. The Stroop effect is the finding that the word meaning (e.g., the word BLUE) interferes with the participant's ability to name the color of the ink (e.g., the word BLUE written in red ink). For our purposes, we will report on individual differences in interference: the difference between the amount of time

taken to name the colors of the inks of a list of color names all written in incongruous colors and the amount of time needed to name an equally long list of color patches. Research on individual differences in Stroop interference scores has shown a very high degree of reliability (cf. Jensen, 1965; Jensen & Rohwer, 1966). See MacLeod (1991) for a comprehensive review of other Stroop procedures and findings.

The Relationships Among the Measures

The various approaches to the measurement of rigidity have yielded several widely used instruments, as well as many lesser known tests. We have identified 11 currently used measures of rigidity: 7 questionnaire measures and 4 behavioral measures. The relationship among these measures has not been extensively examined. Although factor analytic techniques were available for some of the early reviews of rigidity measures, they were cumbersome and not commonly employed (for exceptions, see Oliver & Ferguson, 1951; Horwitz, 1951, as cited in Luchins & Luchins, 1959; Schaie, 1955; or Wolpert, 1955). Since Chown's (1959) review, only a few published articles have examined the relationships among rigidity measures; most studies have simply operationally defined rigidity as the construct measured by their instrument. Today, most studies focus on a single measure, examining the ability of the scale to significantly predict behavior or the underlying factor structure of the scale.

Chown (1959) examined 47 measures of rigidity and concluded that "it is uncertain whether there is any generalized trait of rigidity. . . . Much appears to depend upon the tests of rigidity used, the type and number of tasks involved, and the conditions under which testing is carried out" (p. 201). She noted that the overlap between studies was extremely small and that when two researchers did use the same test, their results were inconsistent. She concluded that it is difficult to determine if the discrepancies are attributable to faulty tests or to differences in experimental conditions, task instructions, or scoring procedures. A similar conclusion was made by Luchins and Luchins (1959), who stated that "existing evidence does not permit any decisive conclusions to be drawn concerning the extent or consistency, generality, or specificity of rigidity" (p. 494).

In the years since Chown's review, little progress has been made in investigating the relationships among the growing number of rigidity tests (Guilford, 1967; Kreidler et al., 1990; Muhar, 1974). The instruments for measuring rigidity appear to have been developed in nonoverlapping stages. Little research has attempted to span the 100 years of the literature to identify commonalities among the measures. Card sorting tasks have been used primarily for clinical diagnoses and psychiatric research; the Einstellung task has been used to study cognition; the Breskin Rigidity Test has been used to study perception; the Stroop task has been used to study interference and attention; the PNS and NFCS scales have been used to study social cognition; Intolerance of Ambiguity has been used to

study political ideology and belief systems; and the CPI-flexibility and Openness to Experience scales have been used to study personality. Most research on rigidity has failed to distinguish between mental and behavioral rigidity, although the TBR has been available for almost 40 years. Even studies that employ the TBR often rely on the composite score as the measure of rigidity and fail to report separate findings for each factor.

A few scattered findings suggest a fair degree of consistency between questionnaire measures. Neuberg and Newsom (1993) found correlations between the PNS and Gough's Rigidity Scale of .58 ($N = 851$), .60 ($N = 360$), and .48 ($N = 191$). Neuberg and Newsom reported a correlation coefficient of $-.42$ ($N = 92$) between the PNS and openness to experience. Webster and Kruglanski (1994) reported correlation coefficients between the NFCS and the Intolerance of Ambiguity scale ($r = .29$; $N = 157$) and the PNS ($r = .24$; $N = 157$). Neuberg, Judice, and West (1997) reported a correlation coefficient between NFCS and openness to experience ($r = -.12$; $N = 273$).

Our review identified one study that examined the relationship between the Breskin Rigidity Test and several other measures of rigidity. Breskin et al. (1970) tested the relationship between the Breskin Rigidity Test, TBR, and Stroop Color-Word Interference Task. Results showed a correlation coefficient of $r = -.40$ between the TBR motor-cognitive flexibility and the Breskin Rigidity Test. A nonsignificant correlation was found between the Breskin Rigidity Test and TBR personality-perceptual flexibility scales ($r = .02$). A significant positive relationship ($r = .40$) was found between the Breskin Rigidity Test and interference on the Stroop Color-Word Interference Task.

Schaie (1955; see also Schaie, 1996, pp. 65–68) reported small, positive correlations between the TBR and rigidity on the Einstellung Water-Jar Task. Schaie and Horst (1956; cited in Schaie, 1996) summarized the results from two samples that used the TBR and the Einstellung Water-Jar Task. Factor analyses revealed that Einstellung rigidity tended to load on the attitudinal flexibility factor and not the motor-cognitive factor. However, the two factors were positively correlated ($r = .51$, $N = 216$, in a diverse sample; and $r = .08$, $N = 200$, in a sample of college students).

Summary of Research Findings for Behavioral Rigidity

Despite the lack of progress in measurement issues, researchers have pressed forward in several substantive areas. The topics of rigidity and age, authoritarianism, intelligence, gender, mental retardation, and schizophrenia have all received considerable attention. In the sections that follow, the research on each of these topics is summarized. Our focus is on three measures of behavioral rigidity—Einstellung, TBR, and WCST. The other eight measures have been reviewed elsewhere (Stroop, CPI-flexibility, openness to experience, Intolerance of Ambiguity), or are relatively new (PNS, NFCS), or lack sufficient research (Breskin

Rigidity Test) to warrant inclusion in a meta-analysis. The three measures that we meta-analyzed are similar in that each involves the development of a response set, changes to the set, and an assessment of perseveration.

Method

Identifying Studies

Studies relevant to our review were identified by searching the PsycINFO (1967–1999) database using the key words rigidity, Einstellung, perseverat*, and WCST. Studies were also identified by searching previous reviews of each measure of rigidity (e.g., Chown, 1959; Luchins & Luchins, 1959), the manual that accompanied the WCST, and references listed in identified articles. Our search for relevant articles was also aided by the help of Warner Schaie and Edith Luchins. To be included in the meta-analysis, a study had to be available in print form, be written in English, and contain sufficient information that it was possible to calculate effect size estimates (i.e., sample size and descriptive statistics, probability values, or inferential statistics). A total of 325 studies were identified; of these, 151 met our criteria and were coded.

Coding

The independent variables, dependent variables, reliability of measures, date of publication, effect sizes, sample sizes, characteristics of the samples, and test setting were coded for each study. For the TBR, effect sizes were obtained for motor–cognitive rigidity. To be consistent with the WCST and Einstellung scores, signs on the TBR effect size estimates were reversed so that higher scores indicated more rigidity. From the WCST, we selected the number of perseverative errors as the measure of rigidity. In instances where this information was not available, we used the percent of perseverative errors. Factor analyses of the WCST have shown these two measures to be highly correlated and to load on a single factor (Goldman et al., 1996). From the Einstellung task, we used the first problem that immediately followed the administration of the set problems. In the typical administration of the Einstellung Water-Jar problems, 5 set problems are followed by 2 critical problems, 1 extinction problem, and then 2 more critical problems. In these studies, we used only the data from the first critical problem. Studies that measured rigidity with any instrument other than those listed above were excluded from the review. Excluded studies are discussed conceptually, but no effect size values are reported.

Analysis

Analyses of the independent variables (age, authoritarianism, gender, intelligence, mental retardation, obsessive–compulsive disorder, and schizophrenia)

were conducted separately. All initial analyses were performed using effect size estimates from each of the three measures of rigidity (Einstellung task, TBR, WCST). A four-step process was used to analyze the studies. First, a weighted average effect size was calculated representing the overall strength of the effect across the three measures. Second, we calculated a homogeneity statistic (Q) to test whether the variability within the effect sizes was more than would be expected by chance. If this test was not significant, it would suggest a consistent effect across the measures and across the studies. That is, if the effect sizes did not deviate significantly from homogeneity, it would suggest that the variance in the effect sizes across studies was due to chance alone and not to other factors. If the homogeneity statistic was significant, we proceeded to explain the variability using the coded variables. One source of variability across studies has to do with the measure of rigidity employed in the study. Because we selected three measures that are conceptually similar, this source of variability was examined only after all other moderators had been tested. If the homogeneity statistic remained significant after considering the coded moderators, separate effect sizes were calculated for each measure of rigidity. All analyses were computed by hand or with the assistance of the Meta computer program (Schwarzer, 1989).

A common procedure in meta-analysis is to adjust the effect size estimates for unreliable measures. However, because problem-solving measures of rigidity rely on one-time assessments, they do not lend themselves to assessments of reliability. We chose a more conservative procedure and did not adjust the effect size estimates.

Results

Age and Rigidity

Do people become more rigid in their cognitions and behaviors as they grow older? A considerable amount of research has addressed the relationship between rigidity and age (Chown, 1961; Kramer, Humphrey, Larish, Logan, & Strayer, 1994; Schaie, 1994, 1996). The empirical investigations can be classified as either cross-sectional or longitudinal. Our review identified 37 articles that reported cross-sectional results using one of the three selected measures of rigidity, and 1 longitudinal study.

Longitudinal research. The most extensive research into the effects of aging on rigidity is a series of reports by Schaie and colleagues based on the Seattle Longitudinal Study (Schaie, 1996; Schaie, LaBouvie, & Beuch, 1973; Schaie & Labouvie-Vief, 1974; Schaie & Parham, 1974, 1975; Schaie & Willis, 1991). The Seattle Longitudinal Study has examined changes in adult personality and mental abilities since 1956. Cross-sectional data are available for more than 4,000 participants between the ages of 22 and 84 years of age, and waves of longitudi-

nal data are available for each cohort. Data were obtained in 7-year intervals, and rigidity was measured with the TBR. Analyses revealed a significant cohort effect, with participants born earlier being more rigid than later-born participants at the same age. Schaie and Willis reported cohort gradient coefficients reflecting the amount of change across each 7-year measurement period as standardized T scores, all of which are small (e.g., $d < .10$). However, the cohort gradients show a linear decrease in both attitudinal flexibility and motor-cognitive flexibility (termed *associational flexibility* by Schaie & Willis) across the groups, with 25-year-olds measured in 1984 scoring 1.5 standard deviations higher on motor-cognitive flexibility than 81-year-olds measured in 1984.

Longitudinal analyses of change in behavioral flexibility based on repeated measures of the same individual also showed a decrease with age, although not as large as those observed in the cross-sectional analyses. Schaie and Willis (1991) reported longitudinal changes in standardized T scores, which we converted to d scores representing the change in rigidity at each 7-year measurement period. For the motor-cognitive dimension of the TBR, the results showed that between the ages of 25–32 years ($d = .06$), 32–39 ($d = .06$), and 39–46 ($d = .06$), flexibility increased slightly. However, between the ages of 46–53 ($d = -.01$), 53–60 ($d = .08$), 60–67 ($d = -.14$), 67–74 ($d = -.18$), and 74–81 ($d = -.42$), behavioral flexibility decreased substantially. Similar results were found for personality-perceptual rigidity (now termed *attitudinal rigidity*).

Cross-sectional studies. Our review identified 37 cross-sectional studies examining age and one of three selected measures of rigidity. Of these, effect sizes were calculable for 22 studies. One of the difficulties in analyzing the age data is the inconsistency in compared groups. Many studies reported differences in rigidity between young and old groups, but the age groups included within these comparisons varied considerably. Results from the longitudinal research reported in the previous section showed stable levels of rigidity between the ages of 18 and 60 years. After 60, rigidity increased linearly. A similar pattern was noted by Luchins and Luchins (1959):

Rigidity, as measured by failure of the extinction task, tended to be less for younger children than for older children, less for middle-aged adults than for older adults, and less for young adults in their twenties than for either children or older adults. (p. 486)

Because of these earlier findings, we chose to facilitate the analysis of age data by classifying age groups as either young adult (18–39), middle adult (40–59), or older adult (60+). Studies examining children were analyzed separately. Three studies reported correlation coefficients between age and rigidity instead of making between-groups comparisons. For these analyses, r values were converted to d values and classified according to the youngest and oldest in the sample. Two studies (Chelune & Thompson, 1987; Welsh, Pennington, & Groisser, 1991) compared children with adults; results showed children to be

more rigid ($d = .63$; $N = 325$) on the WCST. Four studies examined changes in rigidity during childhood. Results showed consistently that between the ages of 5 and 18, children tend to become less rigid (Levin et al., 1991; Riccio et al., 1994; Rosselli & Ardila, 1993; Welsh et al., 1991).

A total of 28 effect size estimates were calculated: comparing young with middle adult ($k = 8$), middle with older adult ($k = 6$), and young with older adult ($k = 14$). Of these, 6 used the Einstellung task, 3 used the TBR, and 19 used the WCST. For the young–middle comparisons ($N = 582$), the results showed a significant difference (weighted $d = -.33$; 95% confidence interval [CI] from $-.06$ to $-.58$) with younger adults being less rigid than middle adults. The effects size deviated significantly from the random effects model, $Q(7) = 15.66$, $p = .03$. Because the random effects model could be rejected, we proceeded to calculate effect size estimates separately for Einstellung ($d = -.08$; $N = 100$), TBR ($d = -.66$; $N = 83$), and WCST ($d = -.33$; $N = 399$). For the middle–older comparison ($N = 301$), the results revealed a significant difference (weighted $d = -.60$; 95% CI from $-.25$ to $-.83$), with middle adults being less rigid, and the effect size variability did not deviate substantially from the random effects model, $Q(5) = 5.48$, $p = .36$. Finally, for the young–older comparison ($N = 915$), results revealed a significant difference (weighted $d = -.71$; 95% CI from $-.57$ to $-.84$), with young adults less rigid, and the effects were homogeneous, $Q(12) = 6.66$, $p = .88$. Four additional studies reported a positive linear relationship between age and rigidity among older adults (aged 55–90 years; Arbuckle & Gold, 1993; Axelrod, Jiron, & Henry, 1992; Davis et al., 1990; Storck, Looft, & Hooper, 1972).

Overall, the results from both the cross-sectional and longitudinal research showed curvilinear relationships between rigidity and age. Between the ages of 5 and 18, rigidity decreased substantially. Between the ages of 18 and 60 rigidity remained fairly stable, and, if anything, decreased slightly. After age 60, rigidity increased linearly.

Authoritarianism and Rigidity

Since the publication of *The Authoritarian Personality* in 1950 (Adorno, Frenkel-Brunswik, Levinson, & Sanford, 1950), more than 2,000 studies have been published on the construct (Meloan, 1993). Adorno et al. (1950) stated, “One of the most pervasive formal aspects of the personality organization of the extremely prejudiced individual is his rigidity” (p. 479). However, empirical evidence supporting this assertion was not provided in *The Authoritarian Personality* (Christie, 1993). Unfortunately, that conclusion by Adorno et al. (1950) has permeated psychological research, and the terms *authoritarian* and *rigid* are often used interchangeably. Indeed, some researchers mistakenly use authoritarianism scores to define rigidity.

We identified 15 studies that examined the relationship between authoritarianism and rigidity. Of those, 5 could not be coded because of insufficient infor-

mation. The 10 coded studies yielded 15 independent effect sizes: 12 from the Einstellung task and 3 from the TBR. All effect sizes were converted to Fisher's Z (Z_r) representing the association between authoritarianism and rigidity. Combined results revealed a nonsignificant relationship between authoritarianism and rigidity: weighted $Z_r = .22$; 95% CI from $-.11$ to $.55$; $N = 1,032$; $k = 15$. Analysis of effect size homogeneity revealed a significant effect: $Q(14) = 47.53$, $p < .001$.

In an earlier review, Christie (1993) reviewed 9 studies that measured both Einstellung rigidity and authoritarianism and found inconsistent results across studies. Christie discussed experimental conditions that may have affected the results. His review led him to hypothesize that studies that measured rigidity under ego-involving (or stressful) conditions tended to produce a positive relationship, whereas studies that measured rigidity under neutral (or relaxed) conditions tended to reveal no relationship.

Following Christie (1993), separate effect size estimates were calculated for studies that measured rigidity under stressful or relaxed (including unspecified) conditions. In the relaxed conditions, results showed a nonsignificant relationship between authoritarianism and rigidity (weighted $Z_r = .19$; 95% CI from $-.13$ to $.50$; $N = 821$; $k = 11$; $Q[10] = 34.32$; $p < .001$). Studies conducted under stressful conditions tended to produce larger effects (weighted $Z_r = .30$; 95% CI from $.21$ to $.39$; $N = 211$; $Q[3] = 3.48$; $p < .18$). Because of the significant deviation from homogeneity within the relaxed condition studies, separate effect size estimates were calculated for TBR and Einstellung. Two of the effect size estimates were obtained using the TBR (weighted $Z_r = .43$; $N = 277$; 95% CI from $.30$ to $.55$), and 9 of the effect size estimates were obtained using the Einstellung Water-Jar Task ($Z_r = .06$; $N = 544$; 95% CI from $.01$ to $.09$). Neither group of effects deviated significantly from homogeneity: TBR, $Q(1) = 3.63$, $p = .06$, Einstellung, $Q(8) = 4.34$, $p = .82$. No published study could be found that examined the relationship between authoritarianism and WCST rigidity.

To summarize, the results for authoritarianism suggest that higher authoritarian scores are positively related to rigidity only under stressful conditions. Under relaxed conditions, authoritarianism is positively related to TBR motor-cognitive scores, but not to scores on the Einstellung task.

Gender

Are men more rigid than women? Several meta-analyses on gender differences have generally shown small differences between women and men (e.g., Eagly, 1994; Eagly, Karau, & Makhijani, 1995). Our review of the literature on gender differences identified 13 studies that used one of our three selected measures of rigidity. Five studies did not report enough information to calculate effect size estimates. The chosen effect size estimate for comparisons of men and women was the d statistic. Results showed a significant overall difference, with men tending to be more rigid than women (weighted $d = .31$; 95% CI from $.24$

to .38; $N = 903$; $k = 7$). The effect size variability deviated significantly from a random effects model, $Q(6) = 35.62$, $p < .001$.

Subsequent analyses attempted to explain the variability in effect sizes. Several authors (e.g., Luchins & Luchins, 1982, 1984) have suggested that the experimental setting is an important factor in determining gender differences in rigidity. For instance, the Luchins and Luchins studies (1959, 1982) using the Einstellung task consistently found no gender differences under relaxed conditions. However, when time pressure was introduced in a 1982 study, gender differences were found, with men being more rigid than women ($d = 1.50$; $N = 50$). This finding has not been replicated. Examining the effect size estimates separately under relaxed conditions identified in our meta-analysis (i.e., no time pressure) revealed a clear pattern for the TBR ($d = .61$; $N = 91$) and the WCST ($d = .40$, $N = 83$; $d = .59$, $N = 129$), but not for the Einstellung Water-Jar Task ($d = .04$, $N = 50$; $d = -.28$, $N = 271$; $d = .38$, $N = 300$).

To summarize the research on gender differences in rigidity, we find evidence for an overall effect whereby men are more rigid than women. However, a considerable amount of variability remains in the scores that cannot be explained by either the assessment instrument or time pressure imposed during test administration.

Rigidity and Intelligence

A growing body of literature suggests that intelligence and rigidity are negatively related. The strongest evidence supporting the intelligence–rigidity relationship comes from Schaie’s longitudinal research (Schaie, 1994; Schaie et al., 1991). Using a “psychometric intelligence measurement battery,” Schaie generated several measures of intellectual ability, including inductive reasoning, spatial orientation, verbal ability, numerical ability, verbal memory, and perceptual speed. He also administered the TBR. Intercorrelations among the derived factors revealed a strong relationship between behavioral flexibility (motor–cognitive) and the measures of mental abilities, with correlations among the latent factors ranging from .26 to .91. The average correlation across the combined measures of cognitive ability was .72 for motor–cognitive flexibility. (Note: Correlations reflect a positive relationship between flexibility and intelligence.)

In their 1959 review, Luchins and Luchins concluded that “behavioral rigidity decreases with intelligence” (p. 486). Our review identified 22 studies that examined the relationship between intelligence and rigidity. From these, we were able to obtain 15 codable, independent effect sizes reflecting the strength of the association between rigidity and intelligence. Results from the meta-analysis revealed a significant negative overall relationship (weighted $Z_r = -.28$; 95% CI from $-.03$ to $-.53$; $N = 1,917$). The effect sizes were heterogeneous, $Q(14) = 52.52$, $p < .001$, so separate effect sizes were calculated by each measure. For the TBR, results showed a significant effect (weighted $Z_r = -.23$; 95% CI from $-.22$ to $-.24$; $N = 215$) with homogeneous variability, $Q(3) = 3.02$, $p = .39$. For the

WCST, results also revealed a significant effect (weighted $Z_r = -.34$; 95% CI from $-.19$ to $-.50$; $N = 1,358$), with the effect size estimates deviating significantly from homogeneity, $Q(8) = 20.12$, $p < .01$. Only two coded studies used the Einstellung Water-Jar Task ($r = .14$, $N = 100$; $r = -.18$, $N = 244$). Overall, these findings suggest a negative relationship between rigidity and general intelligence, although the results for Einstellung rigidity are less clear than for the TBR or WCST.

Additional support for a negative relationship between intelligence and rigidity comes from research on gifted students. Jausovec (1991) examined differences between the way gifted and average students solved problems. Gifted students were selected from a group of 18-year-olds receiving a scholarship for exceptional school performance and high scores on standardized intelligence tests. Average participants were obtained by prescreening 150 18-year-old college students enrolled in an introduction to psychology course. Results indicated that the gifted students tended to be more flexible and creative in their problem solving. Gifted students used more divergent solution attempts to a variety of problems, particularly when the problems were difficult. Interestingly, gifted students used a wider range of strategies for solving complex problems, whereas average students did not differ in the range of strategies they used for easy or difficult problems. The results from this study showed that gifted students were less likely to develop a response set and that if a set did develop, they could quickly shift to a different problem-solving strategy when it was advantageous to do so (see also Luchins & Luchins, 1959).

Rigidity and mental retardation. An extension of the research on the relationship between rigidity and intelligence is the study of rigidity among individuals with mental retardation. Are individuals with mental retardation more rigid in their thinking or behavior than individuals without mental retardation? Research addressing this question dates back to Kurt Lewin's original work on behavioral perseveration among "the feeble-minded" (Kounin, 1948; Lewin, 1935; Werner, 1946; Zigler & Balla, 1982). Lewin asked children with normal intelligence and children with mental retardation, of various ages, to draw pictures of moon faces until they reached satiation. At that point, the children were instructed to draw pictures of whatever they wanted. Results showed that the children with mental retardation did not satiate as quickly to the task, but once they did, they were more likely to draw moon faces during the free-draw session. Lewin (1935) argued that this evidence indicated that children with mental retardation had a greater tendency to perseverate in their behavior than children with normal intelligence and that they had difficulty switching to another activity in the same area.

Subsequent studies on the relationship between rigidity and mental retardation by other researchers have reported inconsistent results (Dulaney & Ellis, 1994; Wolff, 1967; Zigler & Balla, 1982). Indeed, in a review of 18 studies, Wolff (1967) concluded that "no consistent pattern in these results is apparent" (p.

381). More recently, Kreitler et al. (1990) reviewed 25 studies that tested for differences between participants with and without mental retardation, all of whom were matched on mental age. Of the 25 studies, 12 found a positive relationship between rigidity and mental retardation, 11 found no relationship, and 2 found a negative relationship (Dulaney & Ellis; see also Zigler & Balla, for a more detailed review).

Despite the large amount of research dedicated to an examination of differences in rigidity between people with mental retardation and those without, no study could be identified that used one of our three measures of behavioral rigidity. Luchins and Luchins (1959) noted that the Einstellung Water-Jar Task was not appropriate for people with mental retardation because of the math skills required. In general, a wide variety of measures have been used, but there is little overlap between the measures used by different researchers looking at the same topic (Ellis & Dulaney, 1991; Kreitler et al., 1990). In addition, there is evidence that studies in which participants with mental retardation and participants without mental retardation are matched on mental ability reveal different results than studies in which participants are not so matched (Dulaney & Ellis, 1994). Because of the lack of consistency in the measurement of rigidity and the disagreement on measurement instruments, it is not possible to draw any conclusions about differences in rigidity between people with mental retardation and those without.

Obsessive–Compulsive Disorder (OCD)

In searching for psychological variables related to rigidity, OCD seems a likely source. OCD is characterized by recurrent, persistent, and unwanted thoughts and by repetitive, ritualized behavior. In many ways, the compulsion side of OCD seems similar to perseveration.

We identified 10 studies of OCD and rigidity relevant to our review, from which we were able to extract nine independent effect sizes. In each of these studies, groups of people known to have OCD were compared with matched control groups. The results revealed that people with OCD were significantly more rigid than the people in the control groups (weighted $d = .50$; 95% CI from .32 to .68; $N = 496$) and that the results did not deviate from a random effects model, $Q(8) = 5.32, p = .72$.

Schizophrenia

Research on the psychological deficits associated with schizophrenia has a long history. In an early review of this literature, Buss and Lang (1965) concluded, "Schizophrenics give a more closed, narrow, stimulus-bound basis for sorting objects, whereas normals give an open, more inclusive, stimulus-free basis for sorting" (p. 15; see also Goldberg & Weinberger, 1994, and Van der Does & Van den Bosch, 1992). Buss and Lang's review clearly indicated that schizophrenics

have difficulty changing a set that is no longer effective for an experimental task. In contrast, Luchins and Luchins (1959) noted that the Einstellung task had produced inconsistent results and that findings were largely dependent on the characteristics of the comparison group (i.e., siblings, normals, neurotics, or hospitalized normals).

Our review of the literature identified 53 studies of schizophrenia that used one of our selected measures of rigidity. From these, we were able to generate 37 independent effect size estimates. The characteristics of the comparison sample (matched normal, unmatched normal, siblings, twins) as well as the use of medication were coded. Several of the effect size estimates were extremely large (e.g., $d = 6.81$). To limit the amount of variability, outliers were truncated to a maximum d of 1.50.

Overall results showed that schizophrenics were significantly more rigid than controls (combined across all variables): weighted $d = .71$, 95% CI from .63 to .80, $N = 2,290$, $k = 37$. The effect sizes deviated substantially from a random effects model, $Q(36) = 118.80$, $p < .001$. Separate effect sizes were calculated for comparisons in which the schizophrenics were on medication and when they were not (or unspecified). Medicated schizophrenics were significantly more rigid than controls ($d = .52$; 95% CI from .38 to .66; $N = 841$; $k = 13$), and the findings were not homogeneous, $Q(12) = 27.64$, $p < .01$. All 13 of the studies reporting effects for medicated schizophrenics used the WCST. For comparisons between unmedicated schizophrenics and controls, the differences were significantly larger (weighted $d = .83$; 95% CI from .72 to .94; $N = 1,449$; $k = 24$) and the results deviated significantly from the random effects model, $Q(23) = 81.07$, $p < .001$. Of the 24 studies examining unmedicated schizophrenics, 21 used the WCST and 3 used the Einstellung task; none of the identified studies used the TBR. Separate effect sizes showed that schizophrenics tended to show more rigidity on the WCST compared with controls (weighted $d = 1.01$; 95% CI from .88 to 1.27), and the effects were homogeneous, $Q(20) = 28.34$, $p = .10$. In contrast, the results from the Einstellung task did not show a significant difference between schizophrenic and control participants (weighted $d = .05$; 95% CI from $-.21$ to .31), and the effects were not homogeneous, $Q(2) = 10.03$, $p < .01$.

Three studies reported correlations between severity of schizophrenic symptoms and rigidity. Results showed a strong positive association, with more severe schizophrenic patients showing more rigidity than schizophrenic patients who had less severe symptoms ($r = .31$, $N = 30$, Franke et al., 1993; $r = .61$, $N = 75$, Lysaker, Bell, & Bioty, 1995; $r = .36$, Williamson et al., 1989). See also Goldberg and Weinberger (1994) for a cogent review.

Several studies have attempted, with limited success, to train schizophrenics not to make perseverative errors on the WCST (e.g., Bellack, Mueser, Morrison, Tierney, & Podell, 1990; Green, Ganzell, Satz, & Vaclav, 1990; Summerfelt et al., 1991; Vollema, Geurtsen, & van Voorst, 1995; Young & Freyslinger, 1995). The results suggested that perseverative errors can be reduced. For example, re-

TABLE 2
Other Correlates of Rigidity

Correlate	Source	Direction of effect
Academic performance	Rosselli & Ardila (1993)	No significant effect
Alcoholism	Sullivan et al. (1993)	Alcoholic more rigid
	Jenkins & Parsons (1978)	Not codable
	Malmo (1974)	Not codable
	Tarter & Parsons (1971)	Alcoholic more rigid
Alzheimer's disease	Paolo, Axelrod, Troster, Blackwell, & Koller (1996)	Alzheimer's more rigid
	Bondi, Monsch, Butters, Salmon, & Paulsen (1993)	More severe Alzheimer's more rigid
	Litvan, Mohr, Williams, Gomez, & Chase (1991)	Alzheimer's more rigid
Attachment quality	Butcher, Kalverboer, Minderaa, & Doormaal (1993)	Not codable
Attention Deficit Disorder	Everett et al. (1991)	ADD more rigid
	Fischer, Barkley, Edelbrock, & Smallish (1990)	ADD more rigid
	Seidman, Biederman, Faraone, Weber, & Ouellette (1997)	ADD more rigid
	Williams, Littell, Reinoso, & Greve (1994)	ADD more rigid
	Lorsbach & Worman (1988)	Not codable
Autism	Ozonoff (1995)	Autistic more rigid
	Ozonoff & McEvoy (1994)	Not codable
	Ozonoff, Pennington, & Rogers (1991)	Autistic more rigid
	Prior & Hoffman (1990)	Autistic more rigid
	Rumsey (1985)	Autistic more rigid
	Rumsey & Hamburger (1988)	Not codable
	Schneider & Asarnow (1987)	Autistic more rigid
Child abuse	Haskett, Johnson, & Miller (1994)	Not codable
	Milner & Robertson (1990)	Not codable
	Milner, Gold, & Wimberley (1986)	Not codable
Depression	Hart, Kwentus, Wade, & Taylor (1988)	Depressed more rigid
	Martin, Oren, & Boone (1991)	Depressed more rigid
Eating disorders	Shearin, Russ, Hull, & Clarkin (1994)	Not codable

(table continues)

TABLE 2 (continued)

Correlate	Source	Direction of effect
Juvenile delinquency	Rogers & Ballering (1976)	Delinquents more rigid
	Moffitt & Silva (1988)	Delinquents less rigid
Left hemisphere dominance	Gray, Dean, & Seretny (1986)	Not codable
Lobectomy	Trenerry & Jack (1994)	Not codable
Self-esteem	Ramamurti & Gnanakannan (1972)	Less self-esteem more rigid
Mania	Morice (1990)	Manics more rigid
Personality (internal vs. external)	Matson & Fischer (1991)	Internalizers more rigid
Parkinson's disease	Beatty & Monson (1990)	Parkinson's more rigid
	Paolo, Axelrod, Troster, et al. (1996)	Parkinson's more rigid
	Canavan et al. (1989)	Parkinson's more rigid
	Litvan et al. (1991)	Parkinson's more rigid
	Paolo, Troster, Axelrod, & Kroller (1995)	Parkinson's more rigid
	Starkstein, Bolduc, Preziosi, & Robinson (1989)	Not codable
Schizotypal personality	Raine, Sheard, Reynolds, & Lencz (1992)	Not codable
	Lyons, Merla, Young, & Kremen (1991)	Schizotypal more rigid
	Trestman et al. (1995)	Schizotypal more rigid
	Lenzenweger & Korfine (1994)	No significant effect
Sleep apnea	Naegele et al. (1995)	Sleep apnea more rigid
Smoking	Twisk, Snel, Kempter, & van Mechelen (1998)	Not codable
	Vingerhoets, Croon, Jeninga, & Menges (1990)	Not codable
Suicidal thoughts	Perrah & Wichman (1987)	No significant effect
	Rickelman & Houfek (1995)	Not codable
Sex roles	Potash (1978)	Not codable
	Sahoo, Rout, & Rout (1985)	Androgynous less rigid
Unsuccessful coping strategies	Kohlmann (1993)	Not codable
Work Stress	Hellman, Morrison, & Abramowitz (1987)	Not codable

Note. Articles listed as not codable were either conceptual articles or did not provide enough statistical detail with which to calculate an effect.

search showed that a monetary feedback system whereby participants were given rewards for correct responses significantly reduced the number of perseverative errors over successive trials. However, the effects tended to be short-lived, and once the reward system was removed, perseveration levels returned to baseline. In addition, only about half of the schizophrenic participants showed reductions in WCST perseveration. Similar findings have been found when the experimenter provided detailed trial-by-trial instructions.

Other Correlates of Rigidity

Age, authoritarianism, intelligence, gender, mental retardation, OCD, and schizophrenia are by far the most commonly studied correlates of rigidity. In addition, a variety of other correlates have been examined over the past century. However, because only a few studies (and sometimes only one) are associated with these correlates, separate meta-analyses were not performed on them. A list of these correlates is provided in Table 2, which shows the topic studied, references, and the direction of the effect.

Conclusions

A considerable amount of research over the last 100 years has investigated the construct of rigidity. Given the broad-based interest in the construct and its usefulness for understanding human thought and behavior, rigidity will undoubtedly continue to attract researchers from many areas of psychology. In this article we have provided a working definition of rigidity, discussed measurement issues, reviewed established findings using meta-analytic techniques, and suggested directions for future research.

On the basis of our definition of rigidity, the tendency to develop and persevere in the use of mental or behavioral sets, the present review of the literature supports the following major conclusions:

- Rigidity is related to age in a curvilinear manner. Between the ages of 5 and 18 rigidity decreases; between the ages of 18 and 60 rigidity is fairly stable; and from age 60 on rigidity increases in a linear fashion.
- Although rigidity is found to be generally positively related to authoritarianism, the basic effect is moderated by stress, whereby authoritarianism is a stronger predictor of rigid behavior under stressful conditions than it is under relaxed conditions.
- Rigidity is negatively related to intelligence when people of average and above average intelligence levels are compared.
- It is inconclusive whether people with mental retardation differ in rigidity from people without mental retardation.
- Men tend to be more rigid than women.

- OCD is positively related to rigidity.
- Schizophrenic people are more rigid than nonschizophrenic controls and nonschizophrenic siblings. This effect is reduced, but still significant, when medication is administered.

On the basis of our review of the literature, we identified three central, interrelated issues that need to be addressed. First, how should rigidity of thought and behavior be measured? To date, a wide variety of measurement instruments have been developed, ranging from self-report personality inventories to experimentally induced behavioral sets. Yet, frustratingly, there has been little empirical research examining the relationships among the multitude of measures. For instance, Schaie and his colleagues (Schaie, 1955; Schaie, 1996; Schaie et al., 1991; Schaie & Parham, 1975) have proposed three rigidity-related factors and have developed a widely used instrument (TBR) to assess these factors. However, the relationship between the factors of the TBR and other rigidity-related instruments (e.g., Einstellung task, WCST, CPI, openness to experience, the Stroop task, Breskin Rigidity Test, Intolerance of Ambiguity, PNS, or NFCS) has yet to be reported. Some consensus by the research community concerning how best to tap into the rigidity construct would go a long way toward making progress in this area.

Second, active researchers in the field have generally shied away from developing theoretical explanations for rigidity. Part of the problem, just mentioned and mentioned earlier in the measurement section of this article, is that there is a dearth of empirical data showing the interrelationships between the major measures of rigidity. Without this corpus of data, correlation matrices cannot be produced and subjected to factor analytic techniques. This greatly hinders the development of a framework for understanding the multidimensional construct of rigidity. In the end, we believe that no single explanation will likely suffice to account for rigid thinking and behavior across different types of people or variables. For instance, differences in rigidity associated with alcoholism, Parkinson's disease, autism, and schizophrenia may well have a biological basis, whereas rigidity differences related to authoritarianism, intelligence, and gender may be more cognitively based.

Finally, researchers need to examine ways to overcome rigidity. A large body of psychological research has been devoted to changing thoughts, feelings, and behaviors. Many different subfields of psychology are concerned with promoting change in behavior. For example, psychologists working in applied settings typically want to change behavior toward a more socially acceptable or healthy alternative (e.g., smoking cessation, the use of precautions such as condoms to prevent AIDS-risky behavior, reductions in aggressiveness, reduction of drinking and driving, promotion of positive environmental behaviors, reduction of prejudice). Rigidity is the tendency of a person not to change, the nemesis of applied psychologists. A solid theoretical foundation would lead to testable hy-

potheses regarding who will change and when, and this knowledge could in turn be used to develop more effective applied interventions.

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APPENDIX

Studies Included in the Meta-Analysis

Age Studies

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Obsessive-Compulsive Disorder Studies

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