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Inference making and linking both require thinking: Spontaneous trait inference and spontaneous trait transference both rely on working memory capacity☆

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ABSTRACT

Past research suggests that spontaneous trait inference (STI) and spontaneous trait transference (STT) may reflect different cognitive processes, the former being inferential and the latter associational. The present research was designed to explore whether either or both of these processes involve thinking that occupies cognitive capacity. Four studies suggest that reductions in available cognitive capacity reduce both STI and STT effects, both on measures of savings in relearning (which reflect the strength of trait associations with a person) and on trait ratings measures (which reflect the strength of trait inferences made about a person). Similar results were obtained using an individual difference measure of cognitive capacity. Although these results suggest that STI and STT are similar, in that both exhibit interference from reductions in cognitive capacity, other results, such as halo effects in trait ratings, support previous assertions that their underlying processes are distinct.

What kind of person is James? Is he kind and honest? Is he a faithful spouse? Is he the kind of manager I want to work for? Such trait inferences are crucial to our ability to function in the real world. They allow us to make predictions about others' future behaviors (McCarthy & Skowronski, 2011b) and can guide our everyday interactions with others.

One source of trait inferences comes from encounters with descriptions of others' behaviors. For example, after hearing Randy describe how he “aced” his Quantum Mechanics exam, a listener might reasonably infer that Randy is intelligent. Such trait inferences could be prompted by a query about Randy (e.g., “Is he intelligent?”), but can also occur without prompting. Indeed, evidence suggestive of non-prompted *spontaneous trait inferences* (STI) is now ubiquitous (see Carlston & Skowronski, 1994; Carlston, Skowronski, & Sparks, 1995; Uleman, Newman, & Moskowitz, 1996; Uleman, Saribay, & Gonzalez, 2008). More surprising, perhaps, is evidence that people similarly ascribe traits to those who describe behaviors other than their own. For example, if Randy mentions that Emily aced her Quantum Mechanics exam, Randy will be perceived by a listener to be more intelligent (though less so than Emily herself) than if he does not offer a description. The term *spontaneous trait transference* (STT) has been applied to this paradoxical tendency (Skowronski, Carlston, Mae, & Crawford, 1998). STT is important both in suggesting the existence of associative forms of impression formation (e.g., Carlston & Mae, 2006), and also in providing a comparison phenomenon for illuminating the seemingly more rational processes underlying STI.

The processes that underlie STI and STT

Skowronski et al. (1998) suggested that the mental processes that underlie STI differ from the processes that underlie STT. Various research teams have pursued evidence of such differences by comparing cases in which message recipients are exposed either to informants describing their own behavior (STI condition) or to informants describing the behavior of third-parties (STT condition). Skowronski et al. (1998) proposed that when encountering an informant's behavioral self-description, a perceiver: (1) *activates the trait* implied by the description; (2) *ascribes this trait to* the informant, producing an inferential link between mental representations of the trait and the informant; and (3) later *accesses this inferential link* to make subsequent judgments about the informant. In contrast, Skowronski et al. (1998) argued that after encountering an informant's description of a third-party: (1) a trait is *activated* while encoding the behavior description; (2) the activated trait simply becomes *associated* with the mental

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☆ Studies 3 and 4 were based on a Master's thesis conducted by the first author under the supervision of the second author. We thank the many undergraduates at NIU who helped collect and code the data in these studies.

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representation of the informant, and (3) this association is *later used to construct trait judgments about* the informant when such judgments are called for.

Thus, at least three process-related differences may distinguish STT from STI: (1) an inferential process at encoding that *ascribes the trait to the informant* in STI, but not in STT; (2) different resultant mental representations *of the informant and trait* (an *inferential link* in STI, an *associative link* in STT); and (3) *processing differences when a dispositional inference is called for* (*direct retrieval* of the prior inference in STI; *construction of a new inference* from the existing association in STT). A number of studies have now been conducted that support these process-level distinctions (for an overview, see Skowronski, Carlston, & Hartnett, 2008).

Although the labels for both STI and STT contain the term *spontaneous*, this doesn't necessarily mean that the processes involved in either are necessarily thoughtless or automatic (see Uleman, 1999). Work in the area has generally confirmed that these processes occur without much external prompting, but the degree of automaticity involved in these processes is not entirely clear. On the surface, the associative processes underlying spontaneous trait transference may seem to be less likely to involve controlled thought than those underlying spontaneous trait inference. Associative processes occur in most organisms (Fanselow & Poulos, 2004) and many associative processes in humans, such as STT, involve seemingly irrational thought, if they involve much thought at all. In contrast, ascribing traits has often been characterized as a thoughtful (and seemingly rational) process, particularly in early attribution work (Gilbert, Pelham, & Krull, 1988; Jones & Davis, 1965; Kelley, 1967). Nonetheless, past research suggests that both STI (see McCarthy & Skowronski, 2011a) and STT (e.g., Carlston et al., 1995) may possess some features of automaticity.

On the efficiency of STIs

Bargh (1994) suggested that automatic processes are characterized by a lack of process awareness, intentionality, and controllability, and also by processing that is sufficiently efficient that it requires few mental resources. It is this last characteristic, efficiency, that is the focus of this article. Gilbert et al. (1988) suggested that dispositional inferences are characterized by considerable efficiency, occurring despite cognitive loads (except when post-hoc corrections are required). Indeed, some subsequent studies provided evidence that STI-causing processes are sufficiently efficient to occur, even when people are under cognitive load (Crawford, Skowronski, Stiff, & Scherer, 2007b; Lupfer, Clark, & Hutcherson, 1990; Todorov & Uleman, 2002; Uleman, Newman, & Winter, 1992; Winter, Uleman, & Cunniff, 1985).

However, other research is less consistent with the suggestion that STIs are load-independent. Chun, Spiegle, and Kruglanski (2002) showed that when a behavior description is challenging to process, imposing a cognitive load does reduce the tendency to spontaneously make behavior-based correspondent inferences. Similarly, Wigboldus, Sherman, Franzese, and van Knippenberg (2004) found that cognitive load affected people's formation of STIs from difficult to process stereotype-inconsistent behaviors, though not for easily processed stereotype-consistent behaviors.

Additional research indicates that processing goals can alter the extent to which STIs are generated (Lieberman, Jarcho, & Obayashi, 2005; McCulloch, Ferguson, Kawada, & Bargh, 2008). In addition to suggesting that STIs may be somewhat intentional and controllable, past work also suggests that processing loads might interfere with STIs. For example, telling participants that their goal is to detect whether an informant is lying may use up cognitive resources, thereby interfering with the inferential activity underlying STIs (Carlston & Skowronski, 2005; Crawford et al., 2007b).

On the efficiency of STTs

As already noted, the associative nature of spontaneous trait transference seems to make it more likely to meet the criteria for automaticity than spontaneous trait inference. Moreover, the "irrationality" of many associative effects is consistent with the argument that the processes underlying STT are not subject to mental control. For example, people who gossip about others become associated with the traits about which they gossip, and targets randomly paired with descriptions of honest behavior are subsequently viewed as somewhat honest (Skowronski et al., 1998). Moreover, targets randomly linked to guns are thought of as somewhat violent, and bananas presented with a description of an actor's superstitious behavior come to be associated with superstition (Brown & Bassili, 2002). Such associative effects are relatively impervious to people's processing goals (Carlston & Skowronski, 2005; Crawford et al., 2007b; Skowronski et al., 1998) and occur even when people are warned about such effects and told to avoid them (Carlston & Skowronski, 2005, Study 3).

Such work implies that STT processes are not intentional or subject to attempts at mental control (but see Carlston & Skowronski, 2005, for evidence to the contrary). However there is very little research at this point that addresses whether STT processes use cognitive capacity and can therefore be disrupted by a cognitive load. One set of studies might be seen as relevant to this idea. Data provided by Crawford, Skowronski, and their associates (Crawford, Skowronski, & Stiff, 2007a; Crawford, Skowronski, Stiff, & Leonards, 2008) suggest that STT effects can be disrupted by presenting a photo of the person being described along with the more commonly-presented photo of the person doing the describing. The researchers suggest that this disruption occurs because the trait activated by the description becomes attached to the proper target (the actor) rather than the improper one (the informant). An alternative interpretation is that the cognitive activity involved in making a trait inference about the actor uses up cognitive capacity, reducing the resources available to form informant-trait associations. However, in a direct test of the cognitive load idea (Crawford et al., 2007b), researchers found no effect of load on the occurrence of STT.

STI, STT, and processing capacity

The brief literature review that we have provided suggests a lack of empirical clarity about the efficiency of the mental processes underlying STI and of the mental processes underlying STT. Accordingly, the studies described in the present article explore the efficiency of STI and STT by examining whether such effects occur in the presence of cognitive load. The present work seeks both to clarify inconsistencies in the literature (e.g., Todorov & Uleman, 2002 vs. Chun et al., 2002) and also, using comparable manipulations and conditions, to simultaneously examine and compare the effects of load on both STI and STT.

Given the state of the literature and extant theory, any of several outcomes might plausibly emerge from our studies. One is that processing capacity will be unrelated to both STI and STT. Such a result might be expected from the results of some studies (STI — Todorov & Uleman, 2002; STT — Crawford, et al., 2007b) and would point to the idea that only minimal mental capacity is needed to either make spontaneous inferences about a self-informant (STI) or to associate a third-party informant to the trait implied by their description (STT). A second possibility is that cognitive load might interfere with both STI and STT. This would indicate that both STI and STT require some non-trivial level of processing capacity. With STI, that capacity might be used to make an inference about the informant; with STT, that capacity might be used to associate the informant to the trait. This outcome is suggested by the fact that both STI (e.g. Chun et al., 2002) and STT (e.g. Crawford et al., 2008) can be disrupted — although *no* study has yet demonstrated that STT can be disrupted *because* processing capacity is reduced by imposition of cognitive load. A third possibility is that STI will be more affected by a reduction in available processing capacity than will STT. This possibility is consistent with the premise that the inferential activities involved in STI require more processing capacity than the associative activities involved in STT.

All four studies described in this article manipulated processing capacity by imposing a cognitive load. In Studies 1 and 2, different groups of participants were exposed to different load levels (as in Gilbert et al., 1988). In Studies 3 and 4, processing capacity was manipulated within-subjects, with all participants exposed to all load levels. This latter method of manipulating processing capacity has not often been used in the social psychology literature, but has often been employed by cognitive psychologists (e.g., Oberauer, Lange, & Engle, 2004).

Two of the current studies (3 and 4) also explored individual-differences in processing capacity using the OSPAN (Turner & Engle, 1989; Unsworth & Engle, 2007). This widely-used and oft-validated measure is thought to partially reflect individual differences in the ability to maintain information in working memory, an ability that could be critical to both the generation of trait inferences in STI and to the formation of associations in STT. Consequently, we expected this individual-difference measure of processing capacity to yield results parallel to those obtained from the cognitive load manipulation. Such an outcome would help to confirm that any effects of the load manipulation occurred because of load's impact on working memory capacity, and not to other possible consequences of the cognitive load manipulation (e.g., disruption of attention).

Another important feature of our studies is that two of them (1 and 3) explore STI and STT using a savings paradigm employed in previous studies (e.g., Skowronski et al., 1998) and the other two (2 and 4) explore STI and STT through trait judgments made about the informants. Carlston and Skowronski (2005) argue that both kinds of data are important to distinguishing between STI and STT. For example, trait judgments made about self-informants often exhibit halo effects, with effects generalizing from manipulated traits to other, evaluatively-congruent traits. However halo effects do not typically emerge in judgments made about third-party informants, despite significant judgment effects that emerge on the trait manipulated by the informant's description.

To summarize, then, as a set the studies shed light: (1) on the effects of processing capacity on the formation of associations between informant and the manipulated trait, (2) on the formation of inferences about the informant and the manipulated trait, and (3) on the generalization of those inferences to other, evaluatively-congruent traits.

Study 1: Cognitive load manipulation (between-subjects) and savings in relearning

Study 1 looks for evidence of cognitive load effects on STI and STT in a savings-in-relearning paradigm. In this paradigm, participants are exposed to photos of informants along with descriptions allegedly provided by those informants. Some informants describe their own behaviors, providing message recipients with an opportunity to make trait inferences about the informants (STI). Other informants describe the behaviors of third-parties, providing an opportunity for message recipients to associate the traits implied by the behaviors with the informants (STT).

The presence of informant-trait linkages can be assessed using a savings-in-relearning task. After initial exposure to the behavior descriptions, participants are given photographs of a number of people, each paired with a trait word, and asked to remember the pairing. A cued recall task is later presented in which participants must recall the trait when cued with a photo. Prior research suggests that *savings-in-relearning* occurs when a photo of an informant is paired with a trait word matching the trait implications of the behavior that the informant described earlier. The magnitude of this savings effect tends to be larger when faces depict self-informants (presumably reflecting inferential activity) than third-party-informants (presumably reflecting associative activity). In Study 1, we look for evidence indicating whether the magnitude of the savings effect in either the STI condition or the STT condition is moderated by the imposition of a cognitive load presented during processing of the original behavior descriptions.

Method

Participants

One hundred and thirty-three students enrolled in an introductory psychology course at Northern Illinois University participated. Compensation was partial credit toward completion of a course research option.

Materials

Materials for the experiment were used previously (e.g., Carlston & Skowronski, 1994; Carlston et al., 1995; Skowronski et al., 1998). In an initial familiarization task, each subject encountered 24 photos accompanied by behavior descriptions. Twelve descriptions implied a trait (see Carlston & Skowronski, 1994, for pretest results); some traits were positive (e.g., *honest* or *dedicated*), others were negative (e.g., *cruel* or *conceited*). Photos depicted Purdue University students who presumably were unknown to subjects. Each photo was displayed in 250×345 pixels (16 million colors). The students depicted varied in age and ethnicity and there were an equal number of male photos and female photos in the photo set.

Procedure

The procedure was adapted from prior research (e.g., Skowronski et al., 1998). On arrival, participants were led to a computer station. The presentation of materials was controlled by Direct RT software (Empirisoft, 2004). A description of the study was provided on the computer screen and was also read aloud by the experimenter.

Encoding task

Participants were told that in the experiment's first phase they would see photos of people paired either with that person's description of something they did (self-informant condition) or their description of something that someone else did (other-informant condition). On each trial, a photo and a behavior simultaneously appeared and stayed on the computer screen for 12 s; after this time, the next photo-behavior pair automatically appeared. The first two and the last three pairs presented were fillers; the middle 24 pairs constituted the critical photo-behavior pairs. The pairs were presented in a random order with only the constraint that two trait-implicative behaviors were not presented in a row.

Informant manipulation

Of the 12 trait-implying behaviors, six were worded in the first person so that it appeared that the description was provided by the informant (*self-informant*); the other six were worded in the third person so it appeared that the informant was describing someone else (*other-informant*). To avoid confusion about the informant, the gender of the pronouns in the other-informant descriptions (e.g., *he* or *she*) always differed from the gender of the informant (males always described females, females always described males). Of the twelve non-trait-implying sentences, six were also worded in the first person and six were worded in the third person. A counterbalancing scheme was used such that the control traits for some participants were the critical traits for other participants, and the self-describers for some participants were the third-party describers for other participants. Hence, results cannot be explained by idiosyncratic reactions to photo-behavior parings or idiosyncratic reactions to informant-trait pairings.

Cognitive load manipulation

Some participants completed the initial encoding task under *cognitive load*. Load was induced by presenting a 10-digit number at the bottom of each photo. Participants were asked to memorize the number and were prompted to report the number immediately after each photo-behavior pair disappeared from view. Participants in the *no-load condition* were not exposed to the numbers or the number recall task.

Confusion task

After the completion of the encoding phase, participants engaged in a filler task. Participants were given pairs of behaviors, each supposedly performed by a different person, and indicated which of the two individuals they liked better. Participants responded to 30 pairs. Many pairs contained behaviors related to the traits implied by behaviors presented in the encoding phase. This was done to try to overload memory and to make it difficult to use a behavior as a recall cue for a specific trait. Data from Carlston and Skowronski (1994) attest to the power of this procedure; afterwards, participants in their studies could not reliably recognize the behavior that was paired with each photo in the initial encoding task.

Paired-associates learning task

Next, participants were exposed to the previously seen photographs, each paired with a trait word. Participants were told that they would later be asked to recall the word that was paired with each photo. Each pair was viewed for 5 s and was viewed only once. Each of 12 *relearning trial* photos was paired with a trait word implied by the behavior with which it was paired during the encoding phase. For example, if a photo was paired with a mean-implying behavior during the encoding phase, that photo would be paired with the word *mean* in the learning task. Twelve additional *control trial* photos were also paired with trait words, but in the encoding task these photos were paired with neutral behaviors. A counterbalancing scheme was used such that the control trials for some participants were critical trials for other participants. Hence, results cannot be explained by photo-trait pairing confounds.

Trait recall task

Participants completed an anagram-completion filler task that consumed 5 min. Then, in the next task, the computer presented each photo from the learning task, one at a time, in a random order. Participants were required to type into the computer the trait word that was paired with the photo in the learning task. After the word was entered, the next photo appeared. Participants continued until all trials were completed. After completion of one additional task, participants were debriefed and thanked for their participation.

Results and discussion

Following scoring procedures established by Carlston and Skowronski (1994) and used in a number of subsequent studies (e.g., Carlston & Skowronski, 2005; Skowronski et al., 1998), a trait word was coded as correctly recalled using a gist criterion. The proportion of trials on which a word was correctly recalled was separately calculated for each participant for each cell of the Informant (self-informant vs. other-informant) × Trial Type (relearning trial vs. control trial) × Trait Valence (positive vs. negative) within-subject matrix. These proportions were entered into a mixed-model ANOVA that included all of these variables, as well as the between-subjects variable of cognitive load (load vs. no load).

STI and STT effects

As expected, participants better recalled the trait words on relearning trials ($M = .47$, $SD = .28$) than on control trials ($M = .36$, $SD = .24$), $F(1, 131) = 50.01$, $p < .001$, $\eta_p^2 = .23$, indicating that on relearning trials the trait implications of the informants' descriptions were already associated with the informant prior to the learning task. Simple effects tests showed that this effect was statistically reliable in both the self-informant condition (relearning $M = .50$, $SD = .27$; control $M = .36$, $SD = .23$; $F(1, 131) = 37.00$, $p < .001$, $\eta_p^2 = .24$), and the other-informant condition (relearning $M = .43$, $SD = .28$; control $M = .37$, $SD = .25$; $F(1, 131) = 5.11$, $p = .010$, $\eta_p^2 = .047$). However, these means also suggest that, as expected, the relearning effect was stronger for self-informants than for other-informants, $F(1, 131) = 4.33$, $p = .039$, $\eta_p^2 = .040$. These outcomes dovetail with past findings (e.g., Carlston & Skowronski, 2005; Skowronski et al., 1998).

The effects of cognitive load

The magnitude of the savings in relearning effect was affected by cognitive load, $F(1,131) = 6.40$, $p = .013$, $\eta_p^2 = .053$, with a larger savings effect in no load conditions (relearning $M = .50$, $SD = .27$; control $M = .36$, $SD = .23$) than in load conditions (relearning $M = .42$, $SD = .28$; control $M = .36$, $SD = .24$). This difference was entirely due to diminished savings for implied traits under load (simple effects test, $F(1, 131) = 4.37$, $p = .039$, $\eta_p^2 = .042$). However, simple effects test results also indicate that the savings effect remained significant, even under load ($F(1, 131) = 11.21$, $p = .001$, $\eta_p^2 = .064$, compared to $F(1, 131) = 43.03$, $p < .001$, $\eta_p^2 = .20$ in the no-load condition). Perhaps most importantly, the Informant × Trial Type × Cognitive Load interaction was not significant, $F(1, 131) = .229$, $p = .633$, suggesting that the load manipulation affected STI and STT equally. This equality is apparent from the means presented in Table 1, which show that load reduces the magnitude of the savings effect by around 50% in both self-description (STI) and other-description (STT) conditions. This suggests that: (a) greater processing capacity contributes to both spontaneous trait inference and spontaneous trait transference processes, a result especially notable because past research has often found that STT effects are generally unaffected by experimental manipulations (see Carlston & Skowronski, 2005), but that (b) both processes persist even when cognitive capacity is greatly reduced.

Valance effects

The analysis also yielded an unexpected Trial Type × Trait Valence interaction, $F(1, 131) = 14.17$, $p < .001$, $\eta_p^2 = .067$. The means for this effect indicate that the relearning effect was larger for positive traits (relearning $M = .50$, $SD = .48$; control $M = .33$, $SD = .46$; $F(1, 131) = 57.36$, $p < .001$, $\eta_p^2 = .22$) than for negative traits (relearning $M = .43$, $SD = .46$; control $M = .38$, $SD = .47$; $F(1, 131) = 7.59$, $p = .007$, $\eta_p^2 = .056$). Viewed differently, this interaction suggests that on control trials, it was easier to associate informants with negative than positive traits, $F(1, 131) = 4.37$, $p = .04$, $\eta_p^2 = .04$, but that on the relearning trials it was easier to associate informants with positive traits than negative traits, $F(1, 131) = 8.58$, $p = .004$, $\eta_p^2 = .061$. The lack of an interaction with informant type suggests that these valence effects occurred for both self-informants and other-informants. While this result contradicts Carlston and Skowronski's (2005) claim that negativity effects may be a signature of spontaneous trait inference effects, they also note that such negativity effects appear to be weak and their appearance is inconsistent across studies.

Table 1
Mean (SD) percentage of correctly recalled traits as a function of Informant, Cognitive Load, and Trial Type in Study 1.

	Trial Type		
	Relearning	Control	Savings
Self-informant (STI)			
No load	.54 (.26)	.35 (.21)	.19
Load	.46 (.28)	.36 (.25)	.10
Other-informant (STT)			
No load	.47 (.27)	.38 (.25)	.09
Load	.39 (.29)	.35 (.24)	.04

Study 2: Cognitive load manipulation (between-subjects) and trait ratings

The results of Study 1 confirm Chun et al.'s (2002) finding that cognitive load can interfere with the generation of spontaneous trait inferences. Additionally, these results indicate that such interference also occurs with spontaneous trait transference. Given that STT is thought to be a less mindful phenomenon than STI, and hence, to consume fewer mental resources, this result may seem a bit surprising. However, the result is consistent with Crawford et al.'s (2008) suggestion that even the formation of associations in STT requires mental resources.

Study 1 provides mixed results regarding the claim that STT and STI reflect different cognitive processes. The equivalent effects of cognitive load on both phenomena might suggest that similar processes underlie each. However, the greater magnitude of the STI effect than the STT effect could reflect different kinds of underlying linkages (inferential for STI; associative for STT). Alternatively, this larger STI effect might simply reflect especially strong associative linkages for self-informants than for other-informants (see Bassili, 1989).

Carlston and Skowronski (2005) argue that one way to disambiguate these alternatives is to use trait ratings as an adjunct to the savings paradigm. They suggest that one signature of trait inference-making is the presence of halo effects in trait judgments. For example, if Jade's self-description causes her to be judged as dishonest, she should also be judged to be selfish and unsociable (though these latter halo effects tend to be smaller than ratings along the implied trait dimension). In contrast, though Jade's description of a third party might also cause Jade to be judged as dishonest, no halo effects should occur. This prediction has been verified in a number of studies (Carlston & Skowronski, 2005; Crawford et al., 2007b; Skowronski et al., 1998).

Accordingly, we conducted a second study, much like the first, but using a trait rating task in place of the conventional savings task. We expected trait ratings of self-informants to reveal halo effects, whereas trait ratings of other-informants would not. In addition, given the results of Study 1, we expected that the cognitive load manipulation would, for all informants, reduce the extremity of ratings made of the trait implied by the original behavioral description. Whether it would also reduce the magnitude of halo effects in STI conditions was unclear.

Method

Participants

One hundred and eighty-eight students enrolled in an introductory psychology course at Northern Illinois University participated. Compensation was partial credit toward completion of a course research option.

Procedure and materials

With a few exceptions, the procedure and materials used were identical to those used in Study 1. More specifically, in Study 2 a trait rating task used in previous studies (see Carlston & Skowronski, 2005) was substituted for the trait learning and recall tasks. Despite the change in task from memory to judgment, to facilitate comparability across studies we continue to use the terms *relearning trials* (for those who described trait-implicative behaviors) and *control trials* (for those who did not).

In the rating task, the person depicted in each photo was rated on three separate trait dimensions. Each rating reflected how much of the trait a person possessed and was made on unipolar, nine-point scales that had response options labeled at the midpoint and endpoints (1 = *not at all*, 5 = *moderately*, 9 = *extremely*). Each participant made ratings of twenty-four *critical traits* (12 positive and 12 negative) each of which was linked to one informant. Six of these involved informants who provided trait-implicative self-behavior descriptions; six involved informants who provided neutral self-descriptions; six involved informants who provided descriptions of third parties' trait-implicative behaviors; and six involved informants who provided descriptions of third parties' trait-neutral behaviors. Within each of these groups of six, half (three) of the traits were positive and half were negative. A complex counterbalancing scheme was used to vary the critical traits across subject groups. Consequently, any trait valence or trial type results that emerge from the analyses are not confounded with the nature of the traits rated.

In addition to rating each informant on a critical trait, participants also rated each on a trait that was *evaluatively congruent* with (but low in semantic relatedness to) the critical trait, and on a trait that was *evaluatively incongruent* with (and low in semantic relatedness to) the critical trait. The congruent traits and incongruent traits actually served as critical traits on other trials: Each trait appeared once in each of the three roles for a given subject. Counterbalancing ensured that each trait contributed equally often to each condition. Hence, results that emerge for the trait type variable are not confounded with particular traits.

Results and discussion

The trait ratings were separately averaged within each of the twenty-four within-subject cells formed by crossing the Informant (self-informant vs. other-informant) × Trial Type (relearning vs. control) × Trait Valence (positive vs. negative) × Trait Rated (critical, consistent, inconsistent) variables. Thus, three ratings contributed to each mean. The means were then entered into a mixed-model ANOVA that included all of these variables, as well as the between-subjects variable of cognitive load (load vs. no load).

STI and STT effects

We expected participants to rate informants as having more of the trait implied by their descriptions and we expected this effect to be greater in STI (self-description) conditions than in STT (other-description) conditions. Additionally in STI conditions (but not STT conditions) we expected similar, but lesser, halo effects indicating elevated ratings of evaluatively-congruent traits, and decreased ratings of evaluatively-incongruent traits. Finally, we expected cognitive load to diminish ratings of the informant on the implied trait, and possibly to reduce or eliminate halo effects in STI conditions.

These effects were largely observed in the means describing the Informant × Trial Type × Trait Rated interaction, $F(2, 186) = 7.72$, $p < .001$, $\eta_p^2 = .071$. As shown in Table 2, informants were, indeed, rated as having more of the traits they described, particularly when they described their own behaviors. Simple effects tests confirm that this effect was significant both for self-informants, $F(1, 186) = 28.93$, $p < .001$, $\eta_p^2 = .14$, and nearly so for other-informants, $F(1, 186) = 3.79$, $p = .053$, $\eta_p^2 = .039$. Additionally, the means confirm the emergence of halo effects: Informants were rated more positively on traits that were

Table 2

Means (SD) for the Informant × Trial Type × Trait Rated interaction in Study 2.

	Trait Rated		
	Critical	Congruent	Incongruent
Self-informant (STI)			
Relearning	4.35 (.90)	3.86 (.78)	3.57 (.95)
Control	3.82 (.76)	3.64 (.84)	3.73 (.84)
Other-informant (STT)			
Relearning	3.92 (.72)	3.86 (.81)	3.69 (.84)
Control	3.79 (.76)	3.57 (.78)	3.67 (.92)

Note. Ratings reflected how much of the trait each informant possessed and was made on nine-point unipolar scales that had response options labeled at the midpoint and endpoints (1 = *not at all*, 5 = *moderately*, 9 = *extremely*).

Table 3
Means (SD) for the Cognitive Load × Trial Type × Trait Rated interaction in Study 2.

	Trait Rated		
	Critical	Congruent	Incongruent
No cognitive load			
Relearning	4.42 (.82)	4.06 (.84)	3.80 (.78)
Control	3.99 (.61)	3.87 (.68)	4.03 (.79)
Cognitive load			
Relearning	3.86 (.77)	3.66 (.68)	3.49 (.83)
Control	3.62 (.69)	3.34 (.70)	3.37 (.81)

Note. Ratings reflected how much of the trait each informant possessed and was made on nine-point unipolar scales that had response options labeled at the midpoint and endpoints (1 = *not at all*, 5 = *moderately*, 9 = *extremely*).

congruent with the trait implied by an informant's behavior, and less positively on traits that were incongruent with the trait implied by an informant's behavior. As expected, this halo effect was clearly and significantly evident in the ratings of self-informants. The effect was not predicted to emerge in the ratings provided for other-informants, but the means (especially in the congruent condition) hint at the presence of such an effect. Thus, while the data conclusively show that the halo effect is stronger for self-informants than for other-informants, they may not be entirely consistent with Carlston and Skowronski's (2005) contention that the halo effect does not emerge in STT conditions.

The effects of cognitive load

The effects of cognitive load on trait ratings are reflected in a main effect for load, $F(1, 186) = 36.88$, $p < .001$, $\eta_p^2 = .17$, that is qualified by a Trial Type × Trait Rated × Cognitive Load interaction, $F(2, 186) = 5.58$, $p = .004$, $\eta_p^2 = .052$.[1] The means for this interaction show a familiar pattern in the no load condition (see Table 3), one that has often appeared in prior research. These patterning of the means show that relative to the control condition, ratings of informants: (1) are especially elevated on the critical traits that were directly implied by the behaviors; (2) are slightly elevated on the traits that are evaluatively consistent with the critical traits implied; and (3) are slightly reduced on the traits that were evaluatively inconsistent with the critical traits (however, note that only the first of these effects is statistically reliable, $p < .05$). In comparison, in the load condition relearning vs. control comparisons were statistically reliable. The magnitude of the rating difference score (trait implicative condition minus control condition) for critical traits was about half the size of the difference score observed in the no load condition. Moreover, compared to the no load condition, the ratings effect for congruent traits was actually larger, and the effect was reversed for incongruent traits. This pattern of means may imply a mild persistence of trait rating effects (at least for the implied and congruent traits), even under load. More important, however, is the observation that the patterning of the data differed substantially in the load and no load conditions.

Moreover, close inspection of the means in Table 3 suggests one other potentially important effect. These means show that in the load condition, participants' ratings of trait-describing informants were lower across the board than ratings in the corresponding no load control conditions ($F(1, 186) = 4.14$, $p < .05$, $\eta_p^2 = .037$)! In other words, when under load, participants viewed informants who provided trait-relevant self- or other-descriptions as having *less* of the implied (and other) traits than did unloaded participants who rated the same photos in the absence of any trait-implying description at all. It should be noted that the presence of a similar effect may have contributed to the conclusion of some prior research (e.g., Crawford et al., 2007b) that load had no impact on STI. Examination of the data from Experiment 3 of the Crawford et al. study (see Fig. 3, p. 10) shows that there was a tendency for load to reduce recall (especially in STI conditions), but that load-driven reduction was accompanied by a reduction of recall in the control condition. Because of this latter reduction, Crawford et al. may have missed the extent to which load reduces STIs.

Note that in Study 2, we were fortunate: the reductive effects of load effects persisted despite a lowering of ratings on control trials similar to that observed by Crawford et al. Thus, the difference between ratings on trait-implying and control trials thus suggests the persistence of some kind of inferential or associative link between the informant and trait representations, even under load, though the depressed levels of trait ratings suggest a reluctance to use that link to make strong trait ascriptions.

Importantly, the Trial Type × Trait Rated × Cognitive Load interaction was not qualified by an interaction with the informant variable, $F(2, 186) < 1$, *ns*. This suggests that the cognitive load manipulation produced comparable effects for both self- and other-describing informants. As in Study 1, then, cognitive load interferes with the processes underlying both STI and STT, though Study 1 suggests that savings effects occur nonetheless, and Study 2 suggests that the links detected by the savings task have effects on trait ascriptions, though the load depresses these considerably.

Trait valence effects

The analysis also yielded numerous significant effects that included the valence of the trait implied by the behavior. These effects included the following significant effects: a Trait Valence × Trait Rated interaction, $F(2, 186) = 248.14$, $p < .001$, $\eta_p^2 = .33$; a Trait Valence × Trait Rated × Cognitive Load interaction, $F(2, 186) = 5.75$, $p = .003$, $\eta_p^2 = .054$; a Valence × Trial Type interaction, $F(1, 186) = 38.82$, $p < .001$, $\eta_p^2 = .18$; a Valence × Trial Type × Cognitive Load interaction, $F(1, 186) = 6.79$, $p = .01$, $\eta_p^2 = .059$; a valence main effect, $F(1, 186) = 148.87$, $p < .001$, $\eta_p^2 = .27$; a Valence × Trial Type interaction, $F(1, 186) = 38.82$, $p < .001$, $\eta_p^2 = .18$; and a Trait Valence × Cognitive Load interaction, $F(1, 186) = 14.80$, $p < .001$, $\eta_p^2 = .11$. However, these effects are not of much theoretical relevance. Instead, it is important to note one important valence-related effect that did *not* emerge: The valence variable did not interact with the trial type and informant variables, $F(1, 186) = .64$, *ns*. The absence of this interaction conflicts with Carlston and Skowronski's (2005) suggestion that negativity effects ought to be stronger in ratings of self-informants than in ratings of other-informants.

Study 3: Cognitive load (manipulated within-subjects), WM capacity, and trait savings

Cognitive load should exert its impact by affecting the capacity of working memory (WM). WM has been characterized in different ways by different researchers. In perhaps the most famous article on WM, Miller (1956) defined WM in terms of its capacity to hold 7 ± 2 chunks of information. A few years after Miller's (1956) seminal article, Peterson and Peterson (1959) defined WM as the ability to store a memory trace for roughly 20 s without rehearsal. However, these values are not fixed across individuals. Researchers have found strong evidence that there are individual differences in WM (Just & Carpenter, 1992). That is, some people are able to store and process more stimuli than others. Just and Carpenter found that individuals with large WM capacities are relatively unaffected by cognitive load manipulations, but that these have large effects on those with small WM capacities.

Accordingly, Study 3 examined how individual differences in WM capacity interact with the load manipulation to affect STI and STT. The individual-difference measure of processing capacity used was the

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[1] Numerous other significant effects are also embedded in this interaction: a Trial Type x Trait Rated interaction, $F(2, 186) = 13.79$, $p < .001$, $\eta_p^2 = .10$; an Informant x Trait Rated interaction, $F(2, 186) = 6.43$, $p = .001$, $\eta_p^2 = .081$; and main effects for informant, $F(1, 186) = 6.65$, $p = .011$, $\eta_p^2 = .56$, trial type, $F(1, 186) = 36.67$, $p < .001$, $\eta_p^2 = .19$, and trait rated, $F(2, 186) = 39.66$, $p < .001$, $\eta_p^2 = .27$.

widely-used and well-validated OSPAN (Turner & Engle, 1989; Unsworth & Engle, 2007). This measure is thought to partially reflect individual differences in the ability to maintain information accessible in working memory, a mental ability that should be critical to both the generation of trait inferences about informants and to the formation of associations between informants and traits implied by their behavior descriptions.

One possibility is that cognitive load and WM capacity will interact in a manner similar to that described by Just and Carpenter (1992): Only those with especially small WM capacities will fall victim to the demands of cognitive load and show a reduction in STI and STT effects. Another possibility (seemingly unlikely given the results of Studies 1 and 2) is that STT and STT effects occur so automatically that WM capacity will have little effect on their emergence. In this case, neither cognitive load nor WM capacity should diminish STT or STI effects. Yet another possibility is that WM capacity results will mirror the results of cognitive load, each producing independent effects on STT and STI.

Finally, note that in Studies 1 and 2 cognitive load was manipulated between-subjects so that different participants received different load levels. In Study 3, however, processing capacity was manipulated within-subjects: All participants encountered all load levels.

Method

Participants

Two hundred and sixty-nine students enrolled in an introductory psychology course at Northern Illinois University participated. Compensation was partial credit toward completion of a course research option.

Materials and procedure

With a few exceptions, the procedure and materials used were identical to those used in Study 1.

Assessing WM via the OSPAN

All participants in Study 3 completed a computerized version of the operation span task (AOSPAN; Unsworth, Heitz, Schrock, & Engle, 2005) using E-Prime Version 1.0 (Schneider, Eschman, & Zuccolotto, 2002). During the AOSPAN task, participants calculate arithmetic equations while keeping a series of letters in memory for later recall. Working memory capacity is defined as the number of letter strings correctly recalled. Hence, the AOSPAN measures one's ability to maintain a memory trace, particularly when distracted. This version of the OSPAN task can be completed by each participant on their own computer, can be completed relatively quickly, and is computer-scored, automatically producing a WM capacity score on completion. Unsworth et al. (2005) demonstrated that the AOSPAN correlates highly with other measures of WM capacity, has high internal consistency ($\alpha = .78$), and has high test–retest reliability (.83).

Other procedural differences

Study 3 also differed from the other two studies in that cognitive load was manipulated as a within-subjects variable. Participants were told that they would sometimes be asked to remember a number while reading a behavior and looking at a photo. Sometimes there would be no number (no load); sometimes the number would be a two-digit number (low load); and sometimes the number would be a six-digit number (high load). These variations occurred randomly across trials. The increase in the number of load conditions (from two in Studies 1 and 2 to three in Study 3) necessitated an increase in the number of trials (to 48) on which informants were depicted as conveying trait information.

Two other differences between Study 3 and the earlier studies are noted. The placement of the AOSPAN task among other experimental tasks was counterbalanced. Participants were randomly assigned to either complete the AOSPAN task or the memory/savings task first. Second, instead of intermixing self-and other-informants across trials, these informant types were grouped into two separate blocks, with the order of these blocks counterbalanced across participants. Some participants were randomly assigned to first view the self-informant (STI) block; others first viewed the other-informant (STT) block.

Thus, in Study 3, participants attempted to recall 48 traits (compared to 24 traits in Study 1). These were spread across the within-subject variables of trial type (relearning vs. control), informant (self-informant vs. other-informant), and cognitive load (no load vs. low load vs. high load) in a factorial within-subjects design. In addition, there were two between-subjects variables in the design: Participants were exposed to one of two informant block orders (self-informants first, other-informants first) and to one of two task orders (AOSPAN first, memory/savings task first).

Results and discussion

Study 3 used the gist criterion scoring procedures described by Carlston and Skowronski (1994) also used in Studies 1 and 2. The proportion of trials on which a word was correctly recalled was separately calculated for each participant for each cell of the Informant (self-informant vs. other-informant) × Trial Type (relearning trial vs. control trial) × Cognitive Load (no load vs. low load vs. high load) within-subject design. These proportions were entered into a mixed-model ANOVA that included all of these variables, as well as the between-subjects variable of informant order (self-informant trials first vs. other-informant trials first).[2]

STI and STT effects

As in previous studies, participants showed savings in relearning by better recalling the trait words from the learning task on relearning trials ($M = .31$, $SD = .20$) than on control trials ($M = .24$, $SD = .16$), $F(1, 267) = 70.33$, $p < .001$, $\eta_p^2 = .208$. As illustrated by the means for the Informant × Trial Type interaction ($F(1, 267) = 14.63$, $p < .001$, $\eta_p^2 = .052$), and as expected from results of past research, the savings effect was stronger for self-informants (relearning $M = .34$, $SD = .21$; control $M = .24$, $SD = .18$; $F(1, 267) = 73.68$, $p < .001$, $\eta_p^2 = .22$) than for other-informants (relearning $M = .28$, $SD = .23$; control $M = .24$, $SD = .18$; $F(1, 267) = 14.81$, $p < .001$, $\eta_p^2 = .053$).

The effects of manipulated load

Study 3 used a within-subject cognitive load manipulation common in cognitive psychology studies but rarely used in social psychological research. This within-subject manipulation affected the magnitude of savings in trait recall, just as the between-subjects manipulation had in Studies 1 and 2 had, $F(2, 534) = 12.03$, $p < .001$, $\eta_p^2 = .043$. Indeed, the means for this effect show that trait recall was greater for trials performed under lower levels of cognitive load (no load $M = .30$, $SD = .20$; low load $M = .27$, $SD = .20$; high load $M = .25$, $SD = .18$).

However, this effect was qualified by a significant Trial Type × Cognitive Load interaction, $F(2, 534) = 3.99$, $p = .019$, $\eta_p^2 = .015$. Simple effects tests sensibly showed that cognitive load affected the recall of relearning trials, $F(2, 534) = 14.30$, $p < .001$, $\eta_p^2 = .051$, but not the recall of control trials, $F(2, 534) = 2.17$, $p = .115$, $\eta_p^2 = .008$.

Of course, of particular interest was whether the load manipulation differentially affected STI and STT trials. The Informant × Trial Type × Cognitive Load interaction was not significant, $F(2, 534) = 1.46$, $p = .233$, $\eta_p^2 = .005$, suggesting that the effects of the load manipulation were equivalent for both self- and other-informants (see Table 4). These results mirror those yielded by Study 1.

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[2] Preliminary analyses suggested that the task ordering manipulation did not affect the results, so it was not included in our analytic design. Informant order did have modest effects on the results, but not in ways that inform the present hypotheses, so these effects are not reported.

Table 4
Mean (SD) percentage of correctly recalled traits as a function of Informant, Cognitive Load, and Trial Type in Study 3.

	Trial Type		
	Relearning	Control	Savings
Self-informant (STI)			
No load	.38 (.30)	.23 (.26)	.15
Low load	.33 (.29)	.26 (.24)	.07
High load	.30 (.27)	.22 (.25)	.08
Other-informant (STT)			
No load	.32 (.28)	.26 (.25)	.06
Low load	.28 (.26)	.23 (.25)	.05
High load	.26 (.25)	.22 (.24)	.04

The effects of individual differences in working memory

Although cognitive capacity can be experimentally altered through cognitive load, there are also stable individual differences in such capacities. We measured those with the AOSPAN. To assess the effects of these individual differences we conducted a set of hierarchical simultaneous regression analyses in which each participant's score on the AOSPAN was used to predict their recall performance. The effect of AOSPAN was evaluated both in isolation and in combination with the other variables described in the ANOVA (informant, trial type, cognitive load, and informant order). Interactions between an individual's AOSPAN score and other variables were evaluated only after first controlling for individual differences among participants (e.g., by partialling out between-subjects variance). This analysis was hierarchical in that effects were evaluated in a stepwise fashion, with within-participant main effects simultaneously evaluated first (controlling for participants). All two-way interactions were simultaneously evaluated next (controlling for main effects and participants). The next step was to simultaneously explore all three-way interactions (controlling for participants, main effects, and all two-way interactions). The analyses proceeded in this hierarchical fashion, concluding with the five-way interaction.[3]

Many regression results substantially replicated effects described in the Study 3 ANOVA, so only results involving the AOSPAN variable will be described here. As one would expect, participants' AOSPAN scores positively predicted their memory performance, $\beta = .140$, $t(229) = 2.16$, $p = .032$, $\Delta R^2 = .0197$. Moreover, the expected AOSPAN × Trial Type interaction approached significance, $\beta = .086$, $t(229) = -1.79$, $p = .073$, $\Delta R^2 = .0129$. Subsidiary analyses exploring this interaction suggested that WM capacity was positively related to memory performance on relearning trials, $\beta = .157$, $t(229) = 2.43$, $p = .016$, but not on control trials, $\beta = .098$, $t(229) = 1.50$, $p = .135$.

It is noteworthy that neither the Cognitive Load × Trial Type × AOSPAN interaction, $F(2, 2566) < 0.01$, $p = .999$, $\Delta R^2 < .0001$, nor the Cognitive Load × Trial Type × AOSPAN × Informant interaction, $F(5, 2561) = .53$, $p = .756$, $\Delta R^2 < .0001$, were significant. Thus, despite the fact that working memory capacity was related to both overall memory performance and to savings, results from our cognitive load manipulation were not moderated by an individual's working memory capacity. Instead, the effects of the cognitive load manipulation and the memory capacity measure on relearning were additive. Even more important, though, is that results from both load-related variables converge in suggesting that both STI effects and STT effects depend on cognitive capacity.

Study 4: Cognitive load (manipulated within-subjects), WM capacity, and trait ratings

As with Studies 1 and 2, we again sought to replicate and extend the savings task results by substituting a trait rating task for the savings task. Once again, we were particularly interested in looking at possible halo effects, which Carlston and Skowronski (2005) suggest may distinguish inferential effects from associative effects. Given the results of Study 3, we also expected that results from the AOSPAN measure of Working Memory capacity would mirror those obtained from the cognitive load manipulation.

Method

Participants

Three hundred and fifty-eight students enrolled in an introductory psychology course at Northern Illinois University participated. Compensation was partial credit toward completion of a course research option.

Procedure and materials

In Study 4, a trait rating task was substituted for the trait learning and recall tasks used in Study 3. As in Study 2, despite the change in task from memory to judgment, to enhance comparability across studies we continue to use the terms *relearning trials* (for those who described trait-implicative behaviors) and *control trials* (for those who did not).

As in Study 2, the person depicted in each photo was rated on three separate trait dimensions. However in this study we replaced our previously-used 9-point scales with unipolar 5-point scales that had all response options labeled (1 = *not at all characteristic of the photographed person*, 5 = *extremely characteristic of the photographed person*). All other aspects of the procedures remained the same as in Study 2.

Results and discussion

The trait ratings were separately averaged within each of the thirty-six within-subject cells formed by crossing the Informant (self-informant vs. other-informant) × Trial Type (relearning trials vs. control trials) × Cognitive Load (no load, low load, high load) × Trait Rated (critical, consistent, inconsistent) variables.

STI and STT effects

We expected results from Study 4 to replicate our previous results regarding STI and STT effects. This replication is reflected in the Informant × Trial Type × Trait Rated interaction, $F(2, 714) = 77.63$, $p < .001$, $\eta_p^2 = .179$ shown in Table 5. Informants who described trait-implicative behaviors (relearning trials) were rated as having more of the traits that they described. This is more true for self-informants (simple effects $F(1, 357) = 266.45$, $p < .001$, $\eta_p^2 = .43$) than for other-informants (simple effects $F(1, 357) = 34.59$, $p < .001$, $\eta_p^2 = .088$).

Ratings on trait dimensions not implied by an informant's original description provide important evidence of halo effects. Carlston and Skowronski (2005) suggest that such effects should be evident when participants make inferences (STI conditions) but not when they merely form associations (STT conditions). As shown in Table 5, ratings of self-informants clearly show halo effects, with heightened ratings on evaluatively-congruent traits ($F(1, 357) = 24.85$, $p < .001$, $\eta_p^2 = .065$) and lowered ratings on evaluatively-incongruent traits ($F(1, 357) = 51.32$, $p < .001$, $\eta_p^2 = .126$), relative to their respective control conditions. In contrast, for other-informants, neither the

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[3] After preliminary analyses of the AOSPAN scores, 33 (12.27% of 269) participants were excluded from analysis because they failed to maintain the 85% accuracy criterion on the math operations of the AOSPAN. Additional exploration of the AOSPAN data led to the deletion of one additional participant (of the remaining 236); analyses suggested that the data from that participant could be classified as a multivariate outlier (the participant's Mahalanobis distance exceeded the critical value at $p < .001$). The majority of these participants' errors were accuracy errors ($M = 18.15$, $SD = 11.43$) as opposed to speed errors ($M = 3.88$, $SD = 5.93$). In addition, these participants tended to have lower AOSPAN scores ($M = 20.12$, $SD = 13.27$). The pattern and magnitude of results did not change when analyzing the data with these participants included. These results (12.27% of 269 participants) closely mirror those obtained by Unsworth et al. (2005) (15% of 296 participants).

Table 5
Means (SD) for the Informant × Trial Type × Trait Rated interaction in Study 4.

	Trait Rated		
	Critical	Congruent	Incongruent
Self-informant (STI)			
Relearning	3.36 (.66)	2.74 (.61)	2.51 (.57)
Control	2.69 (.64)	2.61 (.59)	2.70 (.57)
Other-informant (STT)			
Relearning	2.94 (.64)	2.74 (.57)	2.69 (.56)
Control	2.76 (.60)	2.69 (.58)	2.70 (.55)

Note. Ratings reflected how much of the trait each informant possessed and was made on five-point unipolar scales that had response options labeled at all points (1 = *not at all*, 5 = *extremely*).

congruent trait ratings nor the incongruent trait ratings given to informants who provided trait-implicative descriptions show halo effects — either for the comparison of ratings given for congruent traits to incongruent traits, or for the comparisons of the ratings given to these traits for the trait-implicative targets and the control targets. These data are consistent with Carlston and Skowronski's (2005) suggestion that because of their inferential component STIs are characterized by halo effects, whereas STTs are not.

Effects of manipulated load

The significant cognitive load effect, $F(2,\ 714) = 5.92$, $p = .003$, $\eta_p^2 = .016$, was qualified by a Trial Type × Trait Rated × Cognitive Load interaction, $F(4,\ 1428) = 4.23$, $p = .002$, $\eta_p^2 = .012$.[4] Results of simple effects tests (see Table 6 for means) indicate that this interaction is driven primarily by ratings on the critical traits, $F(2,\ 714) = 6.57$, $p = .001$, $\eta_p^2 = .018$. With no load and with low load, relearning trials yielded much more extreme judgments of informants on the critical traits than were provided for informants in the control condition; these effects were also present, but weaker, with high load. Somewhat surprisingly, the congruent traits showed an unexpected pattern: Halo effects were greater under low and high load as compared to no load. Further inspection of these means suggest this effect was primarily driven by trait ratings to control trials.

Importantly, the triple interaction was not qualified by the informant variable, $F(4,\ 1428) = 1.28$, $p = .276$, $\eta_p^2 = .004$, suggesting that the cognitive load manipulation produced comparable results in ratings of both self-informants and other-informants. Hence, this result converges with the results of Study 2 in suggesting that cognitive load disrupts both the inferential processes thought to underlie STIs and the associative processes thought to underlie STTs.

The effects of individual differences in working memory

The AOSPAN measure was used to explore the trait judgments in a series of hierarchical regression analyses similar to those described for Study 3.[5] These analyses substantially replicated results for the variables entered into the Study 4 ANOVA, so here we describe only results involving the AOSPAN variable. The analysis yielded a significant AOSPAN × Trial Type interaction, $F(1,\ 3514) = 11.52$, $p < .001$, $\Delta R^2 = .00031$. Subsidiary analyses exploring this interaction suggested that WM capacity was negatively related to trait ratings on control trials, $\beta = -.116$, $t(319) = -2.08$, $p = .039$, but had no relationship to trait ratings for targets who described trait-implicative behaviors on relearning trials, $\beta = .021$, $t(319) = 0.37$, $p = .710$.

Importantly, neither the Cognitive Load × Trial Type × AOSPAN interaction, $F(2,\ 3503) = 0.02$, $p = .978$, $\Delta R^2 < .0001$, nor the Cognitive Load × Trial Type × AOSPAN × Informant interaction, $F(2,\ 3491) = 1.16$, $p = .314$, $\Delta R^2 < .0001$, were significant. Thus, despite the fact that working memory capacity was related to the trait ratings, especially for control trials, it did not selectively moderate load's effect on either the emergence of STI or STT effects in trait ratings. Instead, the effects of manipulated load and the capacity measure on trait ratings were additive. More important, though, is that the results from both load-related variables converge in suggesting that both STI effects and STT effects depend on cognitive capacity.

Table 6
Means (SD) for the Cognitive Load × Trial Type × Trait Rated interaction in Study 4.

	Trait Rated		
	Critical	Congruent	Incongruent
No cognitive load			
Relearning	3.22 (.72)	2.70 (.66)	2.58 (.62)
Control	2.76 (.70)	2.71 (.64)	2.69 (.60)
Low cognitive load			
Relearning	3.20 (.66)	2.78 (.64)	2.62 (.62)
Control	2.70 (.65)	2.62 (.62)	2.70 (.65)
High cognitive load			
Relearning	3.03 (.68)	2.74 (.63)	2.61 (.58)
Control	2.70 (.67)	2.62 (.61)	2.71 (.59)

Note. Ratings reflected how much of the trait each informant possessed and was made on five-point unipolar scales that had response options labeled at all points (1 = *not at all*, 5 = *extremely*).

General discussion

Summary and overview

The studies described in the present article investigate the efficiency of the cognitive processes underlying STT and STI. Past research has yielded conflicting views as to whether STIs are efficient enough to be relatively impervious to variations in cognitive capacity (e.g., Chun et al. 2002 vs. Todorov & Uleman, 2002). The results of STT research are even more uncertain: There is a debate about the extent to which STT effects can ever be disrupted (e.g., Crawford et al. 2007a vs. Crawford et al., 2008), let alone be disrupted by low cognitive capacity (to our knowledge, no extant studies).

The four studies described in the present article approached these issues by examining how working memory capacity is related to processing on STT trials and STI trials. Working memory capacity was both manipulated (via cognitive load) and measured (via the OSPAN). The results of these indicate that STT effects and STI effects are *both* dependent on working memory capacity.

This outcome is interesting in that it emerged in the face of simultaneous evidence suggesting that the processes that drive STI effects and STT effects differ. Both trait recall effects (Studies 1 and 3) and trait rating effects (Studies 2 and 4) were greater on relearning trials than on control trials, but these differences were much greater for self-informants than other-informants. Carlston and Skowronski (2005) have claimed that such magnitude differences reflect the inferences made about self-informants (STI trials) but the trait–person associations made about other-informants (STT trials). Similarly suggestive of the differing processes underlying STT and STI were the findings showing that halo effects in trait judgments (Studies 2 and 4)

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[4] Various components of this interaction were also significant: This includes an Informant x Trial Type interaction, $F(1,\ 356) = 33.59$, $p < .001$, $\eta_p^2 = .086$; a Informant x Trait Rated interaction, $F(2,\ 712) = 53.05$, $p < .001$, $\eta_p^2 = .130$; a Trail Type x Trait Rated interaction, $F(1,\ 356) = 126.86$, $p < .001$, $\eta_p^2 = .263$, and main effects for trial type, $F(1,\ 356) = 119.85$, $p < .001$, $\eta_p^2 = .252$, and trait rated, $F(2,\ 712) = 130.73$, $p < .001$, $\eta_p^2 = .269$.

[5] Thirty-seven (10.34% of 358) participants were excluded from analysis because they failed to maintain the 85% accuracy criterion on the math operations of the AOSPAN. Additional exploration of the AOSPAN data revealed no multivariate outliers. The majority of these participants' errors were accuracy errors ($M = 16.57$, $SD = 12.43$) as opposed to speed errors ($M = 2.76$, $SD = 3.49$). In addition, these participants tended to have lower AOSPAN scores ($M = 27.51$, $SD = 16.05$). The pattern and magnitude of results did not change when analyzing the data with these participants included.

were primarily evident for self-informants (STI trials) and not for other-informants (STT trials).

Our conclusion about the relative inefficiency of STT effects might be seen by some as surprising. However, perhaps this should not be the case, given that evidence has previously suggested that STT effects can sometimes be disrupted (Crawford et al., 2008). Nonetheless, one of the main thrusts of studies in this area has been to infer differences in the processing underlying STT and STI by highlighting how these two effects respond differently to different manipulations and conditions (for a review, see Skowronski et al., 2008). The data that we present here seem to sit in contradiction to this history of differences. This might lead some to suggest that the data that we present supports the notion that STT and STI reflect the same underlying cognitive processes.

However, we think that this seeming paradox can be resolved. According to Carlston and Skowronski (2005), the processes underlying the STT effect and the STI effect may both rely on working memory, *but do so in different ways*. Remember that our studies examined the relation between overall working memory capacity and the STT and STI effects, but did not address the exact *kind* of cognitive work that was performed in the STT and the STI conditions. In theory, in the case of STI, capacity is used to *make an inference* about the informant; in case of STT, capacity is used to *associate the informant to the trait*. Thus, both STT and STI require mental work, but they require different kinds of mental work. This processing type difference can account for why the STI effect and the STT effect are sometimes disrupted by different manipulations (see Skowronski et al., 2008), despite the fact that they both seem to be equally related to working memory capacity. One implication of this line of thought is that the perception that STI is more disruptable than STT may be incorrect. Instead, it may merely be the case that both are equally disruptable, but that to produce a disruption one needs to find variables that are specifically related to the mental processes that are responsible for STI and STT effects. The data that we present in this article suggests that working memory capacity (as manipulated in our studies, or as measured via the AOSPAN) seems to be one of those variables.

One comment about our results using the AOSPAN measure may be warranted. Neither Study 3 nor Study 4 showed that WM capacity interacted with cognitive load. At first blush, this may seem puzzling, as multiple studies within the cognitive psychology literature have produced evidence of such interactions (Just & Carpenter, 1992). More puzzling still is that our studies used the same WM measure and the same load manipulation as used in those earlier studies. One cannot attribute our different outcome to insufficient power or impotent variables: Our load-related variables worked in that both were related to the savings task measure and the judgment measure that we employed.

However, the conundrum might be solved when it is noted that prior studies that demonstrated an interaction between WM and cognitive load employed memory tasks that were primarily concerned with participants' ability to remember the stimulus information. While our studies rely, to some degree, on participants' memories, the studies are more properly construed as being intended to examine participants' ability to identify the meanings of behaviors, to link those meanings with informants depicted by photos, and to make inferences about the informants who provided self-descriptive behaviors. Hence, task differences may account for the absence of interactions between the WM capacity measure and the cognitive load manipulation. In this regard, our finding may point to a new direction for cognitive psychologists to take in their study of manipulated cognitive load and the individual differences in working memory capacity as assessed via the AOSPAN.

Although the primary function of the AOSPAN variable in our studies was to validate the results of the cognitive load manipulations that we used, that measure did yield at least one other finding that may be worth pursuing. In Study 3 there was a positive relationship between AOSPAN and trait recall on relearning trials, but in Study 4 there was a negative relationship between AOSPAN and trait ratings on control trials. Put more simply, individuals with higher WM capacities recalled more relearning trials in Study 3 but rated control trials as being less characteristic of a specific trait in Study 4. These results seem to suggest that individuals with higher WM capacity (as measured by AOSPAN) may be more aware of “who exactly said what.” For example, if Boris kicked the dog and was perceived as mean, individuals with high WM capacity may be more likely to be aware that another informant, Natasha, was *not* the mean informant. In comparison, individuals with low WM capacity may be especially likely to experience informant confusion. That is, individuals with low WM capacity may remember that somebody kicked the dog and was mean, but may not remember whether it was Boris or Natasha. Future studies may further tease apart these explanations by probing participants' memories for informant-behavior matches.

Throughout this paper, we argue that cognitive capacity (as manipulated by cognitive load and measured by WM capacity) affected both trait ascription in STI and trait association in STT. However, one might argue that capacity could have just as likely affected other stages of processing (i.e., trait activation and use of informant-trait linkage). For example, it seems plausible that WM capacity could have affected the retrieval of informant-trait linkages. However, such use could not have been affected by the cognitive load manipulation: The cognitive load manipulation was administered only during the encoding of behaviors. Thus, this methodological fact rules out the idea that cognitive load could have affected retrieval of informant-trait linkages. Also inconvenient for the informant-trait linkage use interpretation is that the load manipulation and the AOSPAN measure produced parallel results, suggesting that the results for these two variables reflected similar underlying causes (i.e., cognitive capacity). The argument that capacity affected the extent to which a reader extracted traits from behaviors is further inconvenienced by data reported elsewhere. Kane, Bleckley, Conway, & Engle (2001) demonstrated that WM Capacity differences do not predict performance on tasks involving automatic processing. The extraction of trait information from behavior descriptions is thought to be such a task (see Gilbert et al., 1988). Given these inconvenient facts, it is hard to argue that WM capacity as assessed by the OSPAN measure affected savings and trait judgment because of its effects on encoding processes. Moreover, the parallelism between individual differences measure and the manipulated load measure point to those effects residing in the effects of cognitive capacity on stimulus processing that occurs after encoding, and not in other processes.

Nonetheless, the idea that working memory capacity can affect other mental processes might be further discounted by additional research. For example, a modified version of the study conducted by Zarate, Uleman, and Voils (2001) might help shed light on whether capacity affects on-line trait activation. Zárate et al. had participants read trait-implicative sentences and perform a lexical decision task (LDT). As one might expect, participants were quicker to identify trait words that were implied by the previous trait-implicative sentences (e.g., quicker to identify the word “funny” following the sentence “Her stories made people laugh so hard they held their sides”) than control sentences that did not imply the trait (e.g., slower to identify the word “funny” following the sentence “he returned a pair of jeans that did not fit”). One could use this paradigm to test whether the imposition of cognitive load during encoding affects subsequent LDT performance. One could similarly examine whether such effects were related to measured individual differences in load (e.g., via the OSPAN). A nonsignificant interaction with cognitive load or with the individual differences measure would show that capacity does not affect one's ability to extract traits during on-line processing, confirming the perception that this stage of processing is highly efficient (Bargh, 1994).

On the other hand, one might simply manipulate the instructions used in Studies 3 and 4 to determine the locus of the load effects. During the encoding of behaviors, one group of participants might be instructed to "look at the photographs and read the behaviors in order to familiarize yourself with the materials in the experiment" (traditional instructions). The other group of participants would be instructed to also "think of trait words that describe each behavior." Such a manipulation might ensure that participants extract traits from reading the behaviors. If load or the individual difference measure yielded similar effects in both conditions, then it would be hard to argue that the effects of load occurred at encoding and not during processing in working memory.

Coda

People constantly use trait constructs when thinking about others. Sometimes, these traits come from obvious and reasonably rational sources, such as observations of the trait-implicative behavior of others (e.g., James robs banks). However, sometimes people can become associated with traits by means that are neither rational nor obvious. As in the case of STT, this occurs when methodologies produce "incidental" associations between trait constructs and cognitive representations of people. One task of research is to explore all the dimensions of these two kinds of trait knowledge, including the conditions under which such trait knowledge is acquired, the kinds of processing that produce these kinds of trait knowledge, the ways in which the effects of these kinds of knowledge depend on the nature of the cognitive representations that one has about another person, and the consequences of the acquisition of such knowledge. The studies described in the present article contribute to our knowledge about the characteristics of these two different types of trait-based thinking and suggest new avenues of research that might continue to inform psychological science about them.

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