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Response Time as Self-Schema Indicator

Implications for Personality Assessment

LARS-ERIK HEDLUND

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Abstract
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The focal objective of this thesis was to examine the potential advantage of introducing the self-schema concept, indexed by response time, into personality assessment. The basic rationale for the use of response time is that a self-schema facilitates response time for self-referent information as it permits people to make assessments easier and automatic. A self-schema is a cognitive structure containing the generic knowledge that people have about themselves, influencing all aspects of the processing of self-relevant information in order to organize, summarize and explain their behavior.

Paper I examined the self-schema proposition that the relation between personality score and response time for the Big Five personality factors is curvilinear in accordance with the inverted-U effect. Using more appropriate statistical methods than in previous studies, Study 1 and Study 2 confirmed the existence of the inverted-U effect for all Big Five factors. Thus the results provided support for the self-schema perspective as people scoring low or high on the Big Five traits responded faster than those scoring in the middle.

Previous research has shown that the Big Five personality factors Openness to Experience and Agreeableness are powerful predictors of prejudice. The main question in Paper II was whether this prediction could be improved by including a measure of self-schema (schematicity). The results of Study 3 demonstrated that response time significantly improved the prediction of generalized prejudice from the mentioned personality factors and disclosed both an additive and a moderating effect. Thus, the relation between personality trait score and generalized prejudice is moderated by how schematic a person is.

Paper III examined the potential linkage between heritability and self-schema. In Study 4, 5, and 6, the relation between heritability and response time for the Big Five personality facets (subfactors) was examined. The results revealed that personality response time is related to personality heritability so that shorter response times are associated with higher heritabilities. Putting the present results into the context of self-schemas, this means that Big Five personality facets with a large heritability on the average would have higher schematicity than those with small heritability estimates.

The results of the present thesis extend previous work in the area of self-schema. The findings suggest that self-schema, measured by response time, may be a useful additional tool to fine-tune personality assessment. Also, the findings put emphasis on the importance of considering possible curvilinear relationships and interaction effects in order to better comprehend the rationale underlying self-schemata processing. Finally, the results imply that the heritability of personality traits should be taken into account when we construct theories and models in personality psychology. The implications of these results are discussed and directions for future research are highlighted.

Keywords: Self-schema, response time, inverted-U effect, heritability, personality assessment, curvilinearity, personality trait, five factor model

Lars-Erik Hedlund, Department of Psychology, Box 1225, Uppsala University, SE-75142 Uppsala, Sweden

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List of Papers

This thesis is based on the following papers, which are referred to in the text by their Roman numerals.

I Akrami, N., Hedlund, L.-E., & Ekehammar, B. (2007). Personality scale response latencies as self-schema indicators: The inverted-U effect revisited. *Personality and Individual Differences, 43,* 611-618.

II Hedlund, L.-E. (2009). *The role of self-schema in the relation between personality and prejudice*. Manuscript submitted for publication.

III Ekehammar, B., Akrami, N., Hedlund, L.-E., Yoshimura, K., Ono, Y., Ando, J., & Yamagata, S. (2009). *The generality of personality heritability: Big-Five trait heritability predicts response time to trait items*. Manuscript submitted for publication.

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Contents

Introduction

Brief Overview

The present thesis is based on six empirical studies. In Study 1, the aim was to re-examine the inverted-U effect, which means that the relation between personality score and response time (response latency) is curvilinear. Particularly, by introducing a more appropriate statistical technique for testing the inverted-U effect previous research was extended. Study 2 presents a replication of Study 1 using another personality instrument and another sample. Confirming the inverted-U effect in these two studies would yield support for the self-schema construct in the context of personality assessment. Study 3 examined whether self-schema information could improve the prediction of prejudice using two Big Five personality factors (Openness to Experience and Agreeableness) from the five factor model. In all analyses, multiple regression techniques were used and response time was used to operationalize how schematic people are. In Study 4, the relation between heritability and response time for the Big Five personality facets (subfactors) was examined. The prediction was that a larger heritability of the facet would be accompanied by a faster response time to the items of the facet. Study 5 was a replication of Study 4. Finally, Study 6 was a replication of Study 4 and Study 5 but with adolescent instead of adult participants.

The thesis is organized in the following way: (a) the self and the self-concept are briefly depicted, (b) the self-schema concept is presented and previous research is summarized, (c) response time as a measure of the degree of schematicity is introduced, and the inverted-U effect is outlined, (d) a concise description of personality, traits, and the five factor personality model is sketched, (e) heritability is delineated and some examples on research regarding studies of personality and heritability are provided, (f) the aim of the studies is presented, (g) the six empirical studies are summarized, and (h) the findings from the studies are discussed.

Self-Schema

Definitions

The self-representational cognitive structure that has received the most attention in cognitive theories of the self is that of the self-schema. According to Markus' (1977) classical definition, a self-schema consists of "cognitive generalizations about the self, derived from past experience, that organize and guide the processing of self-related information contained in the individual's social experience" (p. 64). Hence, Markus explains that self-schemas imply the generalization of knowledge acquired from past experience – they organize and guide the processing of information about the self in social situations. Such self-schemas may include identities, roles, traits, goals, abilities, and preferences (Markus, 1977; Markus, Crane, Bernstein, & Siladi, 1982; Markus & Nurius, 1986).

In sum, the self-schema is a cognitive structure containing the generic knowledge that one has about oneself, influencing all aspects of the processing of self-relevant information in order to organize, summarize and explain one's behavior, including the selection, encoding, organization, and retrieval of personally meaningful stimuli. Moreover, the self-schema contains self-evaluative information to generate self-judgments and provide for the maintenance of self-esteem or self-worth (e.g., Harter, 1990; Roberts & Monroe, 1994).

Functions

Self-schemas are comprised of three distinct types of knowledge; (1) semantic knowledge – generalizations or abstractions that reflect "who the self is", which are stored at the highest levels of the hierarchy, (2) episodic knowledge – specific autobiographical memories nested at the lowest level of the hierarchy; and (3) procedural knowledge – action-based memories in the form of skills, rules, and strategies for making judgments and accomplishing goals relevant to the domain (e.g., Jacoby & Kelley, 1987).

How does the organization of self-schemas affect how we think, feel and behave? A crucial contribution of social cognition research has been the apprehension that self-schemas serve as a foundation for perceiving and interpreting one's own behavior. Further, they serve as lenses through which people view their social world, thereby understanding their social interactions (Markus, 1977; Cross & Markus, 1994). For example, Green and Sedikides (2001) argue that self-schemas provide a sense of control and predictability over the social environment, and they shape social perception when the target description is more ambiguous than when it is not. Self-schemas guide our perceptions and reflections by helping us decide the types of information considered commendable of resource-intensive processing (e.g., Bargh & Chartrand, 2000; Robins & John, 1997). They function as models that adjust incoming information as it is perceived and encoded (Fiske & Dyer, 1985). Consequently, as people come to "know" themselves through observations of thoughts and behaviors, and from others through social interactions, self-schemas are developed to organize memory and behavior (Kihlstrom, Beer, & Klein, 2003; Kihlstrom & Klein, 1997). These self-schemas are particularly important because, once formed, they have a further influence on our subsequent thoughts and behaviors (e.g., Cross & Markus, 1994). Thus, because a self-schema in a given domain plays an important part of that individual's identity, schematic individuals pay close attention to, and favor, information in their schematic domain (Cross & Markus, 1990; Markus & Wurf, 1987). It has been argued that higher levels of self-attention should result in a more clearly articulated self-schema (e.g., Buss, 1991; Kernis & Grannemann, 1988; Nasby, 1989; Scheier, Buss, & Buss, 1978).

Researchers have established that when the self-schema is confronted with self-relevant information, it is automatically activated (e.g., Bargh, 1982; Symons & Johnson, 1997). The self-schema that is activated is the one that is most easily reached and triggered (e.g., Dance & Kuiper, 1987; MacDonald & Kuiper, 1985; Markus, 1977). The most accessible self-schema is the one that is most detailed and well-rehearsed in that particular context, as a study conducted by Markus (1977) demonstrated. In that study, participants who had either previously rated themselves as self-schematic on the trait of dependence or independence, or aschematic [individuals without a self-schema in a particular domain (Cross & Markus, 1994)] on both, completed a response-time task. Participants were presented with words that were associated with independence (e.g., assertive) and dependence (e.g., obliging) and were asked to press a "me" button if the word described them or a "not me" button if it did not. Participants who were self-schematic on independence or dependence were much faster at identifying whether a word characterized them than participants who were aschematic on either of these characteristics. Moreover, self-schematic participants also had better memory for incidents from the past that demonstrated their dependence or independence (Markus, 1977). Shah and Higgins (2001) obtained similar results when they divided participants along other personality dimensions and examined how quickly they reacted to self-descriptive terms.

Self-schemas embrace cognitive representations derived from specific events and conditions involving the individual (e.g., "I was uncertain what to do when I arrived to the meeting because I had forgotten my papers") as well as more general representations derived from the repeated categorization and subsequent evaluation of the person's behavior by himself and by others around him (e.g., "I am extravert" or "I am very relaxing in small groups but becomes quite uncomfortable in large gatherings"). The self-schema can therefore be viewed as a construct with which to interpret one's own and others' behaviors – it allows people to form a clear idea of the type of person they are in a particular situation.

Different types of self-schema

We have an almost immeasurable number of schemas that enable us to do things like identify and categorize objects or make quick adjustments while swinging a tennis racket. These schemas are activated (i.e., brought into working memory) by internal and external cues that indicate that a particular schema is salient in a given situation (e.g., Kihlstrom & Klein, 1997). In social situations, these interpretative frameworks are equally essential – they help us, for example, to carry on conversations with others. We also have schemas in our perception of others. One of the ways we describe and make sense of others is by placing them into social categories (e.g., husband, director) or labeling them as having certain traits (e.g., extraverted).

Cross and Markus (1994) proposed that, in addition to current self-schemas, we also hold possible future self-schemas, for example, self-schemas that reflect how we would like to be in the future. Having complex and varied self-schemas is beneficial for us, buffering us from negative events or failures in our life. If one self-schema is having a negative impact on us, there will be other self-schemas from which we derive satisfaction, or that allow us to see ourselves in a positive light.

Positive and negative self-schemas

Self-schemas also serve as potent internal regulators of thoughts and behaviors. Studies have shown that positive and negative self-schemas influence thoughts and behaviors in different ways. Positive self-schemas engender positive affect and stimulate behavior in the domain. For example, in a sample of college students with equal academic ability, Cross and Markus (1994) found that those with an academic-related self-schema were more likely to continue a difficult task and had more positive affect compared to those students who did not have an academic-related self-schema. Other studies have found similar effects in other domains, for example, exercise (Kendzierski, 1990).

On the other hand, negative self-schemas generate negative thoughts and inhibit behaviors in the actual domain. For example, Cyranowski and Andersen (1998) found that women with negative thoughts about themselves in the domain of sexuality had more anxiety about sex, fewer romantic partners, and more sexual avoidance compared to women who had a positive sexual self-schema. Also, negative self-schemas are associated with negative mood states and withdrawal behavior. The relative proportion of positive to negative self-schemas available in memory may be the cognitive foundation of observed differences in global self-esteem, the affective component of the self-concept. Studies have shown that in normal samples, persons with low self-esteem have more unstable peripheral self-conceptions and fewer positive self-schemas available in memory (Crocker & Park, 2003). Taken together, positive self-schemas may be viewed as cognitive resources whereas negative self-schemas may be viewed as cognitive liabilities (Cyranowski & Andersen, 1998).

Explicit and implicit self-schemas

Self-schemas can be either implicit or explicit (e.g., Westen & Heim, 2003). Implicit self-schemas are automatic and fast whereas explicit self-schemas are intentional and slow. Further, implicit self-schemas are highly accessible, automatically activated, and can automatically influence responses (Devos & Banaji, 2003; Greenwald & Farnham, 2000). Research suggests that both implicit (automatic) and more explicit (intentional) self-concept elements can predict behavior, depending on the circumstances and the specific outcome of interest (Spalding & Harding, 1999).

Some researchers suggest that implicit self-representations like other implicit constructs, such as implicit attitudes (e.g., Dovidio, Kawakami, Johnson, Johnson, & Howard, 1997), are more likely to predict impulsive or uncontrollable behaviors, whereas explicit self-representations are more likely to predict intentional or controllable behaviors (Asendorpf, Banse, & Muecke, 2002; McClelland, Koestner, & Weinberger, 1989). Nevertheless, in other situations, self-concepts assessed with implicit and explicit measures appear to work mutually to shape behavior (Briñol, Petty, & Wheeler, 2006). Consequently, the self-related processes that direct behavior can at the same time operate at varying levels of consciousness and either in an automatic or controlled manner (Mischel & Morf, 2003).

Implicit social cognition has extended social cognition's general focus on the self in two ways (Fiske & Taylor, 1991). First, its focus is on how mental processes occur and affect behavior without conscious guidance and control (e.g., Bargh & Chartrand, 1999). Thus, the activation of traits can influence people's behavior without their awareness or intention (see Wheeler & Petty, 2001). For example, an Asian woman may come to view herself as excelling in math when her ethnic identity is implicitly brought to the foreground but as weak in math when her gender is highlighted (see Shih, Pittinsky, & Ambady, 1999).

Second, implicit social cognition provides methods for measuring implicit self-schemas indirectly employing, for example, response time to specially constructed computerized tasks (e.g., Greenwald, Banaji, Rudman, Farnham, Nosek, & Mellot, 2002). For example, Bargh and Tota (1988) showed that individual differences may be measured by assessing how cognitive load affects response time. They found that nondepressed people had a harder time categorizing negative self-related concepts under conditions of increased cognitive load than did depressed people. This automatic processing of self-relevant information can be explained by the fact that the self-schema automatically screens or processes the information that is relevant for it (Josephs, Markus, & Tafarodi, 1992).

Schematic and aschematic

In her classic definition, Markus (1977) outlined two criteria for determining schematicity, the extent to which a person is schematic for a given dimension (i.e., having a self-schema in a given domain) or not. Specifically, to be classified as schematic, people had to rate themselves as high or low on the dimension and also rate it as very important to them. For example, if you are a student you are likely to be self-schematic on that aspect, provided that being a student is very important to you, that is, central to your self-concept. Thus, you think you are a highly typical example of a student, and you think you are very different from someone who is not a student. In addition, people responding quickly are considered to be more schematic for the personality trait being measured than people responding slowly (Corby & Tryon, 2006; Greenwald, 1980; Nasby, 1985; Siem, 1998). In contrast, according to the terminology proposed by Sheeran and Orbell (2000), you would be aschematic on a particular dimension if it is not important to you and does not reflect who you are. Aschematic people have an unclear self-view on specific dimensions and regard them as neither important nor central to their self-schema (Markus, 1977).

Based on the fact that schematicity affects people's reactions to self-relevant information, Petersen, Stahlberg, and Dauenheimer (2000) confirmed the idea that schematic dimensions occupy a more central position in the cognitive system than aschematic dimensions do. Further, schematic people have been found more likely to make external attributions for their own behavior when their behavior does not match their schema (e.g., Kendzierski, Sheffield, & Morganstein, 2002).

Self-schema research

Far from being operationalized in only one way, recent assessments of self-schematicity have used different variants of the classical measurement of schematic and aschematic individuals (e.g., Avants, Margolin, & Kosten, 1996; Forehand, Deshpandé, & Reed, 2002; Froming, Nasby, & McManus, 1998). The early social psychological researchers were primarily concerned with contrasting the difference in information processing patterns between schematic and aschematic people in various personality traits in understanding information processing and behaviors (e.g., Bruch, Kaflowitz, & Berger, 1988; Fong & Markus, 1982; Kendzierski, 1990; Kuiper & Rogers, 1979; Ruvolo & Markus, 1992; Stein, Roeser, & Markus, 1998; Thompson, 1985). Also, researchers in various applied psychological fields have borrowed this concept to understand human cognitions, affect and behaviors (e.g., Cash & Labarage, 1996; Estabrooks & Courneya, 1997; Stein, 1994).

Some authors have gone beyond the generic nature of self-schema to postulate the existence of more specific self-schemas, such as an academic self-schema and a professional self-schema (e.g., Tarquinio & Somat, 2001). Thus, a plethora of self-schema research has been conducted over the years in a wide variety of domains, like prosocial behavior (e.g., Froming et al., 1998), academic achievement (e.g., Tarquinio & Somat, 2001), gender (e.g., Markus et al., 1982), self-view (e.g., Stein, 1994), and culture (e.g., Kanagawa, Cross, & Markus, 2001). For example, Jung (2006) found that media images of thinness and attractiveness negatively affected college women's mood. Specifically, women with high-appearance self-schema exhibited significantly greater negative mood and higher body dissatisfaction and lower appearance evaluation than did those with low-appearance self-schema. Also Jung and Lennon (2003) suggested a significant relationship between appearance self-schema and body image and mood.

To sum up, research in social psychology has substantiated the functional role of self-schemas. In the different empirical investigations referred to above, it has been found that when a well-articulated schema about the self is present, a consistent pattern can be found in that domain with respect to people's decisions and behaviors, as well as their assessments of themselves and others (e.g., Roediger, Mead, & Bergman, 2001). Further, schematic people are being more likely to notice self-schematic traits in others (e.g., Fong & Markus, 1982). Finally, the results substantiate that information congruent with a self-schema is processed faster and more accurate whereas stimuli that are incongruent to a self-schema will be resisted.

Self-schema as trait indicator

The operationalization of self-schema adopted by Markus and her colleagues (e.g., Markus et al., 1982) implies that the trait level alone may be a good indicator of an existing self-schema. Fundamentally, traits are the conceptual schemata that organize and integrate related details and constitute the very network of cognitive associations against which incoming information is compared (e.g., Fiske & Taylor, 1991; Smith & Kihlstrom, 1987). Furthermore, the "trait level" definition of schema also receives considerable support from data on response time to trait exemplars (e.g., Kuiper, 1981; Lewicki, 1984; Mueller, 1982). Although a trait is taken to represent the structural aspect of a schema (Fiske & Taylor, 1991), there is an important difference between the concepts of trait and self-schema. A trait is a set of empirically related behavioral and cognitive representations most often reflecting a bipolar continuum. The bipolar definition of traits is reflected in trait measurement. A series of adjectives or personality items are constructed to tap both the pole favored for describing the trait and the opposite pole.

Respondents indicate which of the trait items describe them using some response format, such as "true/false". The total number of items that people endorse indexes the degree to which they possess the trait. Although a trait may be referred to by a single summary label (e.g., independence), a bipolar continuum (independent – dependent) is most often implicitly assumed.

On the other hand, a schema is defined as being unipolar (Cantor & Mischel, 1977; Markus & Wurf, 1987). For example, there is one schema for "independent" and another for "dependent". Consequently, the endpoints of these unipolar dimensions are specified as "independent – not independent" and as "dependent – not dependent".

Diener (1996) points out that too much confidence on traits can turn out to be an intellectual impasse as it does not lead to complete understanding. Over the years, personality psychologists have generally been concerned with measuring people's overall trait level by deriving from several observations a single aggregate trait score. Nevertheless, many researchers in personality and social psychology have argued that not all personality traits, attitudes, and values are equally relevant to all people. Allport's (1937) idiographic view of personality, for example, supposed that there is a unique set of psychological features – he called them central traits – that distinguish every individual from every other individual. As personality traits are considered to be comparatively stable dispositions that cause the characteristic pattern of behavior, they logically depend on indications of behavioral consistency (Hampson, 1997). Thus, personality trait measures can be strong predictors of behavior but only if the traits are, in Allport's (1937) terminology, central traits for the individual.

Markus (1977) demonstrated that only those traits that are part of one's self-concept can influence the processing of new information and predict future behavior. For example, a test score indicating a person's degree of friendliness is of great value when friendliness is a central trait for that person, but of limited value when it is not. Traditionally, personality researchers have based their studies on the idea that traits are equally relevant to all people. The proposal that not all traits are equally applicable to all people has implications for the assessment of personality (e.g., Baumeister & Tice, 1988; Britt, 1993). Consequently, the trait score is not fully sufficient in personality research and the single trait score can not be expected to predict all people's behaviors. As an example, research on subjective well-being reveals that traits can be important first steps in our understanding of personality characteristics. However, traits do not represent the entire scientific explanation, suggesting that we must never stop with them as final explanations.

For this reason, one can argue that personality researchers should avoid the temptation to use only measures of, for example, the Big Five personality factors even though they seem expeditious, are usually quick to administer, and easy to interpret. The consequences of not initiating measures of self-schema and response time in personality research could yield real costs in form of less accuracy in behavior prediction and poorer understanding of behavior determinants. Thus, the person's self-schema is of vital importance when describing a person's various personality characteristics.

Self-schema measurement

Through the years, there have been two basic approaches to assessing self-schemata, one direct that generates explicit measures and one indirect that generates implicit measures.

The direct method of assessment requires participants to first assess the self-descriptiveness of a series of related statements on a Likert-type scale, followed by an assessment of the participant's certainty of that view and the importance of that content for her or his identity. Items assessing an individual's gender self-schema, for example, might include statements such as "I am assertive," and "I am gentle" (examples from Bem´s, 1974, *Sex Role Inventory*) and respondents would assess the descriptiveness, certainty, and importance of each item.

However, the use of self-reports has not remained without criticism. Self-report or explicit measures are commonly used in personality research but they have some well-known measurement limitations. In eliciting self-reports it is typically assumed that test takers are able and willing to provide accurate information about themselves. Nonetheless, some researchers have questioned the accuracy of such responses (e.g., Bassili, 1996). For example, self-reports often fail to predict certain behaviors because of concerns with norms and social desirability (Nosek, 2005). Further, they can be biased by a participant's lack of introspection (e.g., Asendorpf et al., 2002; Greenwald & Banaji, 1995).

According to Baumeister, Tice, and Hutton (1989), response time may be less reactive than self-report measures, thereby circumventing defensive and/or self-presentational styles that can lead people to respond in a nonveridical manner. Also, because implicit measures tap nonconscious, uncontrolled cognitive elements, they are less subjected to demand characteristics (Greenwald & Banaji, 1995).

Importance ratings of a trait, which has been used as an additional index to identify the presence or absence of a self-schema, have been argued to be conceptually confounded with trait level (e.g., Paunonen, 1988). Trait importance, trait extremity, and the accessibility of self-knowledge about one's behavior in a trait domain may often be related. To avoid confounds between trait level, trait importance, and trait extremity, the use of response time in assessing people's self-knowledge in a personality domain is conceptually closer to the relevant information in memory than either extremity or importance ratings (e.g., Bassili, 1996).

Although self-reports are important measures of how people view themselves, they seem to tap other aspects of the person than indirect measures. It is plausible that the indirect measure captures dynamic aspects of information processing that are inaccessible to the individual yet relevant to subsequent processes to affect regulation (Robinson, Wilkowski, & Meier, 2006). For issues that are non-controversial and that do not involve issues of social desirability, explicit measures and implicit measures tend to correlate. However, for more socially controversial issues, these measures often diverge (Greenwald, Poehlman, Uhlmann, & Banaji, 2009; Nosek, 2005).

Consequently, the second approach to self-schema assessment is based on response time. The rationale behind this alternative is made up by research on the self by Markus (1977) and others (e.g., Fekken & Holden, 1992). They concluded that self-schema facilitates the processing of information about the self, such that information encoded in salient domains of the self-concept is accessed faster than information not encoded in such domains. For example, traits that are either highly self-descriptive or highly non-descriptive are more quickly recognized than traits that are of neutral descriptiveness. Because domains for which an individual does not hold a readily accessible schema are more difficult to access, longer response times are thus indicative of a weaker schema.

Response Time (Latency)

Measurement

The escalating use of computers for test administration has given test developers admittance to item response time data, which were not achievable using paper-and-pencil testing. The use of computers for test administration provides a unique opportunity to measure response time. The availability of response time information suggests a number of useful alternatives for research and allows a detailed investigation of the relationship between item and examinee characteristics. In particular, implicit measurement of personality characteristics and self-schemas may enhance prediction and understanding when exploiting response times. Mills (2002) argued that it is important to incorporate data on response time and that response-time analysis is a new area of interest. Schnipke and Scrams (2002) argued “that we are obligated to investigate response times in the interest of fairness and equity” (p. 239).

The advantages of implicit measures (like response time) are obvious as these measures reflect more automatic evaluative associations that are not under conscious control and thus do not show distortions in a socially desirable direction (Reissing, Binik, Khalifé, Cohen, & Amsel, 2003). Thus, for example, far more racial or gender prejudice is revealed on implicit measures than on explicit measures (Dovidio, Kawakami, Johnson, Johnson, & Howard, 1997; Greenwald & Banaji, 1995). For such controversial issues, implicit measures have successfully predicted behavior better than explicit measures (Ashburn-Nardo, Knowles, & Monteith, 2003; Dovidio, Kawakami, & Gaertner, 2002; Fazio & Olson, 2003).

The actual timing is typically conducted through the use of computer software that makes use of the computer's internal clock (Bassili & Fletcher, 1991). Most often, such data are collected with the participant seated directly before a microcomputer and responding via the use of designated keys on the keyboard.

Applications

Response time has been used extensively by cognitive and social psychologists in laboratory experiments designed to study cognitive structure (e.g., Fazio, 1990; Luce, 1986), processing efficiency (e.g., Smith, Branscombe, & Bormann, 1988), implicit attitudes (e.g., Greenwald, McGhee, & Schwartz, 1998), as well as attitude importance (Krosnick, 1989) and accessibility (e.g., Fazio, Williams, & Powell, 2000; Fazio & Wilson, 2003).

More interestingly, many computerized categorization tasks have been developed to evaluate response time as a novel type of implicit measurement (e.g., Dasgupta & Greenwald, 2001; Greenwald, McGhee, & Schwartz, 1998; Karpinski & Hilton, 2001). For example, current studies using response-time-based implicit measurement have focused on implicit attitudes and stereotypes concerning social categories, such as race and gender (e.g., Devine, Plant, Amodio, Harmon-Jones, & Vance, 2002; Dovidio, Kawakami, & Gaertner, 2002; Rudman, Ashmore, & Gary, 2001).

Applications of response time beyond social psychology and social cognition research has been seen in, for example, health and clinical psychology (e.g., Teachman & Woody, 2003), personality measurement (e.g., Asendorpf et al., 2002), marketing research (Aaker et al., 1980; LaBarbera & MacLachlan, 1979), consumer research (Kokkinaki & Lunt, 1999), and neuroscience (Phelps, O'Connor, Cunningham, Funayama, Gatenby, & Gore, 2000). Ultimately, the research presented here can be viewed as part of the growing body of research on factors affecting response time (e.g., Yang, O'Neill, & Kramer, 2002) with the goal of providing further insight into the relationship between, for example, test items, examinee response time, and examinee performance.

Response time as a self-schema indicator

Evidence suggests that responding to personality test items involves comparing items to an integrated network of self-knowledge or self-schemata (Markus, 1977; Rogers, 1981). Fekken and Holden (1994) proposed a trait-level operationalization of schema structure where “the latency of responding to a personality test item may reflect the presence of an integrated network of self-knowledge” (p. 105). Hence, response times are thought to be behavioral manifestations of the cognitive processes involved in responding to self-referent material (Paivio, 1975; Rogers, 1981). Furthermore, the processing of incoming information relevant to the person’s self-schemata will systematically influence the speed of response (Kuiper, 1981; Markus, 1977). Items that are very close to the self show fast decision times as do those that are very distant from the self.

A well-established line of research has shown strong evidence for the validity of response times as schema indicators (e.g., Fekken & Holden, 1992, 1994; Holden & Fekken, 1993; Holden & Hibbs, 1995). Thus, responses to items consistent with the referenced self-schema are associated with faster latencies (Holden et al., 1991; Kuiper, 1981; Markus, 1977; Markus et al., 1982; Popham & Holden, 1990).

In accordance with the implicit and automatic nature of self-schemas, a person who is extreme on a trait and the corresponding superordinate schema should be able to perform self-processing tasks with greater speed. Therefore, response time may provide information relevant for locating an individual’s position on various dimensions of personality.

Examples of research using response time

Response time has been referred to as "psychology's ubiquitous dependent variable" (Luce, 1986, p. 1). Much of the progress in the recording and usefulness of response time data can be attributed to the advent of survey research based on computer-assisted telephone interview, as developed in the field of political psychology by Bassili (1993, 1996) and coworkers (Bassili & Bors, 1997; Bassili & Fletcher, 1991). They used response time as an indicator of several concepts, for example, attitude stability and question difficulty, and as a predictor of actual behavior. Bassili (1993) found that response time was a better predictor of discrepancies between voting intentions and actual voting behavior than a verbal measure of “certainty” (a question about the finality of the voter’s intentions).

The use of response time in telephone interviews has been applied successfully to measure the certainty of vote intention in Canadian politics (Bassili, 1993, 1995) as well as in work on American politics (Huckfeldt, Levine, Morgan, & Sprague, 1998, 1999). Further, in a series of empirical studies, response time to questions about attitudes toward political candidates predicted voting behavior – the faster the questions were answered, the more they predicted behavior (Bassili, 1993, 1995; Bassili & Bors, 1997; Fazio & Williams, 1986; Fletcher, 2000).

The most extensive line of research employing response time measures in recent years has used response time to index attitude accessibility, which is an indicator of attitude strength. Attitude accessibility is defined as "the likelihood that the attitude will be activated from memory automatically when the object is encountered" (Fazio, 1995, p. 248). Accessibility is usually operationalized in terms of response time. Quick responses to attitude reports should be less affected by irrelevant factors in the response situation. Here, response time is an indicator of the degree to which an evaluation is associated with an attitude object and the ease with which respondents can therefore answer an attitude question. Thus, response time represents an important aspect of attitude strength. As strong attitudes have been found to be predictive of behavior and resistant to change, response time can be expected to predict both these attitude properties (e.g., Bargh, Chaiken, Govender, & Pratto, 1992; Bassili, 1996; Fazio, 1993, 1995; Krosnick & Petty, 1995).

Research employing Fazio's "accessibility as object-evaluation association" model suggests that strong attitudes – as indexed by accessibility and operationalized by response time – are more predictive of behavior (e.g., Fazio, Chen, McDonel, & Sherman, 1982; Fazio, Powell, & Williams, 1989), more stable over time (Fazio & Williams, 1986), and less influenced by persuasive messages (Bassili & Fletcher, 1991) as compared to weak attitudes.

The inverted-U effect

People who are extreme on a trait should process trait-consistent stimuli more quickly (e.g., Fekken & Holden, 1992). Conversely, if you perceive yourself as being positioned in the middle of the scale, the decision will take more time. Imagine, for example, that you are responding to a questionnaire about a specific aspect of your personality, for example, friendliness. The first decision for you is to decide whether you are a friendly person or not. Being close to either trait pole is associated with more and better organized trait-relevant information, your self-schema about this personality dimension is activated, which facilitates processing and makes the decision about your degree of friendliness easier. Thus, items that are either clearly consistent or inconsistent with the self-schema would take shorter time to respond to than items that are moderately self-descriptive. This means that people scoring high or low on a certain personality trait tend to respond more quickly to the items than those scoring around the mean. This pattern has been found in some previous research and is labeled the inverted-U effect (see Casey & Tryon, 2001; Kupier, 1981; Mueller, Thompson, & Dugan, 1986).

Based on self- and other-ratings on trait descriptive adjectives, Kuiper (1981) sorted the trait ratings for each participant into four "degree of reference categories" and then computed the mean response time for each of the four groups. Using ANOVA and post-hoc comparisons, the results indicated an inverted-U trend, that is, faster response times for the low and high groups than for the intermediate group. Kuiper was probably the one who coined the term “inverted-U effect”.

Mueller et al. (1986) reported inverted-U effects similar to those of Kuiper using another set of trait adjectives that were rated on “distinctiveness”, that is, how well the traits described the participant. A one-way ANOVA yielded a statistically significant overall effect and a visual inspection of the mean response times for the different levels of distinctiveness provided the basis for the inverted-U conclusion.

More recently, Casey and Tryon (2001) have employed their double-press method (separating read time from psychological response time – PRT) on personality data from two different inventories. They tested the inverted-U hypothesis ideographically and decided that to demonstrate the inverted-U effect, a participant’s average PRT for both the lowest and highest responses must be less than for the next intermediate response alternative. Defined in this way, they concluded that a majority of the participants demonstrated the inverted-U effect in the two personality domains they examined. Other studies on the relationship between trait position and response time have been reported by Fekken and Holden (1992, 1994; Holden & Fekken, 1993; Holden, Fekken, & Cotton, 1991; Popham & Holden, 1990) but their research was not specifically designed to test the inverted-U effect. A close look at the relevant previous studies in this area of research reveal, however, that the inverted-U effect for the relation between trait position and response time is not so well verified as one would think.

Personality

Traits

In the context of individual differences research, personality refers to a person’s distinctive interpersonal characteristics described by traits (broad internal dispositions to behave in particular ways). Further, personality traits have been defined as a “dynamic organization, inside the person, of psychophysical systems that create a person’s characteristic patterns of behavior, thoughts, and feelings” (Carver & Scheier, 2000, p. 15). Traits can be distinguished from states and activities which describe those aspects of personality that are temporary, brief, and caused by external circumstances. For example, whereas a person may be gentle throughout his lifetime, an infatuation (a temporal state) typically does not last and even the most enjoyable carousing must come to an end.

Zuckerman, Kuhlman, and Camac (1988) showed that the relevance of a trait for an individual’s self-concept was an important determinant of the link between personality and predicted behavior. Mostly, it appears that an individual’s true self and his/her trait self are identical (McCrae & Costa, 2008;

Wu & Clark, 2003). There is extensive support for the importance of personality traits in many areas of psychology, for example, in predicting job performance (e.g., Barrick & Mount, 1991; Hogan, Hogan, & Roberts, 1996; Hogan & Holland, 2003; Ones, Dilchert, Viswesvaran, & Judge, 2007; Schmidt & Hunter, 1998).

The five factor (Big Five) model

The nucleus that constitutes the five factor model is made up by traits. These have become an essential component in the personality assessment discipline (Wiggins & Pincus, 1992). The five factor model of personality (see, e.g., McCrae & Costa, 2008) is probably the most widely accepted model of personality structure, encompassing Neuroticism (emotional instability), Extraversion, Openness to Experience, Conscientiousness, and Agreeableness. All five dimensions are thought to be independent and linked to specific neurogenetic pathways (Jang, McCrae, Angleitner, Riemann, & Livesley, 1998). A key element of the five factor model is that it is rooted in the nomothetic tradition, that is, it is presumed to apply to all people. McCrae and Costa (1997) have demonstrated that the factor structure of the five factor model is similar and universal across a diverse range of cultures.

It seems reasonable to classify these factors as core personality factors because of their substantial heritability coefficients and their early expression in temperament in human infants and in other animal species (see Ekehammar & Akrami, 2007). Also, they are likely to be causally prior to nonpersonality aspects, like prejudice. This is in accord with the model of McCrae and Costa (2008), which classified the Big Five personality as "basic tendencies", positioned first in a causal chain. Further, McCrae and Costa (2008) denoted observable behavior, such as prejudice displayed in discrimination, as "objective biography", positioned at the end of a causal chain. Recent research on prejudice has revealed strong relations between core (Big Five) personality and prejudice (Ekehammar & Akrami, 2003, 2007; Ekehammar, Akrami, Gylje, & Zakrisson, 2004). In the present work, these empirical findings are used as a point of departure for examining whether the prediction of prejudice using Big Five personality factors can be improved by taking people's schematicity on these personality factors into account.

Various questionnaires have been developed to measure Big Five personality, such as the Revised NEO Personality Inventory (NEO-PI-R; Costa & McCrae, 1992), which is a 240 item self-report inventory. Each factor is defined further by six facet scales (i.e., the narrow personality traits that constitute each personality factor) and items are rated for applicability on a five-point Likert scale.

Heritability

Definitions

Heritability is a statistic concept that refers to the proportion of observed variance in a group of individuals that can be accounted for by genetic variance (Plomin, Chipuer, & Loehlin, 1990). The discipline makes an important distinction between the genotype, the genetic makeup of an individual, and the phenotype, the individual's observable appearance and behavior that arise out of the interaction of his or her genotype with the environment. Heritability (h^2) is per definition the proportion of phenotypic variance that is attributable to genotypic variance. Thus, it is not the proportion of a phenotype that is genetic but rather the proportion of phenotypic variance that is due to genetic factors (Visscher, Hill, & Wray, 2008).

Phenotypic variance refers to observed individual differences, such as height, weight, or personality. Genotypic variance refers to individual differences in the composition of genes possessed by each person. Thus, a heritability of .50 means that 50% of the observed phenotypic variation is attributable to genotypic variation. For example, when researchers conclude that the heritability of extraversion is 50%, they are concluding that 50% of the total variance in extraversion in their sample is associated with genetic influences. They cannot conclude that a specific person's extraversion level is 50% genetic – the concept of heritability applies not to individuals but to differences among many individuals. Stated in statistical terms, heritability applies to the variance of a set of observations rather than to a single specific observation (Krueger, South, Johnson, & Iacono, 2008). Heritability is a population parameter and, therefore, it depends on population-specific factors. It does not necessarily predict the value of heritability in other populations (or other species). Nevertheless, it is surprising how constant heritabilities are across populations and species (Visscher et al., 2008).

In the example above, the environmental component is simply the proportion of phenotypic variance that is not attributable to genetic variance ($1 - h^2$). Thus a heritability of .50 means that the environmental component is .50. Given its definition as a ratio of variance components, the value of heritability always lies between 0 and 1. For instance, for height in humans, narrow-sense heritability is approximately 0.8 (Macgregor, Cornes, Martin, & Visscher, 2006). For traits associated with fitness in natural populations, heritability is typically 0.1–0.2 (Visscher et al., 2008).

It is important to note that the family studies of genetic influence measure only the effects of shared environments, those that make individuals in the same family more similar (e.g., parenting, mutual traumas, etc.). These shared environments become less similar as children grow up as even identical twins may be motivated to seek out different environments over time (Rutter, Pickles, Murray, & Eaves, 2001). Shared environmental influences are rarely found, although researchers have suggested that these effects may be more powerful for positive traits (Krueger, Hicks, & McGue, 2001). For example, shared environmental influences were reported for romantic love styles, with little genetic influence detected (Waller & Shaver, 1994).

Although we typically think of attitudes as being learned (Eagly, Chen, Chaiken, & Shaw-Barnes, 1999), many attitudes show a large genetic component (Olson, Vernon, Harris, & Jang, 2001). In fact, many attitudes show similar heritability coefficients as psychological constructs with a more generally accepted genetic basis, such as intelligence or psychopathology. This does not imply that there is a direct causal link from individual genes or groups of genes to specific attitudes. More likely, heritabilities are mediated by such factors as intelligence, temperament, personality traits or physical characteristics (Olson et al., 2001; Tesser, 1993). Tesser used the example of the highly heritable attitude toward jazz music to illustrate these indirect effects. He drew attention to the fact that it is quite implausible to assume that there is a gene for jazz preference. However, the enjoyment of jazz is likely to be influenced by heritable personality traits (e.g., Openness to Experience).

The Big Five and heritability

There have been several assessments of the extent to which genes or family environments account for individual differences on the Big Five dimensions. Data from many twin, adoption and family studies provide consistent evidence for a substantial genetic influence for various personality traits and dimensions (Loehlin, 1993; Loehlin, Willerman, & Horn, 1988). Most of these studies have come to the conclusion that all five factors are moderately and about equally heritable. Heritability estimates for Big Five traits are relatively stable across the life course at about 40-60% (Bouchard & Loehlin, 2001). In fact, research has shown that individual differences in almost all facets of the Big Five factors of personality can be explained by genetic and nonshared environmental influences (Jang, Livesley, Angleitner, Riemann, & Vernon, 2002). For the most part, studies have demonstrated that genes and nonshared environmental factors account for the majority of individual differences among people in personality (Loehlin, 1992).

A heritability analysis of the Big Five dimensions as measured by the NEO-PI-R of Costa and McCrae (1992) used a total of 660 monozygotic (MZ) pairs and 380 dizygotic (DZ) pairs from pooled Canadian and German twin samples (Jang et al., 1998). For all five traits a simple model involving only additive genes and nonshared environment fit the data. Estimates of the heritabilities of factor scales for Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness to Experience were .50, .48, .49, .49, and .48, respectively. These estimates are obviously very similar.

Bergman et al. (1993) administered a shortened version of the NEO Personality Inventory to a sample of MZ and DZ twins reared together and reared apart. They found a substantial genetic effect for Openness to Experience and Conscientiousness but only a modest genetic effect for Agreeableness. Jang, Livesley, and Vernon (1996) used the NEO-PI-R in order to assess the heritability of Big Five. The genetic influence for the five dimensions was 41% (Neuroticism), 53% (Extraversion), 61% (Openness to Experience), 41% (Agreeableness), and 44% (Conscientiousness). Moreover, the facet scales also showed considerable heritability, though for several facets the genetic influence was mainly nonadditive. Loehlin, McCrae, Costa, and John (1998) estimated that 51 to 58% of the individual variation along the Big Five dimensions was genetic in origin, 42 to 49% was due to experience unique to the individual, to temporary situational factors, and to gene-environment interaction, and none was due to effects of environment shared by the twins. Moreover, these contributions were quite similar across the Big Five factors.

A study carried out by Riemann, Angleitner, and Strelau (1997), where ratings were obtained from two peers of the twins as well as from the twins themselves. The authors carried out a joint model fitting to the self- and peer-report data. From this, the estimates of the genetic contributions to the Big Five dimensions were .60 (Extraversion), .57 (Agreeableness), .71 (Conscientiousness), .61 (Neuroticism), and .81 (Openness to Experience), with the effects of shared environment again being negligible. The estimates of genetic effects were substantial for each of the Big Five dimensions. Furthermore, the heritabilities were higher than those typical for twin self-report data alone. Johnson and Krueger (2005) applied multivariate models specifying genetic and environmental influences on adjectives describing each of the five personality domains specified in the five factor model of personality. The estimates of genetic influence for the latent phenotypes were 49% and 56% for Extraversion and Neuroticism, respectively. For Agreeableness, Conscientiousness, and Openness to Experience, however, the heritability estimates were lower.

Recently, Johnson, Vernon, and Feiler (2008) made a review of over 50 years of behavioral genetic research on the Big Five and related personality traits. They identified 145 studies that reported twin and other kinship correlations and estimated the heritability via model-fitting methods. In total, these studies were based on data collected from 85,640 pairs of MZ twins, 106,644 pairs of DZ twins, and 46,215 pairs of other non-twin kinships, such as parents and their children and non-twin siblings. The results showed that individual differences in the Big Five were approximately equally attributable to genetic and nonshared environmental factors whereas influence of the shared environment was essentially nonexistent. The mean heritability of personality traits in this meta-analysis was .45. Further, estimates of genetic and environmental effects were similar in different cultures, indicating the universal biological basis of the five factor model in the human species (Yamagata et al., 2006).

Major Aims and Research Questions

The overall aim of the present thesis is to evaluate the importance of self-schema and response time in personality research.

The first specific aim was to test the self-schema proposition that response time to personality items is curvilinearly (inverted-U) related to people's position on the item domain in question. Thus, it was expected that people scoring high (e.g., 5) or low (e.g., 1) on a specific personality factor would have shorter response times than those scoring in the middle (e.g., 3) on a 1-5 Likert-like scale. In the present research, the inverted-U response-time effect was examined using a more efficient methodology than in previous studies (see Casey & Tryon, 2001; Kuiper, 1981; Mueller et al., 1986). Thus, polynomial regression analyses employing power functions of predictors (linear, quadratic and cubic etc.) in a regression equation to model curvilinear relationship (see Cohen, Cohen, West, & Aiken, 2003) were used. In this way was tested if the relation between participants' position on each of the Big Five personality factors and their average response times across items for the same factors was characterized by a linear or curvilinear (inverted-U) trend. Also, the test was aimed to arrive at a conclusion for which personality factors the inverted-U effect is obtained. Thus, is the inverted U-effect valid for all Big Five personality factors?

The second aim was to incorporate the self-schema concept in personality assessment to examine a possible improvement in the prediction of an external variable. The point of departure here was three previous studies (Ekehammar & Akrami, 2003, 2007; Ekehammar et al., 2004; see also a meta-analysis of Sibley & Duckitt, 2008) that showed that two of the Big Five factors, Agreeableness and Openness to Experience, provided good predictions of generalized prejudice (a composite measure of four types of prejudice). Against the background of these findings, the purpose was to examine whether the introduction of self-schema information in Big Five personality measurement could improve the prediction of prejudice. This was achieved by using the two personality factors, Agreeableness and Openness to Experience, and response time information for these factors. In addition to the main effect of the personality factor scores, we explored possible effects of response time and interaction between response time and personality factor scores.

The third aim was to examine the relation between heritability and response time for the Big Five personality facets. The reasoning here was based on the assumption that self-schema in personality research parallels attitude strength in attitude research. According to previous findings (Tesser, 1993), the strength of a specific attitude, as measured by response time, is related to the heritability of that attitude. In a similar vein, it was assumed that self-schema, as measured by response time to the items of a personality factor/facet, is related to the heritability of that factor/facet. The expected outcome of the assumption was that personality response time is related to personality heritability so that shorter response times are associated with higher heritabilities.

Empirical Studies

Paper I

Background

The aim of the present two studies was to make a more accurate examination of the inverted-U response-time effect using a more efficient methodology than in the previous studies. Thus, a thorough look at the relevant previous studies in this area of research revealed that the inverted-U effect for the relation between trait position and response time is not as well verified as one would think. Previous studies have used one-way ANOVAs and/or visual inspection to examine the relations between trait score and response time. Instead, the present studies employed polynomial regression analyses to examine if the relation between participants' position on each of the Big Five personality factors and their average response times across items for the same factors is characterized by a linear or curvilinear (quadratic) trend. This method allows a statistical test of the hypothesis that curvilinearity gives a significant improvement in data fit as compared to a linear hypothesis. Thus, in contrast to previous attempts, the present approach a) allows a specification of the equation for the trends, b) permits a statistical test of the linear and curvilinear trends, and c) provides an estimation of the magnitudes of the linear and curvilinear trends.

Study 1

Method

Participants

There were 156 participants (49% women) aged between 18 and 57 years (M = 23.9 years). They were Swedish nonpsychology university students and students at the local authority-administered adult education. The students represented various academic disciplines, such as social science, medicine, economics, and technology.

Personality instrument

The official Swedish translation of the Big Five instrument NEO-PI (Costa & McCrae, 1985) was used to measure the Big Five factors.

Procedure

All participants were tested individually on a computer, and instructions and item wordings were presented on the computer screen. The responses and response times (RTs) were automatically stored in a file for each participant. The presentation order of the items was the same as in the original inventory. The items of all scales were answered on 5-step Likert-type scales ranging from *strongly disagree* (1) to *strongly agree* (5). The average personality scores and average raw RTs across items were computed for all participants and all scales.

Response time

The double standardization method suggested by Popham and Holden (1990) was used, which has the advantage of controlling for general person and item characteristics. Thus, we first standardized the RTs within persons across items to control for general person characteristics, like differences in reading and motor speed. The RTs were then standardized within items across persons to control for general item characteristics, such as differences in item length and vocabulary level.

Results and comments

The findings showed that there is clear evidence for a curvilinear (quadratic) relation between personality trait level and RT for all five factors (Table 1). For three factors (Extraversion, Openness to Experience, and Conscientiousness), there was a significant linear trend as well and these three factors also showed the highest overall relation between personality score and response time (see Table 1, Total R^2 column). The findings support the inverted-U effect. As can be seen in Figure 1, all Big Five factors display an inverted-U relationship between personality score and RT.

Table 1

*Polynomial Regression Analyses with Total Scores on Big Five Personality Factors as Independent Variables and Mean Response Time (Standardized within Persons and Items) as Dependent Variable in Study 1 (*N *= 156)*

	Trend			
Factor	Linear R^2	Quadratic ΔR^2	Cubic ΔR^2	Total R^{2a}
Extraversion	**.111**	**.030**	.019	**.160**
Neuroticism	.000	**.044**	.000	.044
Openness	**.112**	**.066**	.012	**.190**
Conscientiousness	**.084**	**.137**	.005	**.225**
Agreeableness	.023	**.029**	.000	**.052**

Note. Values in **boldface** are significant at $p < .05$, at least. [a]All trends including nonsignificant ones.

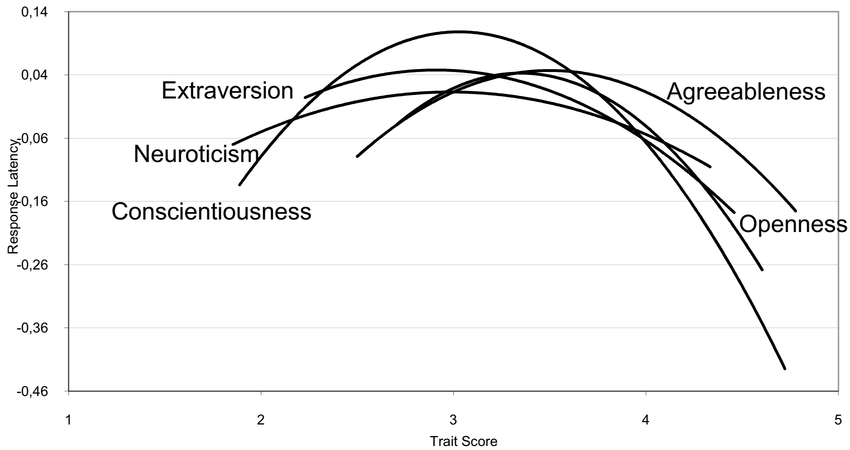

Figure 1. Regression trends showing the inverted-U relation between the Big Five factor scores and standardized response times to items of these factors (Study 1, $N = 156$).

Study 2

Background

This study was a replication of Study 1, using a sample from the same population as in Study 1, but employing a more recent Big Five personality instrument.

Method

Participants

The sample comprised 158 participants (50% women), aged between 19 and 50 years ($M = 24.7$ years). Like Study 1, the participants were Swedish non-psychology university students and students at the local authority-administered adult education. The students represented various academic disciplines, such as social science, medicine, economics, and technology.

Personality instrument

In the present study, the official Swedish version (Bergman, 2003) of the Revised NEO Personality Inventory (NEO-PI-R; Costa & McCrae, 1992) was used.

Procedure

The same procedure as in Study 1 was employed. The total personality scores and average raw response times across the items in each personality factor were computed for all participants and scales (see Table 2).

Response time

The RT data were treated as in Study 1.

Results and comments

The findings in Study 2 were quite in line with those in Study 1. The results, shown in Table 2, indicate quadratic relations for all five personality factors. Again, for three factors (Extraversion, Openness to Experience, and Conscientiousness), there was a significant linear trend as well and these three factors also showed the highest overall relation between personality score and RT (see Table 2, Total R^2 column). An inspection of the regression trends revealed a similar pattern as shown in Figure 1.

These findings add further support to the notion that the relation between personality item score and RT is curvilinear and forms an inverted-U relationship. In this study, like Study 1, there was no indication of any cubic trend.

Table 2

*Polynomial Regression Analyses with Total Scores on Big Five Personality Factors as Independent Variables and Mean Response Time (Standardized within Persons and Items) as Dependent Variables in Study 2 (*N *= 158)*

	Trend			
	Linear	Quadratic	Cubic	
Factor	R^2	ΔR^2	ΔR^2	Total R^{2a}
Extraversion	**.153**	**.070**	.000	**.223**
Neuroticism	.007	**.035**	.002	**.044**
Openness	**.187**	**.025**	.000	**.211**
Conscientiousness	**.076**	**.023**	.004	**.103**
Agreeableness	.015	**.038**	.000	**.053**

Note. Values in boldface are significant at $p < .05$, at least. [a]All trends including insignificant ones.

Paper II

Background

The major aim of this study, which can be considered methodological rather than conceptual, was to answer the question about whether the self-schema concept (operationalized by response time) could improve the prediction of generalized prejudice, compared to what could be achieved by using personality trait scores alone. This was supposed to be shown either as an additive factor (a main effect of response time) or as a moderator (an interaction between response time and trait score). The idea was that self-schema can be used as a moderator variable for personality to improve the predictability of prejudice. A moderator variable modifies, or makes conditional, the relation between two other variables. Thus, the association between predictor and criterion varies as a function of the moderator variable (Aiken & West, 1991; Cohen et al., 2003; Curran, Bauer, & Willoughby, 2004).

A common drawback in personality assessment is the lack of techniques that would ease assessment in "real world" applied settings (e.g., assessment of a single employee). It is of vital importance to explore techniques that would ease the appraisal of individuals outside laboratory settings. Moreover, it is of fundamental significance to discover an appropriate instrument to assess self-favoring tendencies in personality inventories, especially when used in employment settings.

Accordingly, an important aim of Study 3 was to develop a methodology that would work with ease in any practical situation. Thus, there is a necessity to develop response time for practical use in assessment contexts, as response time can be used to improve the predictive validity of personality variables. Because of the exploratory nature of the study, the best course would be to include raw response time. The logic behind this was that standardization procedures in general have been conducted in a sample-dependent fashion, with response times standardized on the basis of observed data for a particular sample. This method would be impossible to accomplish for operational administration because in a practical situation we do not have the data needed to make such transformations. Consequently, in addition to a standardization procedure, raw response time was used in the analysis of data in Paper II.

Linearity versus curvilinearity

A methodological problem in personality research has been the general assumption of a linear relationship between personality factors and outcome variables. For example, Paunonen and Jackson (1985) claimed that the majority of studies in personality have assumed linear relationships, when the relationship is more properly described as curvilinear. Further, other researchers consider that interactions and curvilinear (quadratic) terms are more likely than their reported occurrence in published research (e.g., Aiken & West, 1991; Cohen et al., 2003; Darlington, 1990; Jaccard, Wan, & Turrisi 1990; Pedhazur, 1982).

Paunonen (1988), among others, advocated the need to control for the moderator's potential curvilinear relations with the trait variable, otherwise there is a risk of interpreting moderator effects that are spurious. To avoid interpreting moderator effects that are spurious, and control for the correlation between trait relevance and trait extremity, hierarchical regression analyses is a method recommended by several authors (e.g., Britt, 1993; Cohen et al., 2003; Lubinski & Humphreys, 1990; Paunonen & Jackson, 1985; Waller, Tellegen, McDonald, & Lykken, 1996).

Many cases exist in the social sciences in which complex relationships are expected between predictors and a criterion. These complex relationships often take the form of a monotonically increasing (or decreasing) curvilinear relationship, an U-shaped or an inverted U-shaped function. To examine or detect these relationships, specific higher-order terms must be built and included into the regression equation.

Previous research on the relation between personality item response time and self-schema has treated response time data in different ways. In the present studies, hierarchical regression analyses were conducted that first would consider the linear relation between total personality trait score and response time. Then, an independent curvilinear factor was evaluated by adding the square of response time as a second predictor in the regression equation. To the best of my knowledge, the present study is the first to examine the relation between personality and prejudice while considering the impact of response time (self-schema).

Centering scores

When analyzing data using raw score predictors, a common drawback may be that the data sufferes heavily from multicollinearity. In order to avoid multicollinearity problems, it is recommended to center the predictor and moderator variables and then use the centered scores to form the interaction (Aiken & West, 1991; Cohen et al., 2003; Jaccard, Wan, & Turrusi, 1990). The most common centering approach is to subtract the mean from the each individual score (cf. Tate, 1984). This approach was used in the present research.

Study 3

Method

Participants

The sample was the same as in Study 1 and comprised 156 participants (49% women) aged between 18 and 57 years ($M = 23.8$ years).

Personality instrument

The Agreeableness and Openness to Experience scales from the official Swedish translation of the NEO-PI (Costa & McCrae, 1985) Big Five instrument was used.

Prejudice measures

Four different scales assessing four types of prejudice were employed – the Modern Racial Prejudice Scale (Akrami, Ekehammar, & Araya, 2000), the Modern Sexism Scale (Ekehammar, Akrami, & Araya, 2000), the Modern Attitudes toward People with Intellectual Disabilities Scale (Akrami, Ekehammar, Claesson, & Sonnander, 2006) and finally, the Sexual Prejudice Scale (Bergh, Ekehammar, & Akrami, 2009). From these scales, a generalized prejudice factor was formed, which was calculated as standardized factor scores based on the one-factor solution obtained from a principal components analysis of the scores from all prejudice scales (see Ekehammar & Akrami, 2003; see also Bäckström & Björklund, 2007). Generalized prejudice was then used as the dependent variable in the analyses below because previous research (see Sibley & Duckitt, 2008) has shown that personality is a better predictor of generalized prejudice as compared specific measures (e.g., sexism, homophobia). Participants responded to a computerized version of the scales by marking their response to each item on a 5-step Likert scale ranging from *Do not agree at all* (1) to *Agree fully* (5). Responses and response times (RT) to all items were stored for each participant.

Procedure

All participants were tested individually on a computer, and instructions and item wordings were presented on the computer screen. The individual responses and response times were automatically stored in a file. All items were randomly mixed within the domains of personality and prejudice, respectively, and the item order was randomized individually. To reduce variability in response time as a result of individual differences in response rate, participants were asked to respond as quickly but as accurately as possible to each of the questions appearing on the computer screen (see Fazio, 1990).

Response time

For each of the two Big Five factors, a measure of schematicity was computed for each participant as the mean RT across all items on respective factor, where shorter RTs indicate more schematicity. First, and in line with Akrami, Hedlund, & Ekehammar (2007), RTs below 1.2 sec (41 RTs; 0.4% of all RTs) and above 20.0 sec (35 RTs; 0.3% of all RTs) were removed. Second, schematicity scores were computed based on raw RTs as suggested by, for example, Vasilopoulos, Cucina, and McElreath (2005; see also Siem, 1998). This methodology was applied to ease possible use of the regression equation in applied settings where individual participants can be tested and evaluated without referring to a norm group for a double standardization procedure. Also, the RT data were treated following the *mean-deviation* procedure suggested by Neubauer and Malle (1997) where the sample mean for each item is subtracted from each participant's RT and mean RT for each scale is computed based on the items in respective scale.

Results and comments

The correlation analyses displayed negative correlations between generalized prejudice and the trait scores for Agreeableness ($r = -.43$, $p < .001$) and Openness to Experience ($r = -.43$, $p < .001$). Thus, the more agreeable and open-minded people are, the less prejudice they express. Further, there was a significant correlation between prejudice and schematicity for Agreeableness ($r = -.17$, $p < .05$) as well as Openness to Experience ($r = -.19$, $p < .05$). Using the raw RT schematicity scores, hierarchical regression analyses were conducted to examine whether schematicity (RT) would improve the prediction of generalized prejudice, as an additive factor (a main effect of RT) and/or as a moderator (an interaction between RT and trait score). Separate analyses were conducted for Agreeableness and for Openness to Experience (see Table 3).

In the first step, the personality trait scores were entered. In both cases, the personality traits contributed significantly to the prediction, indicating that trait score alone is a fair predictor of generalized prejudice.

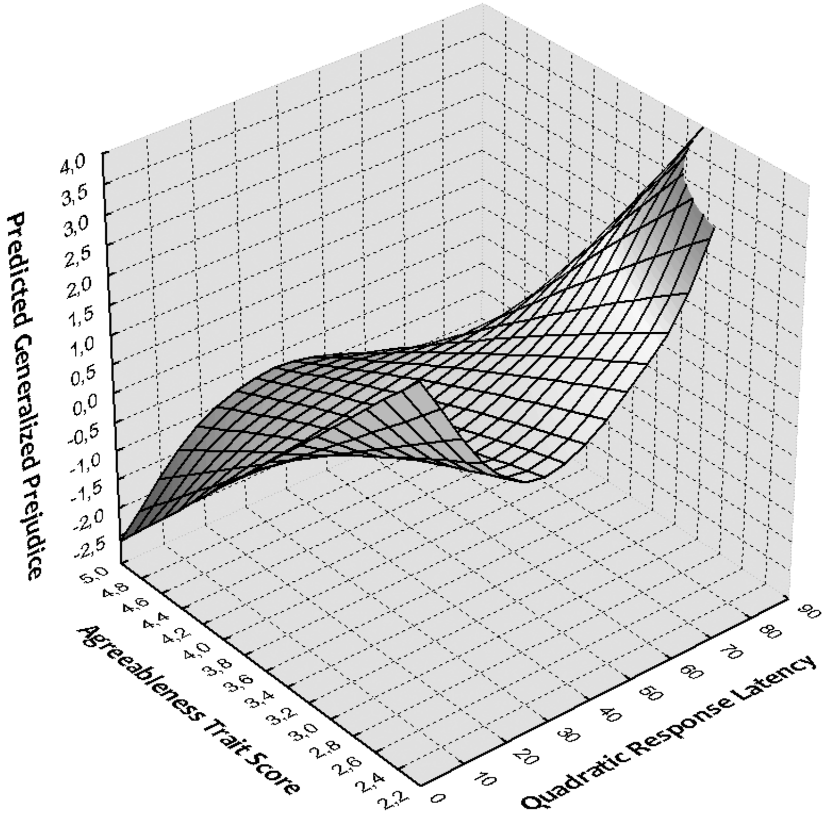

Figure 2. Graphic illustration of the interaction between Agreeableness trait score and response time as predictors of generalized prejudice.

In the next step, schematicity (RT) in its linear form was entered into the regression model and proved to give a significant increment in explained variance in both analyses. After that, in the third step, the effect of curvilinearity was examined by including squared schematicity (RT^2). In the fourth step, the trait score × schematicity interaction was examined. Neither step three nor step four provided any significant increment of the predictive power for any of the factors. Taking the curvilinearity into account also in the interaction term, the trait score × squared schematicity (RT^2) interaction was introduced in the final step (see Table 3). This interaction equation significantly increased explained variance in both analyses. As a final point, we conducted the same analysis as above but based on the mean-deviation RT scores. These analyses showed a perfectly corresponding pattern of results

Generally speaking, the result of this study indicates that the relationship between personality trait score and generalized prejudice is moderated by how schematic a person is. By taking the main and interaction effect of response time into account, the prediction of generalized prejudice could be improved using two Big Five personality factors as predictors. More specifically, using Agreeableness as predictor, R increased from .43 to .51, and using Openness to Experience, R also increased from .43 to .51. Finally, with both factors together as predictors, R increased from .54 to .62. Table 3 displays the increment in R^2 after each term was entered into the equation.

Table 3

Results of Hierarchical Regression Analysis Using Generalized Prejudice as Dependent and Personality Trait Score and Schematicity (Raw RT) as Independent Variables

Step	Independent Variable	Agreeableness		Openness to Experience	
		ΔR^2	β_A	ΔR^2	β_O
1	Trait Score (TS)	**.182**	**.305**	**.184**	**.339**
2	Schematicity (RT)	**.043**	**-.202**	**.037**	-.105
3	RT^2	.001	-.025	.014	**-.260**
4	TS × RT	.015	-.135	.000	-.091
5	TS × RT^2	**.019**	**.172**	**.024**	**.250**
	R^2 total	**.260**		**.259**	

Note. Figures in **boldface** are significant at $p < .05$ at least.

The character of the significant interaction effects is illustrated in Figure 2 (Agreeableness) and Figure 3 (Openness). As the figures show, RT moderates the negative relation between trait scores and prejudice for both personality factors. Specifically, those with *high* Agreeableness and Openness scores display lower level of prejudice if they have either long or short RTs whereas those with *low* Agreeableness and Openness display higher prejudice scores if they have either long or short RTs. The character of the interaction highlights the importance of introducing self-schema in this context. The significant interaction effect in Table 3 connects to the results of Paper I where a curvilinear effect between personality scores and response time was found.

In light of self-schema theory, the present results imply that it is meaningful to calculate both trait score and RT when assessing an external variable and use the interaction between these two components in a prediction equation. Extending previous research on the relation between a personality trait score and an external variable, we have shown that the relationship between a personality trait score and an external variable is perhaps not as straightforward as previously believed when introducing the concept of self-schema.

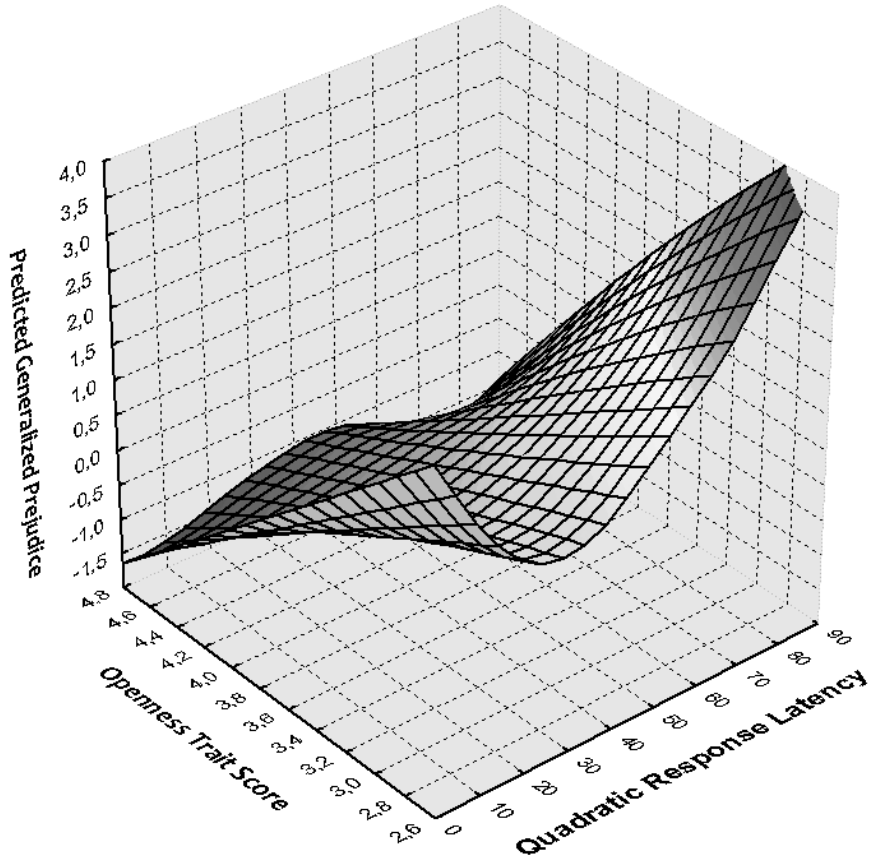

Figure 3. Graphic illustration of the interaction between Openness to Experience trait score and response time as predictors of generalized prejudice.

Paper III

Background

It is of crucial significance to develop methods that can help researchers to improve psychological assessment. One such contribution could be the examination of the link between heritability and various behavioral indicators. A widespread line of research employing response time measurement in recent years has been to use response time to index attitude accessibility measures (e.g., Fazio, Williams, & Powell, 2000). Attitude accessibility is the likelihood that the attitude will be activated from memory automatically when the object is encountered (i.e., attitude strength). Fazio's influential model of attitudes posits that an attitude is a cognitive association in memory between an attitude object and an evaluation of the object (see Fazio, 1995, for a review). The strength of the association determines its accessibility, which is indexed by response time. The use of response time to test theories of attitude accessibility is well-grounded in cognitive psychology. The assumption underlying this approach is that those with greater accessibility will have shorter response times. As measures of attitude strength, response time provides researchers with the benefit of an operative and objective measure that is not subject to biases of respondent's self-reports (Bassili & Krosnick, 2000).

Tesser (1993) brought heritability into attitude research by proposing, on the basis of a general response-strength hypothesis, that heritability is associated with response and attitude strength. His study demonstrated a negative correlation between heritability estimates of social attitude items and corresponding response times. Accordingly, it was established that the greater the heritability the shorter the response time. If Tesser's conclusion can be generalized to the personality domain, it is expected that the larger the heritability of a personality trait, the faster would people respond to items linked to that trait. For that reason, bringing the response-strength hypothesis to the personality domain, the following studies (Study 4-6) were aimed at examining the relation between heritability and response time for the facets within the five factor personality model. Thus, the major assumption in the following studies is that schematicity in personality research parallels attitude strength in attitude research. Thus, the hypothesis was that personality response time is negatively associated with personality heritability.

However, the research on heritability requires large-scale testing of monozygotic (MZ) and dizygotic (DZ) twin pairs. Therefore, like Tesser (1993), the present research employed heritability estimates (h^2) that have been obtained by other researchers. After scanning the literature for heritability estimates of the Big Five facets, only two possibly studies were revealed (Jang et al., 1998; Pilia et al., 2006). However, the latter was excluded because it did not employ the twin design, which is to be preferred for estimating heritability (e.g., Plomin, DeFries, McClearn, & McGuffin, 2001). Thus, only the study of Jang et al. (1998) remained. They reported heritability estimates for 26 of the 30 Big Five facets using the NEO-PI-R (Costa & McCrae, 1992). In addition to the Jang et al. data, previously unpublished heritability estimates based on the study by Yamagata et al. (2006), were included. The Yamagata et al. study provides heritability estimates for all 30 Big Five facets (see Table 4).

Jung et al.'s sample consisted of 618 MZ and 380 DZ Canadian/German twin pairs with a mean age of around 32 years (range = 15–71 years) and Yamagata et al.'s study was based on a Japanese sample comprising 426 MZ and 220 DZ twin pairs aged between 14 and 30 years ($M \approx 20$ years). The correlation (r) between the Canadian/German and Japanese heritability estimates across facets was .83. The mean of the heritability estimates was .39 for the Jung et al.'s study and .36 for Yamagata et al.'s study.

Table 4

Heritability Estimates (h^2) for the Big Five Facets Based on Previous Research

	Sample	
Facet	Canadian/German	Japanese
Neuroticism (N)		
Anxiety (N1)	.41	.36
Hostility (N2)	.37	.34
Depression (N3)	.44	.37
Self-Consciousness (N4)	.46	.38
Impulsiveness (N5)	.37	.28
Vulnerability (N6)	.40	.33
Extraversion (E)		
Warmth (E1)	.40	.39
Gregariousness (E2)	.40	.41
Assertiveness (E3)	.46	.40
Activity (E4)	.38	.38
Excitement-Seeking (E5)	.46	.42
Positive Emotions (E6)	.38	.35
Openness to Experience (O)		
Fantasy (O1)	.40	.37
Aesthetics (O2)	.46	.47
Feelings (O3)	.31	.32
Actions (O4)	.44	.36
Ideas (O5)	.49	.42
Values (O6)	–	.29
Agreeableness (A)		
Trust (A1)	.37	.34
Straightforwardness (A2)	.31	.29
Altruism (A3)	.27	.29
Compliance (A4)	.38	.34
Modesty (A5)	–	.43
Tender-Mindedness (A6)	.34	.28
Conscientiousness (C)		
Competence (C1)	.29	.32
Order (C2)	–	.30
Dutifulness (C3)	.37	.36
Achievement-Striving (C4)	.46	.43
Self-Discipline (C5)	–	.44
Deliberation (C6)	.30	.25

Note. The Canadian/German heritability estimates were obtained from Jang et al. (1998), the Japanese estimates were obtained from unpublished data based on Yamagata et al. (2006). – = estimates were not provided.

Personality instrument

In all studies (Study 4 to 6), the official Swedish version (Bergman, 2003) of the Revised NEO Personality Inventory (NEO-PI-R; Costa & McCrae, 1992) was used. NEO-PI-R measures the Big Five factors and the six underlying facets within each factor. Each facet is measured by 8 items.

Response time

Responding to the inventory was computerized and response and response time to each item were automatically stored for each participant. Participants were not told that their response times were stored but they were told that they should answer the items spontaneously without "thinking too long". Response time, from item onset to response, was measured through the internal clock of the computer.

Strategy for analyzing response time data

Response time data can be analyzed in two ways (see Tesser, 1993). One way is to regard the person as the unit of analysis. Thus, one calculates the median (because of skewed distributions) response time across the items of each Big Five facet for each participant. To deal with the effect of differences in facet/item length, the length (number of letters) of all facets was counted (see Table 5) and then the partial correlation (controlling for facet length) between the median response times and corresponding heritability estimates was calculated for each participant. Another way is to consider the Big Five facet as the unit of analysis. However, this way of analysis is associated with some possible artifacts, for example, between-facets individual differences in response time that may contaminate the results. Thus, the present research employed the person as the unit of analysis.

Descriptive Statistics for Study 4 to 6

The Cronbach alphas for the facet score reliabilities ranged from .58 to .86 whereas the reliabilities for facet response times varied between .68 and .81 (see Table 5). These estimates are all quite acceptable. As response time includes read time, it was necessary to partial out facet length when calculating the correlation between facet heritability and facet response time. The mean partial correlation (after Fisher´s z_r transformation) between response time and facet length across participants, when controlling the facet score, displayed significant coefficients in the three studies (Study 4 = .67, Study 5 = .68, and Study 6 = .64). Thus, the longer the facet, the longer the response time, which motivates partializing out facet length when computing the correlation between heritability and response time. Also, because of significant correlations between facet response time and facet score in the three studies (Study 1 = -.12, Study 2 = -.08, and Study 3 = -.10), the facet scores were partialed out as well.

Table 5

Facet Length and Reliability Estimates of the Big Five Facet Scores and Response Times for Study 4 to 6 Combined

		Cronbach alpha (α)	
Facet	Facet length	Facet score	Response time
Neuroticism (N)			
Anxiety (N1)	321	.81	.73
Hostility (N2)	419	.71	.75
Depression (N3)	409	.82	.74
Self-Consciousness (N4)	594	.72	.77
Impulsiveness (N5)	411	.59	.77
Vulnerability (N6)	433	.80	.76
Extraversion (E)			
Warmth (E1)	422	.76	.76
Gregariousness (E2)	438	.76	.73
Assertiveness (E3)	408	.82	.75
Activity (E4)	346	.65	.74
Excitement-Seeking (E5)	446	.58	.75
Positive Emotions (E6)	363	.81	.68
Openness to Experience (O)			
Fantasy (O1)	569	.75	.78
Aesthetics (O2)	480	.84	.80
Feelings (O3)	529	.73	.78
Actions (O4)	459	.64	78
Ideas (O5)	500	.78	.77
Values (O6)	729	.59	.81
Agreeableness (A)			
Trust (A1)	511	.85	.74
Straightforwardness (A2)	485	.78	.77
Altruism (A3)	420	.77	.69
Compliance (A4)	435	.66	.77
Modesty (A5)	411	.75	.76
Tender-Mindedness (A6)	492	.74	.75
Conscientiousness (C)			
Competence (C1)	429	.67	.74
Order (C2)	465	.69	.76
Dutifulness (C3)	468	.63	.77
Achievement-Striving (C4)	408	.63	.77
Self-Discipline (C5)	478	.86	.79
Deliberation (C6)	384	.80	.73

Note. Facet length was defined as the number of letters across all items in each facet based on the Swedish version of the NEO-PI-R.

Study 4

Method

Participants

The sample was the same as in Study 2 and comprised 158 participants (50% women) aged between 19 and 50 years ($M = 24.7$ years).

Response time data

First, five response times (RTs) above 100 sec. were excluded. Then all RTs that were 3 *SD*s above or below the grand mean were excluded (1.68% of the RTs). Further, four participants who had more than 10% of their RTs excluded in this way were omitted.

Results and comments

The mean RT was 5.66 sec. ($SD = 4.29$ sec.). A negative mean correlation between heritability estimate and median RT across participants (facet length and facet score partialed out) supported the hypothesis that RT was negatively correlated with heritability estimate (-.12 for the Canadian/German sample, and -.15 for the Japanese sample). The proportion of negative correlations across the 154 participants was 73% for the Canadian/German and 77% for the Japanese sample. More important, one-tailed one-sample *t*-tests of mean correlations showed that these were significantly different from 0 (see Table 6). Thus, despite the small mean correlations, the outcome supports the hypothesis and indicates that response time is negatively related to the heritability estimate.

Table 6

Mean Partial Correlations (Facet Length and Facet Scores Partialed Out) between Response Time and Heritability Estimates (h^2) in Three Samples

Study	Heritability estimate	Mean *r*	*SD* of *r*	*t*-test[a]	% negative *r*s
4	Canadian/German	-.12	.20	$t(153) = 7.21$	73
	Japanese	-.15	.20	$t(153) = 9.26$	77
5	Canadian/German	-.09	.18	$t(128) = 5.74$	70
	Japanese	-.16	.17	$t(128) = 10.87$	81
6	Canadian/German	-.10	.24	$t(117) = 4.69$	67
	Japanese	-.15	.19	$t(117) = 8.56$	75

[a]One-tailed one-sample *t*-tests of mean correlations against $\rho = 0.00$. All *t*-values are significant at $p < .00001$, at least.

Study 5

Background

To test the robustness of the findings in Study 4, we carried out Study 5, which was essentially a replication on another adult sample.

Method

Participants

The sample comprised 130 (51% women) university students and nonstudents, aged between 18 and 58 years (*M* = 24.7 years, *SD* = 7.7 years).

Response time data

The same steps were taken as in Study 4 for the treatment of RT data. Only one observation had an RT above 100 sec. and was excluded. Further, 1.6% of the data observations were excluded because of values 3 *SD*s above or below the grand mean. Finally, one participant had more than 10% of his RTs excluded in this way and was excluded from further analyses.

Results and comments

The mean RT was 5.35 sec. (*SD* = 3.37 sec.). A negative mean correlation between heritability estimate and median RT across participants (facet length and facet score partialed out) supported the hypothesis that RT was negatively correlated with heritability estimate (-.09 for the Canadian/German sample, and -.16 for the Japanese sample). The proportion of negative correlations across the 129 participants was 70% for the Canadian/German and 81% for the Japanese sample. More importantly, one-tailed one-sample *t*-tests of mean correlations showed that these were significantly different from 0 (see Table 6). Thus, despite the small mean correlations, the outcome supports the hypothesis and indicates that response time is negatively related to the heritability estimate.

Study 6

Background

To test the robustness of the findings in Study 4 and Study 5, Study 6 was carried out. This was essentially a replication employing an adolescent sample instead of the adult samples used in Study 4 and 5.

Method

Participants

The sample comprised 121 (68% women) students from various programs in high school. Participant age varied between 16 and 19 years (*M* = 16.9 years, *SD* = 0.8 years).

Response time data

The same steps were taken as in Study 4 and 5 for the treatment of RT data. First, 10 RTs above 100 sec. were excluded. Further, 1.7% of the data observations were excluded because of values 3 SDs above or below the grand mean. Finally, three participants had more than 10% of their RTs excluded in this way and were excluded from further analyses.

Results and comments

The mean RT was 4.80 sec. (*SD* = 4.57 sec.). A negative mean correlation between heritability estimate and median RT across participants (facet length and facet score partialed out) supported the hypothesis that RT was negatively correlated with heritability estimate (-.10 for the Canadian/German sample, and -.15 for the Japanese sample). The proportion of negative correlations across the 118 participants was 67% for the Canadian/German and 75% for the Japanese sample. More importantly, one-tailed one-sample *t*-tests of mean correlations showed that these were significantly different from 0 (see Table 6). Thus, despite the small mean correlations, the outcome supports the hypothesis and indicates that response time is negatively related to the heritability estimate.

General Discussion

Major Findings

Paper I

Previous studies have used ANOVAs and visual inspections to detect inverted-U effects. A more appropriate statistical method was employed in the present research, which made possible a strict statistical test of the inverted-U hypothesis. To the best of my knowledge, the studies here (Study 1 & 2) are the first to employ this method for studying the relation between personality trait scores and response times. The predicted nonlinearity between trait score and response time was investigated by examining the improvement in fit of the linear regression equation by entering the quadratic term of the predictor (personality trait scores) and successively higher polynomial terms. This was accomplished by use of polynomial regression procedures. From the self-schema perspective, it was expected that an inverted-U function is the most likely quadratic relationship that would emerge between trait score and response time. Individuals with low or high levels on the Big Five trait scores were expected to respond faster than individuals with scores in the middle of the scale.

Study 1 and Study 2 confirmed the existence of the inverted-U effect for all Big Five factors. Faster response times were revealed for participants scoring high or low on the personality factors compared to those scoring in the middle. Thus, the studies lend support to the findings of Casey and Tryon (2001), Kuiper (1981), and Mueller et al. (1986). Also, the findings extend previous research in this area by using a more appropriate statistical approach.

Paper II

The main aim of Study 3 was to test whether response time data would improve the prediction of generalized prejudice above trait score information, either as an additive factor (a main effect of response time) or as a moderator (an interaction effect between response time and trait score). The results disclosed both an additive and a moderating effect. Thus, adding response time and the quadratic response time × personality trait score interaction to the regression equation significantly increased the explained variance in generalized prejudice. This suggests that the relationship between personality trait score and generalized prejudice is moderated by how schematic a person is. By taking the main and interaction effect of response time into account, the prediction of generalized prejudice was improved.

This study provides evidence that response time can advance personality measurement. Thus, the results demonstrate that response time can be used to improve the predictive validity of personality assessment.

Paper III

The present three studies (Study 4-6) have shown that there are small but systematic relations between response time to the items of the Big Five personality facets and the heritability of these facets. Significant negative correlations were observed between response time and heritability in all three studies. Thus, adults and adolescents tended to respond faster to items in facets with large heritability as compared to facets with low heritability. Putting the present results into the context of self-schemas, this means that Big Five personality facets with large heritability on the average would have higher schematicity than facets with small heritability. So, the main hypothesis was supported in all three studies. Theoretically, a self-schema for a given trait is paid more and repetitive attention to and may play an important part of that individual's identity. This suggests that personality traits with greater heritabilities are paid more attention to and play a larger role for people's identities than personality traits with lower heritabilities. The magnitude of the obtained correlations between heritability estimate and response time for Big Five personality facets fell within the range of coefficients previously reported by Tesser (1993) in the area of attitude research.

Support for the Self-Schema Concept

From a theoretical point of view, the findings in Paper I provide support for the self-schema concept in the context of personality assessment. In accord with the automatic nature of self-schemas, people respond faster to personality items if they are more extreme (high or low) on a trait dimension. Thus, personality items that are either clearly consistent or inconsistent with the self-schema would take shorter time to respond to than items that are moderately self-descriptive. From an applied point of view, the findings offer promise in the context of assessment and prediction where response time can be used as indicators of how schematic people are. This could provide additional information to people's trait level scores and, thus, improve personality assessment (see, e.g., Britt & Shepperd, 1999; Siem, 1996).

The results in Paper II provide support for introducing self-schema in an applied setting of personality research. Generally speaking, the results showed that self-schemata (measured by response time) worked out as additional information to personality factors in predicting an external variable (prejudice). In line with Fazio and Olson (2003), among others, the present results support the idea that indirect measures that function outside people's awareness and control, like response time, have the potential of being useful in this context.

A general conclusion from the results of Paper III is that they highlight the link between heritability and self-schema. The findings indicate that response time as an indicator of self-schema is a useful variable in personality research. Specifically, the results imply that the heritability of personality is directly connected to self-schema, which should be taken into account when we construct theories and models of personality.

Methodological Issues

According to Fazio (1990), reaction-time data exhibit a significant degree of variability and skewness. For a discussion of various methods of dealing with errors and skewness in response time data, see Fazio (1990). To avoid this dilemma, researchers have typically been required to transform the data (e.g., by logarithmic transformations) before analyses.

However, it should be noted that some researchers warn against using transformations to normalize a skewed distribution, arguing that it is often difficult to interpret the results because the transformation changes the meaning of the scale (e.g., Busemeyer & Jones, 1983). Further, Siem (1996) made inquiries for further evaluation of the double-standardization procedure. He drew attention to the fact that double-standardization procedures can result in different scores depending on the order in which the procedure is performed (within-item then within-subject compared to within-subject then within-item). Additionally, Zuckerman, Gagne, Nafshi, Knee, and Kieffer (2002, p. 302) pointed out the importance for researchers to "be cautious about any transformation (e.g. log transformation) that may change the balance" between main effects and interaction.

Moreover, Baldwin and Sinclair (1996) established that by programming a time limit of 2 sec. per trial extremely long response times (which likely are produced by inattention or lack of familiarity with the target word) are coded as missing and so the data do not need to be transformed. This approach typically yields results very similar to those of transformed data, and produces means based on raw rather than transformed response times, which would be less directly interpretable. Additionally, Bassili and Bors (1997) used no transformation of the response times whereas Bassili and Scott (1996) truncated their response times at 2 standard deviations above the mean.

Cucina and Vasilopoulus (2005) compared untransformed and transformed scores. Their results displayed that, in general, the results of the analyses were similar. Their conclusion was that in no case did the transformation change the overall interpretation of their results. In another study, Vasilopoulos et al. (2005) conducted an examination to address the concern about using raw latencies. They compared the results from an analysis using transformed response times with another analysis using raw response times. The results for both sets of analyses were similar.

Apparently, there is a plethora of opinions regarding different methods to deal with the possible effects of non-normal response time distributions. An important aim of Study 3 was to develop a methodology that would work with ease in any practical situation (e.g., assessment of a single employee). Thus, it is important to explore techniques that would ease the assessment of individuals outside laboratory settings. Consequently, no data normalization or trimming techniques were employed in the analysis of data in that study.

It was reasoned that because of the exploratory nature of the study, the best course would be to include response time in its unaffected version. The logic behind this was that standardization procedures in general have been conducted in a sample-dependent fashion, with response times standardized on the basis of observed data for a particular sample. This method would be impossible to accomplish for operational administration because in a practical situation we do not have the implements that are needed to make any transformation.

Some Limitations

Although this thesis contributes to the understanding of the role of response time in personality assessment, there are some limitations to discuss. Further research might help to overcome these limitations in addition to further examining the more promising findings from these studies. A limitation of Study 3, for example, was that it relied on only one type of criterion measure – generalized prejudice. This may limit the external validity of the study.

In spite of these limitations, however, the current research has clear implications for the concept of self-schemata. Self-schemata have traditionally been operationalized using as criteria scale-score extremity and (self-reported) importance of the trait dimension to one's self-concept. Moreover, using response time may make it also needless to add the criterion of importance of a trait to one's self-concept in order to identify the presence or absence of a self-schema. The present thesis used response time as a measure of self-schema presence, which is efficient, unobtrusive, and less susceptible to response biases than the traditional scales which have been used to fine-tune personality measures.

As to the statistical conclusion validity, a limitation of the studies in Paper II and III is that the observed effect sizes were relatively small even though the figures were in line with those obtained when using other criterion variables than prejudice (see e.g., Siem, 1996) or attitudes instead of personality traits (see Tesser, 1993). Also, in Paper II, insufficient statistical power limits the possibility to detect hypothesized interaction effects using moderated multiple regression (Aguinis, 1995). Tests of interactions and curvilinear effects have considerably less power than tests of main effects and linear trends (McClelland & Judd, 1993). Consequently, McClelland and Judd (1993) pointed out that it is extremely difficult to obtain statistically significant interactions in field research and recommended that lower levels of statistical significance should be accepted. Regarding Paper III, we agree with Tesser (1993) that "(i)n view of errors inherent in estimating heritability, the difference in samples, and the errors in measuring the responses, it is remarkable that anything could be detected!" (p. 139). However, there are several reasons why power may not have been optimal in these studies. Beside the usual concerns about number of participants, one must have in mind that the heritability estimates were obtained on people from other populations (a combined German/Canadian sample and a Japanese sample with large age ranges) than those employed in the present three studies (Swedish samples with limited age ranges).

Future Research

Contemporary research on social attitudes has moved, to a greater extent, away from investigating explicit prejudiced beliefs to exploring the implicit cognitive processes that are connected with prejudice (Devine et al., 2002; Greenwald & Banaij, 1995). The present results support the idea that indirect measures, like response time, have the potential of being useful in this context. One of the unique contributions of these studies is the examination of potential curvilinear relationships between response time and personality trait scores. Future research should continue to consider possible linear as well as curvilinear relationships that may influence item level response time.

The studies presented here represent a step toward a deeper understanding of the processes by which self-schema can improve our predictions of social attitudes, like prejudice. Individual differences in self-schemas moderate the effect of core personality traits on prejudice. The results emphasize the importance of studying personality traits and self-schemas in combination. However, additional research is necessary in order to get a clearer picture of the moderating role of self-schema in the relation between trait score and various measures of social attitudes. Future research should continue to consider an interaction approach in attempting to clarify the complex relationships between self-schema constructs and personality outcomes.

Another future direction would be to explicate the relation between response time and the Big Five at a more specific level (e.g., facets). Determining how response time relates to these specific scales will provide a more nuanced understanding of self-schema. Self-schema may perhaps be better characterized by a combination of Big Five facets than by their broad domains.

The findings indicate that self-schema as indexed by response time is a useful variable in personality research. Nevertheless, there is a need for developing response time for practical use in assessment contexts, as response time can be used to improve the predictive validity of personality variables. Future research might benefit from examining possible alternatives to the various treatments of response times to ease the benefits of the method outside laboratory settings. For example, Siem (1996) proposed that it is worth examining the possibility of regulating response times based on a normative sample and adjusting individual response times based on a measure of simple response time collected in conjunction with the administration of the personality inventory. Related to this, it is of crucial importance to find a reliable instrument to assess self-favoring tendencies in personality inventories, especially when used in employment settings. Further, the relationship between response time and other variables can be further elaborated on larger samples, allowing the researcher to apply more powerful tests.

According to Rutter (2002), "…genetic factors play a substantial role in the origins of individual differences with respect to all psychological traits…" (p. 2). Thus, examinations of the heritability of attitudes suggest that social attitudes, such as conservatism and authoritarianism, are perhaps as heritable as personality traits (Bouchard & McGue, 2003). These findings direct future research to incorporate heritability estimates into the research of prejudice as well.

As a final point, to what extent does self-schema determine personality and social behavior outcomes? Future research needs to address in some depth how self-schema interacts with genetic factors to influence stereotypical attitudes and behaviors in a developmental framework. The results of the studies in this thesis imply that the heritability of personality is directly connected to self-schema. Future research directed toward uncovering the mechanisms and processes involved in the relationship between self-schema, heritability and various social attitudes is necessary to fully comprehend individual characteristics. It is important to determine whether the recently discovered relationships between self-schema and heritability are present in future replications of this study. As these processing mechanisms and structural properties become better understood, researchers will hopefully be able to sort out the essence of the factors that influence human beings.

Final Words

The findings of the present papers put emphasis on the use of response time as a rewarding line of research for assessing and understanding various personality characteristics. That is, the time of responding to a personality test item reflects the presence of a well-organized, integrated network of self-knowledge, called self-schema. Moreover, it facilitates the processing of relevant personality information.

The present results are anticipated to be used to extend applications that may be put into practice considering the use of response time. Furthermore, the expected application of personality assessment to real world issues makes the evaluation of "practical" response time measurements increasingly important. For example, in organizational and industrial contexts personality assessment is critical in making fair decisions in respect to equal opportunity hiring and social justice (e.g., Hogan et al., 1996). More valid measures will doubtless lead to a better understanding of personality schemas, their antecedents, and consequences.

Finally, these results have set the focus on the relationship between response time and heritability estimates. These findings would help us to increase our future understanding concerning the relative importance of an individual's biological inborn qualities (nature) vs. an individual's unique environment and experiences (nurture) in causing individual differences in physical, behavioral, or psychological characteristics.

The results presented here have substantially extended the work that has been done in the area of response time. They also indicate how much more research that needs to be done in this area.

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