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The Self-Consistency Model of Subjective Confidence

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How do people monitor the correctness of their answers? A self-consistency model is proposed for the process underlying confidence judgments and their accuracy. In answering a 2-alternative question, participants are assumed to retrieve a sample of representations of the question and base their confidence on the consistency with which the chosen answer is supported across representations. Confidence is modeled by analogy to the calculation of statistical level of confidence (SLC) in testing hypotheses about a population and represents the participant's assessment of the likelihood that a new sample will yield the same choice. Assuming that participants draw representations from a commonly shared item-specific population of representations, predictions were derived regarding the function relating confidence to inter-participant consensus and intra-participant consistency for the more preferred (majority) and the less preferred (minority) choices. The predicted pattern was confirmed for several different tasks. The confidence–accuracy relationship was shown to be a by-product of the consistency–correctness relationship: It is positive because the answers that are consistently chosen are generally correct, but negative when the wrong answers tend to be favored. The overconfidence bias stems from the reliability–validity discrepancy: Confidence monitors reliability (or self-consistency), but its accuracy is evaluated in calibration studies against correctness. Simulation and empirical results suggest that response speed is a frugal cue for self-consistency, and its validity depends on the validity of self-consistency in predicting performance. Another mnemonic cue—accessibility, which is the overall amount of information that comes to mind—makes an added, independent contribution. Self-consistency and accessibility may correspond to the 2 parameters that affect SLC: sample variance and sample size.

Keywords: subjective confidence, metacognition, self-consistency, confidence–accuracy relationship, calibration

In this article, a general theory of subjective confidence is proposed for two-alternative general-knowledge questions. The theory addresses the two major questions about confidence judgments: What is the basis of these judgments, and what are the reasons for their general accuracy? The theory consists of two parts. The first and major part is a self-consistency model (SCM). Evidence in support of the model is presented. In addition, a modification of the model allows accommodating results on choice latency. In the second, minor part, an additional parameter—accessibility—is introduced, which is shown to make a marked, independent contribution to confidence judgments.

It should be stressed at the outset that SCM is a novel conjunction of very basic assumptions that are included in previous theories of subjective confidence. The model is much less elaborate than most of these theories, but the specific combination of a few rudimentary assumptions brings to the fore several qualitative patterns that have not been documented in previous research. These patterns, which concern systematic differences in confidence between different choices, were found to hold true across a wide range of domains. In addition, SCM helps integrate results on several issues that have received extensive theoretical discussions in the literature such as the basis of confidence judgments, the relationship between confidence and response latency, the accuracy of confidence judgments, and the overconfidence bias observed in calibration studies. Much of the theoretical and empirical work to be presented concerns confidence in general knowledge, but other findings are presented briefly, which testify for the generality of the model across several other tasks.

The Subjective Certainty in One's Own Knowledge

Assessments of subjective confidence in one's own knowledge and judgments have been used and investigated in a wide range of domains including perception and psychophysics, memory and metacognition, decision making and choice, eyewitness testimony, social cognition, animal cognition, and neuroscience (see Dunlosky & Metcalfe, 2009). Confidence judgments have been also used to test theories in different areas. However, as Vickers (2001) noted, "what is remarkable is that, despite its practical importance and pervasiveness, the variable of confidence seems to have played a Cinderella role in cognitive psychology—relied on for its usefulness, but overlooked as an interesting variable in its own right" (p. 148).

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A great deal of research on confidence has concerned the correspondence between confidence judgments and actual performance. Two aspects of correspondence have been distinguished: monitoring resolution and monitoring calibration. Monitoring resolution, also called discrimination accuracy or relative accuracy (Liberman & Tversky, 1993; Nelson, 1984; Yaniv, Yates, & Smith, 1991; Yates, 1990), refers to the within-person confidence–accuracy (C/A) correlation, which reflects the ability of participants to discriminate between correct and incorrect answers. Calibration, in contrast, concerns the absolute discrepancy between confidence and performance—the extent to which confidence judgments are realistic or disclose an overconfidence bias (inflated confidence relative to performance) or an underconfidence bias (Griffin & Brenner, 2004; Lichtenstein, Fischhoff, & Phillips, 1982). This aspect of monitoring accuracy is also referred to as *bias* or *absolute accuracy* (Nelson & Dunlosky, 1991; Yates, 1990). Different patterns of miscalibration have been distinguished (see, e.g., Erev, Wallsten, & Budescu, 1994; Griffin & Brenner, 2004), but these do not concern us here. Suffice it to say that calibration can be perfect when resolution is very low, and vice versa (Koriat & Goldsmith, 1996).

In the area of judgment and decision making, there has been more work on calibration than on resolution, with a special focus on the factors that cause confidence judgments to deviate from perfect calibration (see Griffin & Brenner, 2004). In contrast, research in metacognition in the context of learning and memory has focused primarily on resolution (see Koriat, 2007; Metcalfe & Dunlosky, 2008). The observation that steered an interest in metacognition is that metacognitive judgments are generally accurate in predicting memory performance (Brown & McNeill, 1966; Hart, 1965). Such has been found to be the case for judgments of learning (JOLs; Nelson & Dunlosky, 1991), feeling-of-knowing (FOK) ratings (Koriat, 1993), and confidence judgments (Koriat & Goldsmith, 1996). The ability to monitor one's own knowledge was seen by Tulving and Madigan (1970) as "one of the truly unique characteristics of human memory" (p. 477). This ability raises the question: How do people know that they know?

Clearly, what is needed is a theory of the *bases* of metacognitive judgments in general and of confidence judgments in particular. An understanding of the processes underlying metacognitive judgments should provide a clue to the accuracy and inaccuracy of both resolution and calibration. Therefore, we begin with an examination of previous approaches to the bases of metacognitive judgments before presenting the proposed view regarding the basis of confidence judgments.

The Bases of Metacognitive Judgments

What are the bases of metacognitive judgments? Three theoretical approaches to this question may be distinguished: the *direct-access approach*, the *information-based approach*, and the *experience-based approach*. The direct-access approach assumes that metacognitive judgments are based on people's privileged access to the presence and strength of stored memory traces (see Schwartz, 1994). To illustrate, Hart (1965) proposed that FOK judgments are based on the output of an internal monitor that can survey the contents of memory and determine whether the sought for target exists in store. With regard to JOLs elicited during study, Cohen, Sandler, and Keglevich (1991) proposed that learners detect directly the strength of encoding of different items and transform these strength differences into recall probability ratings. A similar view seems to underlie the use of confidence judgments in the context of strength theories of memory. Several models assume that confidence in old/new memory recognition tests is scaled directly from the perceived familiarity of the probe (see Van Zandt, 2000, for a review). Thus, a single continuum ("signal strength") is postulated, which is defined conjointly by the old/new response and the confidence level attached to it, so that confidence is essentially used as an index of memory strength (e.g., Lockhart & Murdock, 1970; Parks, 1966; see Van Zandt, 2000).

In contrast to the direct-access view, most researchers in metacognition assume that metacognitive judgments are inferential in nature, relying on a variety of beliefs and heuristics that may be applied differentially under different conditions (see Benjamin & Bjork, 1996; Koriat, 1997; Koriat, Ma'ayan, & Nussinson, 2006). A distinction is drawn, however, between information-based and experience-based judgments (see Kelley & Jacoby, 1996; Koriat, Nussinson, Bless, & Shaked, 2008). The processes underlying these two types of judgment have been integrated by some researchers within a dual-process model (see Epstein & Pacini, 1999; Evans, 2008; Jacoby, Kelley, & McElree, 1999; Kahneman, 2003; Koriat & Levy-Sadot, 1999; Sloman, 1996; Strack, 1992), but they are treated here separately. In the information-based approach, metacognitive judgments are assumed to rely on an analytic inference in which various considerations retrieved from memory are consulted and weighed to reach an educated metacognitive judgment (Griffin & Tversky, 1992; Koriat, Lichtenstein, & Fischhoff, 1980; McKenzie, 1997). The experience-based approach, in contrast, focuses on the contribution of mnemonic cues that derive on-line from task performance. These cues are assumed to give rise directly to a metacognitive feeling (see Koriat, 2000). Indeed, extensive research has testified to the effects of such cues as processing fluency, accessibility, ease of retrieval, and memorizing effort on a variety of metacognitive judgments (see Alter & Oppenheimer, 2009). For example, confidence judgments have been found to increase with manipulations that enhance the fluency with which an answer or a solution is reached (e.g., Alter, Oppenheimer, Epley, & Eyre, 2007; Garry, Manning, Loftus, & Sherman, 1996; Shaw, 1996). Of particular relevance to the present work are the findings relating confidence to response latency: Confidence in an answer increases with the speed with which that answer is selected or retrieved (e.g., Kelley & Lindsay, 1993; Koriat et al., 2006; Robinson, Johnson, & Herndon, 1997; Zakay & Tuvia, 1998), and response speed is generally diagnostic of the correctness of the answer. Therefore, reliance on response speed as a cue for confidence can contribute to the C/A correlation (Ackerman & Koriat, 2011; Barnes, Nelson, Dunlosky, Mazzoni, & Narens, 1999; Costermans, Lories, & Ansay, 1992). Thus, confidence and its accuracy appear to depend in part on the on-line feedback from the process of answering a question or solving a problem.

The Bases of Confidence Judgments: The Present Proposal

Let us focus now on the processes underlying confidence judgments. The proposal advanced in this article subscribes to the experience-based approach. It assumes that the immediate bases of subjective confidence lie primarily in mnemonic cues that derive from task performance rather than in the specific content of declarative information retrieved from memory. This assumption is based on observations indicating that participants hardly apply their declarative knowledge and theories in making metacognitive judgments. For example, Koriat, Bjork, Sheffer, and Bar (2004) found that participants studying a list of paired-associates gave similar recall predictions (JOLs) whether they expected to be tested immediately after study, after a week, or even after a year. In addition, Kornell and Bjork (2009) found that JOLs also fail to take into account the effects of number of study trials on memory (see also Kornell, 2011; Kornell, Rhodes, Castel, & Tauber, 2011). Thus, participants do not apply spontaneously some of the most basic beliefs about learning and remembering in making metacognitive judgments. Furthermore, using an ease-of retrieval paradigm (see Schwarz, 2004), Koriat et al. (2008) observed that when participants were asked to list four reasons in support of their answer, their confidence in the answer was *lower* than when they were asked to list only one supporting reason (see also Haddock, Rothman, Reber, & Schwarz, 1999). Presumably, the effects of ease of retrieval can override the effects of the declarative content of the supporting reasons in affecting confidence judgments (Jacoby, Kelley, & Dywan, 1989).

The proposed theory, however, also accommodates features of the information-driven approach. It is proposed that when participants are presented with a two-alternative forced-choice (2AFC) general-knowledge question, they engage typically in an analytic-like process, retrieving various pieces of information from memory, weighing the pros and cons for each answer, and then settling on one option (Alba & Marmorstein, 1987; Allwood & Montgomery, 1987; Koriat et al., 1980). This view is in the spirit of the reason-based approach of Shafir, Simonson, and Tversky (1993). They argued that when faced with the need to choose, people often seek and construct reasons to resolve the conflict and justify their choice. Of course, many of the clues that come to mind in attempting to make a choice consist of associations, hunches, and images that are not readily expressed in the form of declarative statements but may influence the choice. When participants have then to assess their confidence in the choice, they do not go over the entire process of deliberation but rely primarily on the "gist" of that process (Stephen & Pham, 2008). They base their confidence mostly on contentless mnemonic cues such as the amount of deliberation and conflict that they had experienced in reaching the decision, the amount of effort that they had invested, and the speed with which the decision had been reached. These general-purpose, nonanalytic cues (see Jacoby & Brooks, 1984) represent the feedback gained from the *process* of making a choice. Although they differ in quality from the considerations that might have been consulted in making the choice, they mirror significant aspects of the process that had determined the choice itself, primarily the balance of evidence in favor of the two alternatives. Collectively, these cues capture self-consistency—the reliability with which the chosen answer was supported across the clues and considerations retrieved.

SCM assumes that the major cue for confidence is self-consistency, which is conceptualized as a global mnemonic cue that captures the agreement among the accessed considerations. It can affect confidence directly or through some of its specific subjective expressions, such as the "feelings of doubt" (Adams & Adams, 1961, p. 43) or the amount of effort and time invested in making a choice (Kelley & Lindsay, 1993). Self-consistency is conceptualized as a contentless mnemonic cue that reflects the mere number of pro and con considerations associated with the choice irrespective of their meaning and importance (see Alba & Marmorstein, 1987). As is shown below, response speed captures faithfully differences in self-consistency and represents a frugal cue for these differences.

Another specific cue that is considered in the later part of the article is accessibility, which reflects the overall richness of the information that is activated by a question. Accessibility too is contentless because it affects confidence independent of which answer is supported by the clues that come to mind.

Learning principles play a critical role not only in determining the considerations and associations that come to mind but also in educating subjective experience. Proponents of the ecological probability approach (Brunswik, 1956; Fiedler, 2007; Gigerenzer, Hoffrage, & Kleinbölting, 1991) claimed that in the course of the interaction with the environment, people internalize the associations between cues and events in the world, and they use the internalized knowledge when making judgments. In turn, as Benjamin and Bjork (1996) noted, information that is better learned and more strongly associated to the cues that guide retrieval tends to be more readily retrievable and tends to come to mind with greater consistency and persistence. Thus, both the declarative considerations and mnemonic cues underlying choice and confidence mirror largely the effects of past experience.

The SCM to be detailed later focuses on the *basis* of confidence judgments, but the model was motivated primarily by studies that addressed the *accuracy* (resolution) of these judgments. In the next section, I describe some of these observations, which will also have to be explained by SCM.

The Accuracy of Confidence Judgments: The Consensuality Principle

As noted earlier, the upsurge of interest in metacognition derives in part from what Tulving and Madigan (1970) referred to as memory's knowledge of its own knowledge: By and large, people know when they know and when they do not know, and they can discriminate between correct answers and wrong answers. What are the processes underlying monitoring accuracy?

In an early study (Koriat, 1975) that examined the C/A relationship, I had participants match antonymic pairs from noncognate languages (e.g., *tuun–luk*) with their English equivalents (*deep–shallow*). Previous studies using this procedure had found that people's matches are significantly better than chance, and I was interested to know whether participants can also monitor the correctness of their guesses. Participants' matches were significantly better than chance, and, somewhat surprisingly, the percentage of correct matches increased steeply with confidence judgments, from 53.6% for a confidence rating of 1 (*a totally wild guess*) to 65.9% for a rating of 4 (*reasonably likely to be right*). These results presented a puzzle: How can participants who have never heard of languages such as Yoruba successfully monitor the correctness of their guesses? Neither the information-based approach nor the experience-based approach offers a hint.

In an attempt to explain the high C/A correlation, Koriat (1976) reasoned that perhaps the observation that participants' matches are accurate by and large ("knowledge") creates a confounding for the assessment of the C/A correlation ("metaknowledge"): The correct match is the one that is consensually endorsed, so confidence judgments might actually be correlated with the consensuality of the match rather than with its correctness. The results of Koriat (1976) confirmed this possibility. In that study, a deliberate effort was made to include a large proportion of items for which participants were likely to agree on the *wrong* match. The items were classified post hoc into three classes according to whether the majority of participants agreed on the correct match (consensually correct [CC]), agreed on the wrong match (consensually wrong [CW]), or did not agree on either match (nonconsensual [NC]). The results clearly indicated that confidence ratings correlated with the consensuality of the match rather than with its correctness: For the CC class, correct answers were endorsed with stronger confidence than wrong answers, whereas for the CW class, the *wrong* answers were associated with stronger confidence. For the NC class, confidence was not related to the correctness of the match.

This interactive pattern, which was referred to as the *consensuality principle*, has been confirmed for several domains (Koriat, 2008b, and see later), suggesting that the positive C/A correlation that has been observed in a great number of studies derives from the fact that in these studies participants were more often correct than wrong. That is, participants were successful in monitoring the correctness of their answers *indirectly* by relying on some cues that are correlated with accuracy. These cues would seem to underlie the consensuality of the response—the extent to which it tends to be endorsed by the majority of people. An additional finding of Koriat (2008b) was that response latency yielded results that closely mimicked those of confidence: Whereas the CC items exhibited the typical pattern of shorter choice latencies for correct than for wrong answers, the CW items exhibited the opposite pattern.

These results not only help demystify people's ability to monitor their own knowledge but also provide a clue into the basis of confidence judgments. In SCM, to be presented below, the confidence–consensuality correlation was used as a point of departure for specifying the relationships between choice, confidence, response latency, and accuracy in terms of *within-person* dynamics.

The SCM of Subjective Confidence

Basic Assumptions

SCM adopts the metaphor of an intuitive statistician underlying human decision and choice (Peterson & Beach, 1967; also see McKenzie, 2005). It assumes that although the validation of one's own knowledge is based on retrieving information from memory, the underlying process is analogous to that in which information is sampled from the outside world with the intention (a) to test a hypothesis about a population and (b) to assess the likelihood that the conclusion reached is correct. In statistical hypothesis testing, a critical determinant of the statistical level of confidence (SLC)[1] is sample variance. It is proposed that likewise when faced with a 2AFC problem, participants sample several representations of the problem, and their confidence in the choice is based on the extent to which the sampled representations agree in favoring the chosen alternative. Confidence represents roughly an assessment of *reproducibility*—the likelihood that the same choice will be made in a subsequent encounter with the item. Although confidence judgments are construed as pertaining to *validity*—the probability that the answer chosen is *correct*, they are actually based on cues about *reliability*.

In sum, underlying subjective confidence is the implicit belief (common among researchers but criticized by statisticians; see Dienes, 2011; Schervish, 1996) that SLC is diagnostic of the correctness of the tested hypothesis as well as the likely reproducibility of the observed result. Like SLC, subjective confidence depends on sample variance. In a later section of the article, I discuss the effects of accessibility, which suggest that like SLC, confidence is also affected by a factor that corresponds to sample size.

The term *representation* refers to the output of a variety of cognitive operations that are used in attempting to reach a choice between two options. It is used as an abstract term that can be applied across different 2AFC tasks. Thus, it may include a particular interpretation or framing of a choice problem (Tversky & Kahneman, 1981), a specific consideration (Koriat et al., 1980), a "cue" that is used to infer the answer (Gigerenzer et al., 1991), or any thought that is activated by the question or by one of the alternative answers. When participants are required to list the reasons for their choice of an answer to almanac questions (Koriat et al., 1980, 2008), they typically mention logical or rational considerations. However, it is clear that some of the representations that tip the balance in favor of one choice or the other consist of associations and images that cannot be expressed in a propositional form, and some operate bellow full consciousness. Indeed, studies of the illusory-truth effect indicate that the mere familiarity and fluency of a statement that are caused by its repetition or by its context can influence the perceived truth of that statement (Arkes, Hackett, & Boehm, 1989; Bacon, 1979; Hasher, Goldstein, & Toppino, 1977; Unkelbach & Stahl, 2009). The use of "representation" as an abstract term allows SCM to be applied to general knowledge, word matching, perceptual judgments, social attitudes, and social beliefs (see later). Clearly, the type of clues that come to mind in making a choice should differ in quality for these different domains. However, SCM is indifferent to the specific nature of these clues.

The confidence–consensuality correlation is interpreted by SCM in terms of the assumption that the population of representations associated with a general-knowledge item is largely commonly shared by all participants with the same experience and beliefs (see Gigerenzer et al., 1991; Juslin, 1993). This assumption is supported by findings indicating that differences between items in properties that are relevant to metacognitive judgments are quite reliable across participants (Koriat, 1995, 2008c; Koriat & Lieblich, 1977). Furthermore, proponents of the ecological approach to cognition (Dhami, Hertwig, & Hoffrage, 2004; Gigerenzer, 2008; Juslin, 1994) have stressed the general accuracy of the

[1] The notion of SLC is used here in an informal manner, embodying the idea that researchers' confidence in the correctness of a statistical hypothesis, as well as the likely reproducibility of the observed result, is a monotonically decreasing function of the p value (in the Fisherian hypothesis-testing approach), regardless of whether this is justified.

shared knowledge, which is assumed to result from the adaptation to the natural environment.

However, SCM also assumes some fluctuation in the sampling process, which may result in variations in both choice and confidence. This fluctuation derives from the assumption that only a small sample of representations can be retrieved on each occasion and that the specific representations activated may differ because of a variety of factors (see Bower, 1972; Estes, 1950). It is assumed tentatively that as far as confidence judgments are concerned, each representation yields an implicit binary subdecision, and all subdecisions have the same weight. The ultimate, overt choice reflects the alternative most consistently favored across representations.

Implementation of SCM for the Basis of Confidence Judgments

A version of SCM is now outlined, which incorporates the assumptions mentioned above with the exception of those concerning choice latency and accessibility. Assume that each 2AFC general-knowledge question is associated with a population of potential representations and that each representation favors one of the two answers. Each item can then be characterized by a probability distribution, with p_{maj} denoting the probability that a representation favoring the majority alternative will be sampled.

Assuming a specific sample size n, p_{maj} for a given item may be estimated from pc_{maj}, the probability with which the majority alternative is chosen. This probability can be seen as a property of a binary choice item. It can be indexed operationally by the proportion of participants who choose the preferred alternative ("item consensus") or by the proportion of times that the same choice is made by a person across repeated presentations of the item ("item consistency," assuming tentatively that repeated choices are independent). Thus, for an item with a 40%–60% between-participant split of choices, item consensus will be 60%. For an item with a 25%–75% within-participant split, item consistency will be 75%, and so on.

Figure 1 plots pc_{maj} for n of 5, 7, and 9[2] as a function of p_{maj} ($p_{\text{maj}} = .50$ was also included in this figure). These probabilities were derived from the binomial distribution. It can be seen, for example, that when $p_{\text{maj}} = .70$, samples of $n = 7$ are expected to lead to a .87 proportion of choosing the majority alternative.

I turn next to self-consistency, which is inversely related to the sample standard deviation. Of course, if each representation is assumed to yield a binary choice, then standard deviation should be a direct function of $\hat{p}_{\text{maj}}$. However, the mean and standard deviation are treated as if they are two independent parameters to prepare for a potential extension to a model in which each representation is assumed to yield subdecisions that differ in strength.

A simple measure of self-consistency is the proportion of subdecisions favoring the alternative chosen. An index, which is of broader generality, is related to the standard deviation of the subdecisions, $\sqrt{\hat{p}\hat{q}}$. I use $1 - \sqrt{\hat{p}\hat{q}}$ as an index of consistency (range = .5–1.0). Figure 2A indicates how self-consistency should increase with p_{maj}.

The data presented in Figures 1 and 2A were reorganized to form Figure 2B, by simply using in the x-axis the pc_{maj} values corresponding to the p_{maj} values. In this figure, the index of self-consistency is plotted as a function of pc_{maj}, the probability with which the majority alternative is chosen. This probability can be seen as a property of a binary choice item, given a particular value of n.

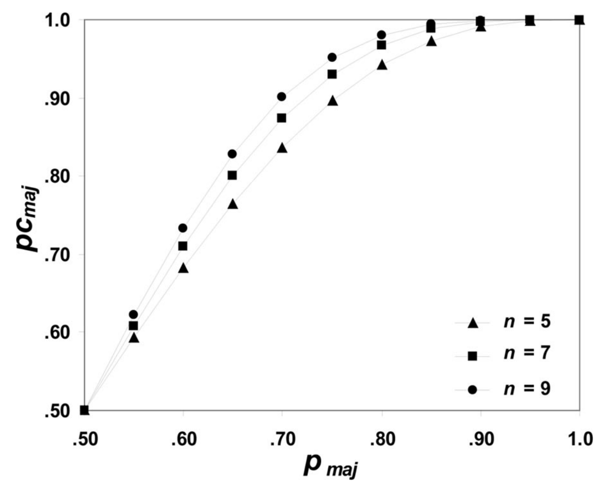

Figure 1. Probability of choosing the majority answer (pc_{maj}) as a function of the proportion of representations favoring the majority answer (p_{maj}) for n (sample size) of 5, 7, and 9.

Figure 2B illustrates the first prediction of the model: The average confidence associated with an item should increase with pc_{maj}. Thus, an item that elicits the same response on 90% of its presentations (either across people or across repetitions for the same individual) should be associated with higher confidence than an item that elicits the same response on 70% of its presentations. This prediction can also be derived from other models, such as the cue-based models associated with the ecological approach to confidence judgments (Gigerenzer et al., 1991; Juslin, 1993).

Whereas the first prediction concerns inter-item differences in confidence, a second set of predictions concerns inter-choice differences. This set of predictions follows uniquely from the conjunction of assumptions underlying SCM. Although previous models could be readily adapted to yield the same predictions (see later), the fact of the matter is that these predictions have never been tested or proposed before. According to SCM, for any given item, confidence should differ systematically depending on which answer is chosen: When the majority alternative is chosen, it will be assigned higher confidence than when the minority alternative is chosen. The rationale behind this prediction is that a correlation exists between sample means and sample standard deviations, such that minority samples (samples that favor the minority choice) should have larger standard deviations on average than majority samples (samples that favor the majority choice). Thus, for each n, when a random sample of representations *happens to favor* a minority choice, the proportion of subdecisions favoring that choice will be smaller on average than when the sample favors the

[2] Sample size (n) was assumed tentatively to revolve around seven representations. When participants were required to list reasons for and against each of the two alternative answers before indicating their choice, they listed an average of 3.17 reasons for each question. It was assumed that this value is an underestimation of n because many of the clues that are activated by a question are not readily verbalizable.

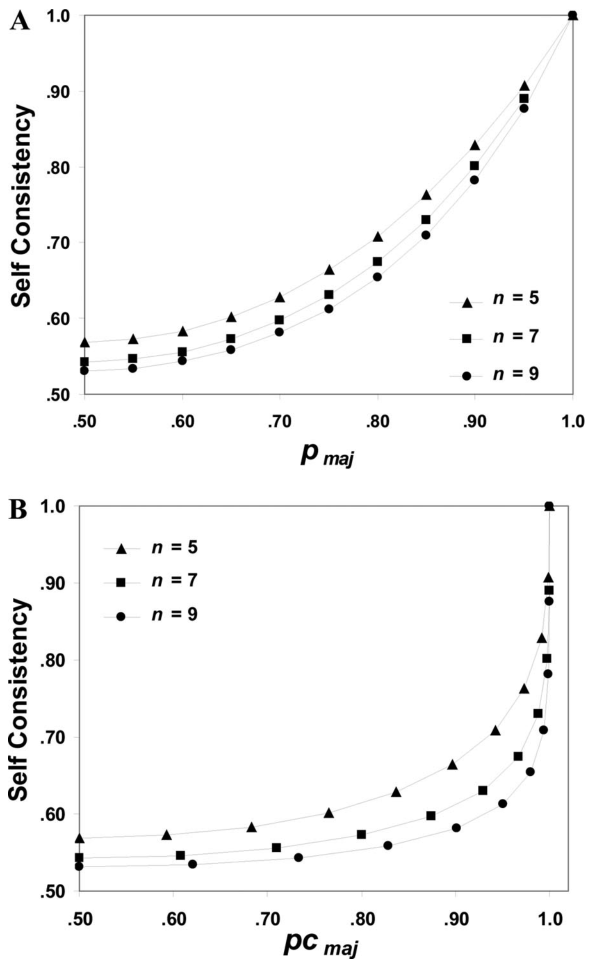

Figure 2. The consistency with which the same answer is favored (indexed by $1 - \sqrt{\hat{p}\hat{q}}$) across samples of size (n) 5, 7, and 9 as a function of the proportion of representations favoring the majority answer (p_{maj}) (Panel A) and as a function of the probability of choosing the majority answer (pc_{maj}) (Panel B).

majority choice. To illustrate, assume that $p_{maj} = .70$, and $n = 7$, the likelihood that six or seven representations will favor the majority answer is .329, whereas only in .004 of the samples will six or seven representations favor the minority answer.

The predicted function relating subjective confidence to p_{maj} is depicted in Figure 3A, which plots self-consistency for majority and minority choices as a function of p_{maj}, for $n = 7$ (the figure includes also the values for $p_{maj} = .5$ and $p_{maj} = 1.0$). It can be seen that confidence in the majority choice increases with p_{maj}. In contrast, confidence in the minority choice is relatively insensitive to p_{maj}, or decreases very shallowly with increasing p_{maj}. Thus, for high p_{maj} values, a very strong discrepancy is expected between confidence in the majority and minority choices. Note that Figure 3A could have been plotted with p varying over the entire range between 0 and 1.00. However, because of the choice-independent-confidence (CIC) effect (Koriat, 2008c), I adopt the .50–1.00 format, as is explained later.

The same data appear in Figure 3B, but now as a function of pc_{maj}. The preferred alternative is referred to as the *consensual* response (inter-participant) or the *frequent* response (intra-participant) and is designated simply as the "majority" response. The less frequent alternative is referred to as the "minority" response. Accordingly, it is predicted that the majority answer, when chosen, will be assigned higher confidence than the minority answer. Furthermore, for the majority answer, confidence should increase with increasing item consensus and with increasing item consistency. For the minority answer, confidence should decrease very slightly with item consensus and item consistency.

It should be stressed that the results in Figure 3 were obtained under the assumption that participants choose the alternative that is favored by the majority of representations in *their* accessed sample of representations. The functions depicted in Figure 3B explain why confidence judgments should correlate with the consensuality of the answer even when the sampling of representations is random.

The third prediction is implied in the previous analysis but deserves a separate consideration in view of its theoretical signif-

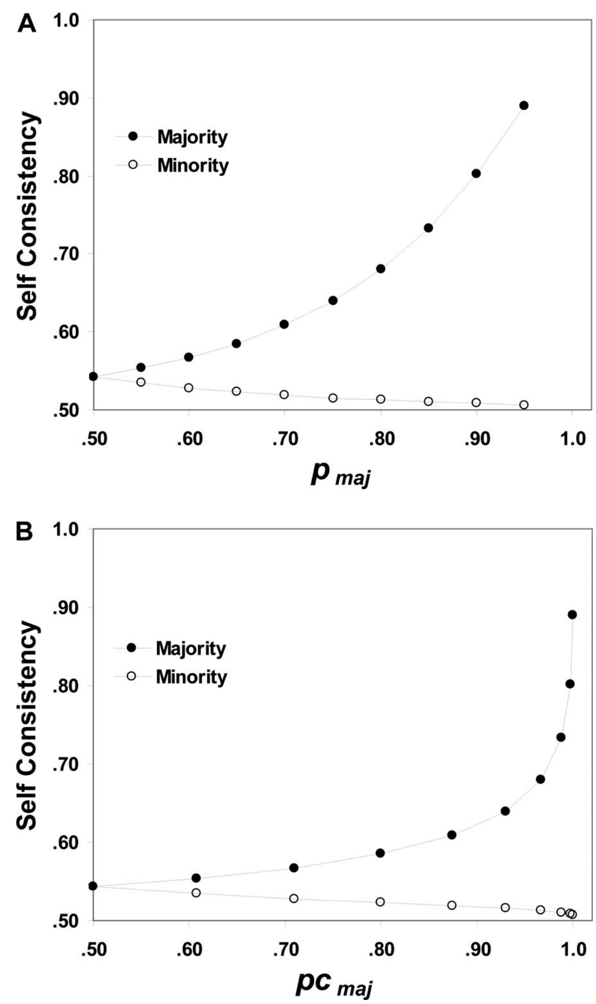

Figure 3. The consistency with which the same answer is favored (indexed by $1 - \sqrt{\hat{p}\hat{q}}$) as a function of the proportion of representations favoring the majority answer (p_{maj}) (Panel A) and as a function of the probability of choosing the majority answer (pc_{maj}) (Panel B) for majority and minority choices. The results presented are for $n = 7$.

icance. It concerns the predictive nature of subjective confidence. From a phenomenological point of view, ratings of subjective confidence (a) are retrospective in nature, conveying the person's conviction about a choice that has been made, and (b) pertain to validity—the likelihood that the answer chosen is correct. The foregoing discussion, however, implies that subjective confidence is prospective in nature: It reflects an assessment of the reproducibility of the choice—the likelihood that the same answer will be chosen when the same question is presented again. Figure 4 presents the expected relationship between confidence in an initial choice and the likelihood that the same choice will be made in subsequent presentations of the same item. The results are based on a simulation experiment that assumes a distribution of two-alternative items that differ in p_{maj}, with p_{maj} varying from .55 to .95, at .05 steps (but a proportion of .50 was also included). In each of 60,000 iterations, a population was selected at random with the constraint that the likelihood of selecting a population conformed to a binomial distribution with a peak at both $p_{maj} = .70$ and $p_{maj} = .75$. In each iteration, five, seven, or nine representations were sampled from the population, and the majority value was recorded. The likelihood of drawing a sample that favors the same or a different choice in a second draw was also recorded. The figure presents the likelihood of making the same choice on a subsequent draw as a function of the consistency with which the majority value was chosen in the first draw, assuming that repeated decisions are independent. Thus, the consistency (confidence) with which an answer is favored across different sampled representations should predict the likelihood of choosing that answer (overtly) on subsequent encounters with the same choice situation.

The model sketched above assumed a fixed sample size. Later, I examine how the model might be modified to accommodate differences in choice latency, assuming that choice latency is indicative of sample size. I then examine how such differences should affect confidence judgments.

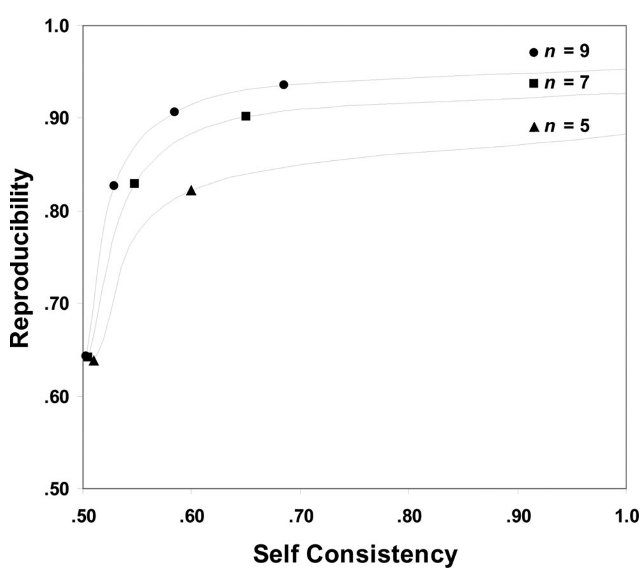

Figure 4. The likelihood of making the same choice on a subsequent attempt (reproducibility) as a function of self-consistency—the consistency with which the same answer is favored (indexed by $1 - \sqrt{\hat{p}\hat{q}}$) for n (sample size) of 5, 7, and 9.

The organization of the rest of the article is as follows. The first section presents empirical evidence in support of the predictions that derive from the self-consistency basis of confidence judgments. The evidence focuses first on inter-participant consensus and then on within-person consistency. Finally, extensions of these predictions to other tasks are reviewed briefly, which testify for the generality of SCM. The second section concerns the accuracy of confidence judgments. It outlines the predictions of SCM with regard to metacognitive resolution and metacognitive calibration. SCM is shown to provide a principled account for observations pertaining to both aspects of the C/A correspondence, and relevant evidence is reported.

The third section concerns choice latency. To incorporate the effects of choice latency, SCM is modified by adding a self-terminating mechanism. Evidence is reviewed indicating that choice latency is a frugal cue for self-consistency, and its validity, like that of confidence judgments, is mediated by the relationship between self-consistency and correct performance.

The final section examines the effects of another mnemonic cue—accessibility—the overall amount of clues that a question brings to mind. Results are presented indicating that accessibility contributes to confidence over and above the contribution of self-consistency. The possibility is evaluated that whereas self-consistency mirrors the component of sample variance in the assessment of SLC, accessibility mirrors the component of sample size.

Empirical Evidence: The Basis of Confidence Judgments

The predictions of the model that derive from the postulated basis of subjective confidence are tested using a reanalysis of previously published results as well as new results. In presenting the results, the focus is on their qualitative pattern, with the understanding that more detailed predictions should require a refinement of the model beyond the rudimentary form in which it was presented.

The Relationship Between Confidence and Cross-Person Response Consensus

Word matching: Koriat (1976). Consider the data collected by Koriat (1976), which were the first to demonstrate the consensuality principle. In that study, 100 participants were presented with 85 antonyms from noncognate languages and were asked to match them with their English correspondents and to indicate their confidence on a 4-point scale. The remaining procedural details are found in Koriat (1976). In the analyses to be reported here, for each of the 85 items, the more frequent response for each item was defined ad hoc as the consensual or majority response for that item. Item consensus was defined as the proportion of participants who chose the consensual response to that item.

Figure 5 presents mean confidence ratings for each of five item consensus categories (.51–.59 . . . .90–1.00), plotted separately for majority and minority responses. As predicted (see Figure 2B), mean overall confidence ratings ("All") increased monotonically with item consensus: The correlation between mean confidence and mean item consensus was .436 ($p < .0001$) across all 85 items.

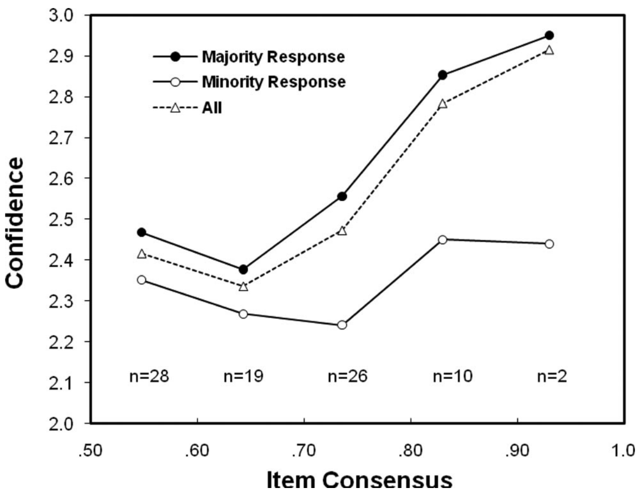

Figure 5. Mean confidence ratings (on a 1–4 scale) in the correctness of word matching for majority responses, minority responses, and all responses combined as a function of item consensus (the proportion of participants who chose the majority response). The results are based on a reanalysis of the data of Koriat (1976).

Importantly, however, confidence judgments differed markedly for participants who made different choices. Across all items, confidence rating averaged 2.53 for majority responses compared with 2.31 for minority responses, $t(84) = 8.23$, $p < .0001$. This difference was consistent: For 71 items, confidence was higher for the majority than for the minority response in comparison with 12 items that exhibited the opposite pattern (for two items there was a tie), $p < .0001$, by a binomial test. Consistent with predictions (see Figure 3B), confidence in majority responses increased with item consensus: The correlation across all 85 items was .452. Confidence for minority responses did not vary significantly with item consensus; the respective correlation was .044.

General knowledge: Koriat (2008b). The word-matching task has the advantage that participants have no way of knowing the correct answer with certainty. However, SCM might not apply to the task of answering general-knowledge questions in which the choice of the correct answer relies heavily on prior real-world knowledge. On the face of it, the subjective confidence in the correctness of one's answer in the latter task would appear to depend on somewhat different processes than the sort of self-consistency mechanism proposed here, which assumes a random sampling of representations.

To examine the predictions of SCM for general-knowledge, I reanalyzed the data from Koriat's (2008b) study, which offer additional analyses to be presented in later sections. This study involved 2AFC general-knowledge questions. All answers were one- or two-word long, either a concept or a name of a person or a place (e.g., "What actress played Dorothy in the original version of the movie The Wizard of Oz? [a] Judy Garland, [b] Greta Garbo). This format was important for the measurement of choice latency (see later). In addition, the questions were chosen deliberately to yield a large representation of "deceptive" items (see Koriat, 1995). There were 105 questions and 41 participants. Confidence was measured on a 50%–100% scale.

Figure 6A presents mean confidence judgments for each of six item consensus categories for both majority and minority answers (for one item, all participants chose the majority answer). The results agree quite well with predictions. Mean confidence increased with item consensus: The correlation over all items was .505, $p < .0001$. Majority answers were endorsed with higher confidence (70.9%) than minority answers (64.6%), $t(103) = 6.74$, $p < .0001$. The difference between confidence in the majority and minority answers was quite substantial for items with very high consensus, amounting to 20% points. For 78 items, confidence was higher for the majority than for the minority answer in comparison with 26 items yielding the opposite pattern, $p < .0001$, by a binomial test. Confidence in the majority answers increased monotonically with item consensus: The correlation across all items was .514 ($p < .0001$). The respective correlation for minority answers was .083, *ns*.

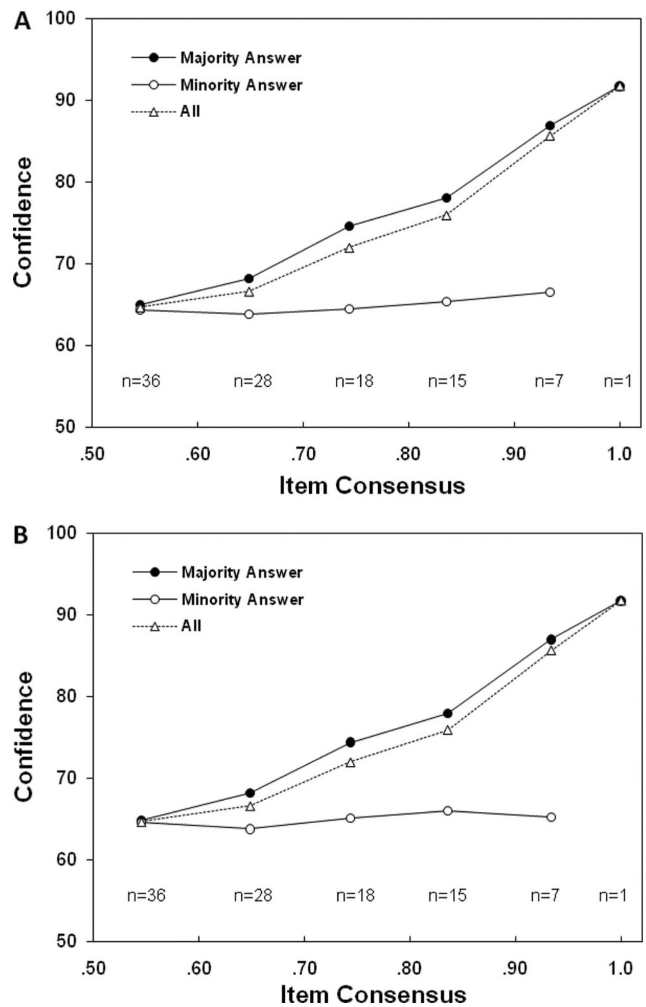

Figure 6. Panel A: Mean confidence in the correctness of answers to general-information questions for majority and minority answers and all responses combined as a function of item consensus (the proportion of participants who chose the majority answer). Panel B presents the same data after correcting confidence judgments for inter-individual differences in mean confidence judgments (see text). The results are based on a reanalysis of the data of Koriat (2008b).

Because the confidence means for majority and minority responses were based on different participants for each item, the possibility exists that these differences actually reflect a between-individual effect: Participants who tend to choose consensual responses tend to be more confident. To control for chronic individual differences in mean confidence (see Kleitman & Stankov, 2001; Stankov & Crawford, 1997), the confidence judgments of each participant were standardized so that the mean and standard deviation of each participant were the same as those of the raw scores across all participants (69.76% and 18.66, respectively). Average scores were then calculated for each item for majority and minority responses. Analyses comparing majority and minority responses yielded a very similar pattern of results to that found for the raw scores (see Figure 6B).

In addition, to control for individual differences in degree of knowledge (see Lichtenstein & Fischhoff, 1977), participants were divided into a low-knowledge group ($n = 20$) and a high-knowledge group ($n = 21$) on the basis of the percentage of correct answers. Figure 7 presents the same data as Figure 6A, but now plotted separately for the two knowledge groups. The pattern of results is very similar for the two groups.

In sum, the results for the word-matching and general-knowledge tasks are qualitatively in line with SCM. First, mean confidence associated with an item increased with increasing item consensus. Second, majority answers, when chosen, were endorsed with stronger confidence than minority answers. Importantly, for the general-knowledge task, this effect was not due to chronic individual differences either in overall confidence judgments or in general knowledge. Third, confidence in majority answers increased with item consensus, whereas for minority choices, confidence was largely indifferent to item consensus. Finally, the majority–minority difference was also obtained in between-individual analyses: For each item, participants who chose the majority answer reported higher confidence than participants who chose the minority answer. These results are in line with the idea that participants' choices are based on the sampling of clues from a commonly shared pool, and that confidence judgments increase with the consistency with which the various clues favor the answer chosen.

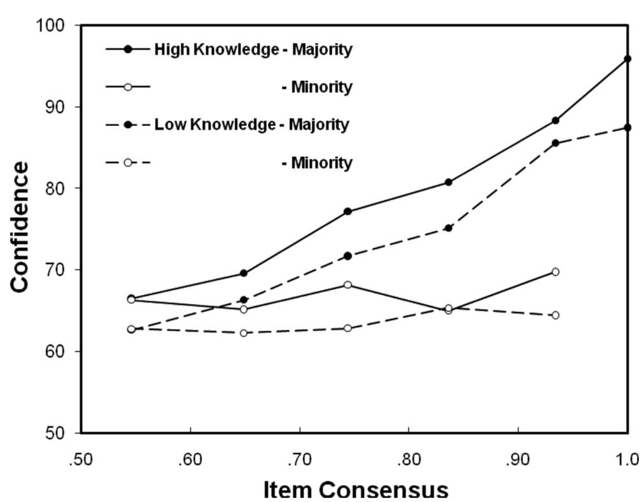

Figure 7. Mean confidence in the correctness of the answers to general-information questions for majority and minority answers as a function of item consensus (the proportion of participants who chose the majority answer). The results, based on a reanalysis of the data of Koriat (2008b), are presented separately for high-knowledge and low-knowledge participants.

Inter-participant agreement in choice and confidence. The assumption that the representations associated with an item are commonly shared implies that properties of items—notably, the likelihood of choosing the majority answer and confidence in that answer—are generally reliable across participants. To examine this implication, the participants in Koriat (2008b) were divided into two groups (splitting between odd- and even-numbered participants). For each group, the proportion of majority choices for each item was calculated. Across the 105 items, the correlation between the two group proportions was .69, $p < .0001$. The corresponding correlation for mean confidence judgments in the majority choice was .89, $p < .0001$.[3] Inter-participant reliability was also assessed using Cronbach's alpha coefficient (Crocker & Algina, 1986), which yielded a coefficient of .90 for answer choice and .97 for confidence judgments. These coefficients are remarkably high, supporting the assumption that participants base their choice and confidence on representations that are commonly shared.

The Relationship Between Confidence and Within-Person Response Consistency

Confidence as a function of within-person response consistency. It was proposed that when participants choose an answer on different occasions, they sample representations from (more or less) the same population of representations on each occasion. Therefore, similar results to those reported above should be found when items and answers are categorized in terms of within-person consistency rather than in terms of between-person consensus.

The results of an unpublished study (Koriat, 1981) were analyzed to test the predictions of SCM in a within-individual design. In that study, three women students were presented 20 times with an 84-item word-matching task. The items were those used in Koriat (1976), except for one item that was eliminated for the sake of counterbalancing. The word-matching task was used because participants are less likely to remember their previous answers to the same items than when the items consist of general-knowledge questions. All materials were compiled in 20 booklets, each containing all 84 items. The orders of the English members and of the foreign members of each pair were counterbalanced across different booklets, and the order of the pairs within booklet was partly randomized. Participants filled out one booklet every day, using 20 successive days whenever possible. The instructions and procedure for each administration were the same as in Koriat (1976) except that the participants assessed their confidence on an 11-point scale consisting of the numbers 50, 55, 60 . . . 100, representing assessed probability correct.

For each participant, a majority answer was defined as the one most frequently chosen by her across the 20 presentations (excluding items for which each of the answers was chosen 10 times).

[3] The higher correlation for confidence than for choice possibly derives from the contribution of accessibility (or the CIC effect; Koriat, 2008c) to be discussed later.

Figure 8 presents mean confidence for majority and minority responses as a function of the number of presentations in which the majority response was chosen ("item consistency"). The figure also includes the mean for the tie items (item consistency = 10). The results indicated first that average confidence increased with item consistency: The correlations across the 84 items between mean confidence and item consistency were .50 for Participant 1, .44 for Participant 2, and .79 for Participant 3—all significant at the .0001 level. Second, when participants chose their more frequent response, their confidence was higher than when they chose their less frequent response. Mean confidence for the majority and minority responses were as follows, respectively (taking into account only items for which both means were available): 59.6% and 57.7%, $t(64) = 2.74$, $p < .01$, for Participant 1; 80.2% and 76.6%, $t(60) = 3.48$, $p < .001$, for Participant 2; and 78.4% and 72.8%, $t(73) = 5.75$, $p < .0001$, for Participant 3.

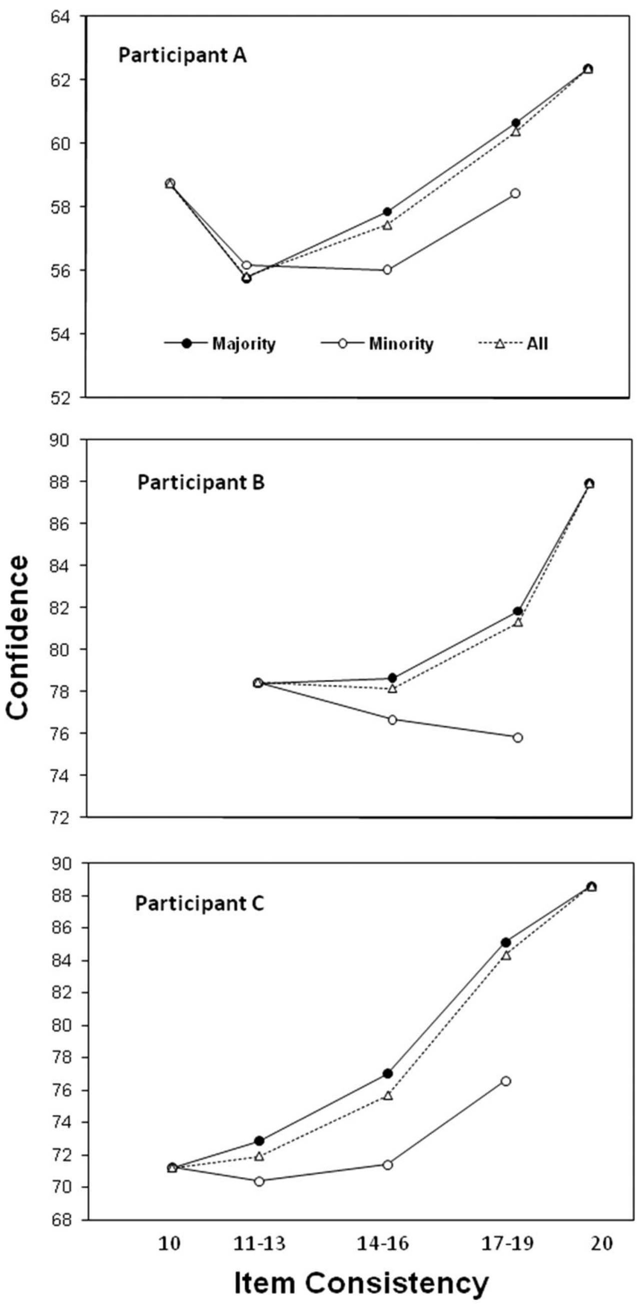

Figure 8. Mean confidence in the majority and minority responses as a function of item consistency—the number of trials in which the majority response was chosen across the 20 presentations. The means are based on item consistencies of 10, 11–13, 14–16, 17–19, and 20 (Koriat, 1981).

In addition, for all three participants, confidence in the majority response tended to increase rather monotonically with the frequency with which it was chosen. The pertinent correlations (excluding items for which one of the responses was chosen 10 or 20 times) were .43, .23, and .75 for Participants 1–3, respectively. Confidence in the minority response yielded a less systematic relationship: The respective correlations were .23, –.09, and .30.

In sum, the results of the within-person analyses are quite similar to those obtained for the between-participant analyses. Clearly, many objections can be leveled against the use of both between-individual agreement and within-individual consistency as providing estimates for the theoretical notion of p_{maj}. However, the observation that similar patterns were found across the two paradigms lends some credence to the assumption that between-individual consensus and within-individual consistency reflect a common property, a property that underlies confidence judgments. Thus, whatever were the reasons for the change of choice from one presentation to another, confidence judgments changed systematically with properties of the choice that were tapped by a parameter (item consistency) that transpired across all presentations.

Consensus and self-consistency. According to SCM, cross-participant consensus and within-participant consistency should be correlated. This possibility was examined using the results from Koriat (2008b). In that study, a second session took place in which the same questions were presented a second time. Participants' choices in Presentation 1 were divided between those that were repeated in Presentation 2 and those that were changed. For each participant, the proportion of *other* participants (out of 40) who made the same choice in Presentation 1 as that made by him or her was calculated for each item. This proportion averaged .60 for repeated choices in comparison with .50 for changed choices, $t(40) = 14.59$, $p < .0001$. Thus, the choices that evidenced higher within-participant consistency were more likely to be made by other participants in Presentation 1 than choices that were changed in Presentation 2.

Confidence as a predictor of reproducibility. The results from Koriat (1981) were also used to examine the idea that confidence in a choice monitors reproducibility—the likelihood that the same choice will be made again in subsequent encounters with the same item. Figure 9 presents the likelihood of repeating the Presentation 1 choice across the subsequent 19 presentations as a function of Presentation 1 confidence. The results represent the means across the three participants. The function is generally monotonic indicating a higher likelihood of repetition for responses initially assigned higher confidence ratings. The correlation across the nine points in the figure was .82, $p < .01$.

Further evidence comes from the results of Koriat (2008b) with general-knowledge questions. When responses made in Presentation 1 were divided for each participant at the median confidence judgments, the likelihood of repeating the same response in Presentation 2 averaged .74 and .95 for below-median and above-

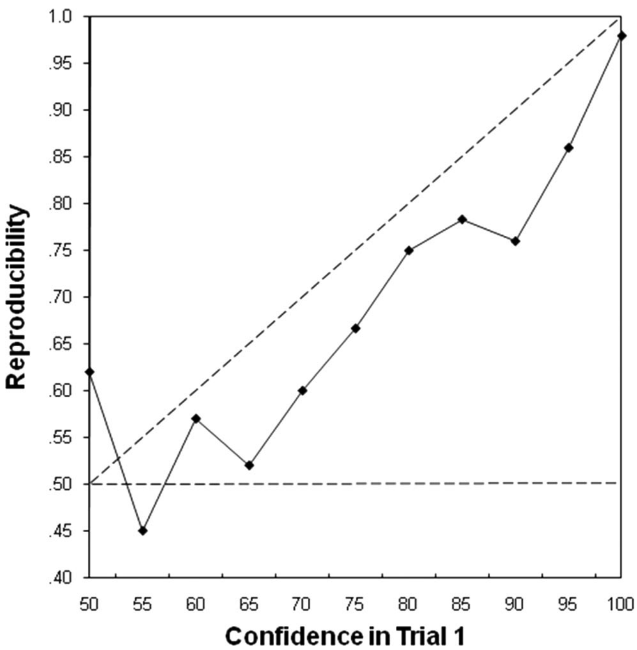

Figure 9. Confidence in Trial 1 as a predictor of reproducibility—the percentage of times that the response made in Trial 1 was repeated across the subsequent 19 trials (based on Koriat, 1981). The diagonal line indicates perfect calibration.

median responses, respectively (based on 40 participants because for one participant the median was 100), $t(39) = 12.11$, $p < .0001$. Thus, confidence is diagnostic of reproducibility. Saito (1998) also reported results indicating that confidence in one presentation of general-knowledge questions predicted the likelihood of repeating the same answer on a second presentation.

Extensions of SCM for the Basis of Confidence Judgments

In this section, I summarize the results of recent studies, which indicate that the predictions of SCM generalize to domains other than real-world general knowledge. Such is expected to be the case if confidence indeed depends on contentless mnemonic cues that reflect the amount of doubt or deliberation experienced.

The relationship between confidence and within-person response consistency. I examine first the effects of within-person item consistency. Consider first social beliefs: In a recent study (Koriat & Adiv, 2011a), participants were presented with a list of statements describing beliefs (e.g., "Every problem has a solution"; "There is a supreme being controlling the universe"). They made *true–false* judgments on each statement and indicated their confidence (on a 0–100 scale). The task was repeated six times over 2 days. Assuming that in responding to each item, participants sample considerations from a population of considerations and base their confidence on self-consistency, we may expect that confidence should differ for the more frequent and the less frequent choices as predicted (see Figure 3B). To examine this possibility, for each participant and item, the responses were classified as frequent (made four or more times) or rare (made twice or once). Mean confidence for the two types of response is presented in Figure 10A, as a function of item consistency (included also are the results for item consistency = 3). It can be seen that the overall pattern of the results is similar to what was found for word matching (see Figure 8).

A similar pattern is expected for social attitudes, when participants are asked to indicate their degree of certainty in their attitude (see Krosnick, Boninger, Chuang, Berent, & Carnot, 1993; Tormala & Rucker, 2007). In a recent study (Koriat & Adiv, 2011b), participants made *yes/no* responses according to whether they favored or disfavored certain attitude objects (e.g., "capital punishment") and indicated their confidence. The list of statements was presented seven times on 2 successive days. The results are presented in Figure 10B. Participants were more confident when they made their more frequent response than when they made their less frequent response. These results suggest that confidence judgments can provide a clue to the on-line construction of attitudinal judgments, which is assumed to be based on the information accessible at the time of the judgment (Bless & Schwarz, 2010).

Figures 10C and 10D, in turn, present the results for perceptual comparison tasks in which participants judged which of two irregular lines was longer (see Figure 10C) or which of two geometrical shapes occupied a larger area (see Figure 10D; Koriat, 2011). Each task was administered five times. The use of perceptual tasks was motivated by the claim that the process underlying confidence in perceptual judgments differs qualitatively from that underlying confidence in general knowledge (Dawes, 1980; Keren, 1988; see Baranski & Petrusic, 1994). However, the results yielded a similar pattern to that observed for word matching and social beliefs and attitudes, suggesting that SCM can apply to perceptual tasks as well. It is important to stress that the stimuli used were more complex than the tasks used typically in psychophysical judgments (e.g., comparing the length of straight lines; Juslin & Olsson, 1997), so that participants presumably sampled different representations of the stimuli before making their choice.

Note that in all four studies, participants tended to respond consistently to the same items across presentations. Nevertheless, there was some variation in their responses, and when the response corresponded to the participant's more frequent response, confidence was higher than when it corresponded to the participant's less frequent response. In all four studies, this effect was observed even on the first presentation: Confidence in the first presentation was higher for responses that were repeated more often across the subsequent presentations than for those that were repeated less often (see Koriat, 2011; Koriat & Adiv, 2011b).

The relationship between confidence and cross-person response consensus. Let us turn next to the effects of item consensus. In all four studies mentioned in the previous section, the effects of cross-person consensus were examined using either the data from the first presentation (beliefs and attitudes) or those obtained across all presentations (perceptual comparisons). The data of each experiment were analyzed using the same procedure as that used for general knowledge (Koriat, 2008b; see Figure 6A). The results for the four studies appear in Figure 11 in the same arrangement as they appeared in Figure 10. It can be seen that the patterns are roughly similar to those demonstrated for word matching (see Figure 5) and for general knowledge (see Figure 6A). These results are consistent with the assumption that participants sample representations roughly from the same item-specific populations of representations. It is impressive that the consensuality

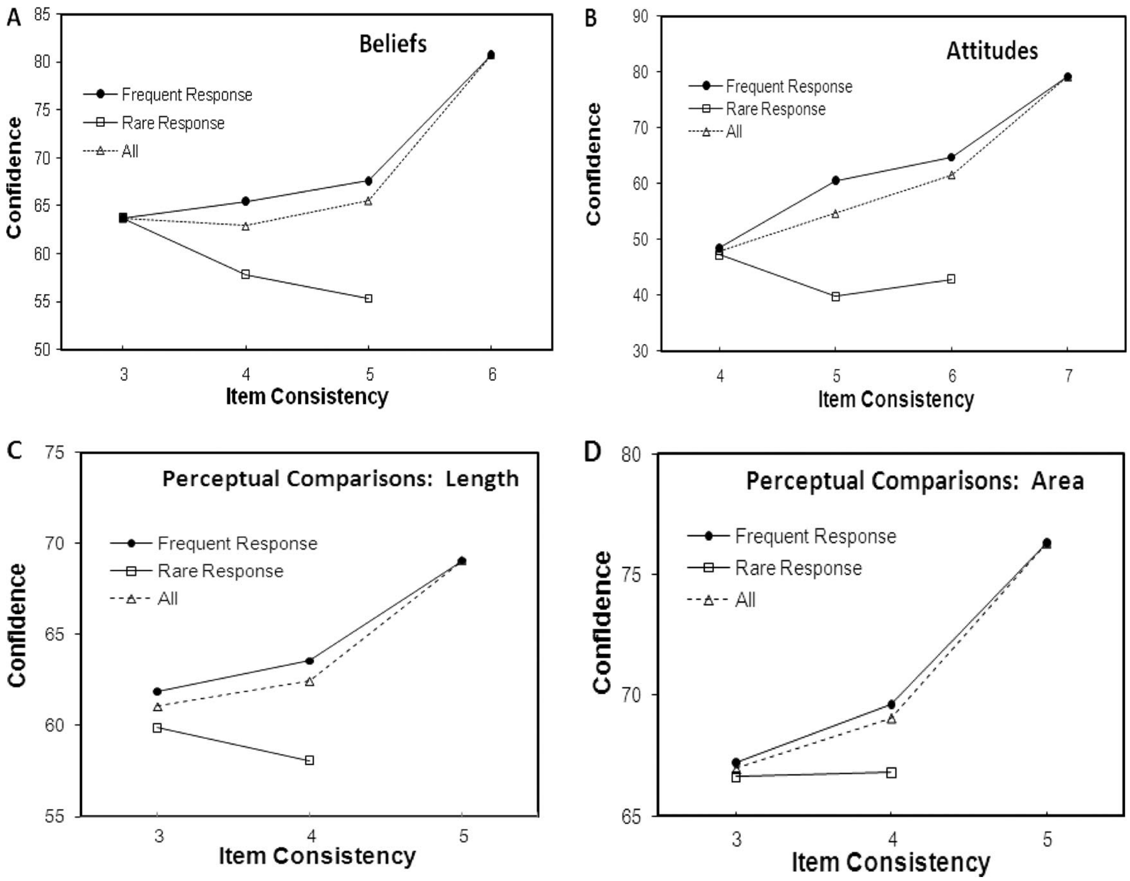

Figure 10. Mean confidence for frequent and rare choices as a function of item consistency (the number of times that the majority choice was made). The results are based on four studies (see text for details). Panel A is adapted from "Confidence in One's Social Beliefs: Implications for Belief Justification," by A. Koriat and S. Adiv, 2011a. Panel B is adapted with permission from "The Construction of Attitudinal Judgments: Evidence From Attitude Certainty and Response Latency," by A. Koriat and S. Adiv, 2011b, *Social Cognition*, *29*, p. 589. Copyright 2011 by Guilford Press. Panels C and D are adapted from "Subjective Confidence in Perceptual Judgments: A Test of the Self-Consistency Model," by A. Koriat, 2011, *Journal of Experimental Psychology: General*, *140*, p. 124. Copyright 2011 by the American Psychological Association.

differences were obtained even for social beliefs and attitudes, which are known to yield reliable individual differences. It would appear that even in these domains, there is a commonly shared core of representations associated with each item. Therefore, confidence in a choice can be predicted from the proportion of participants who make that choice. Note that like in the case of general knowledge, the difference between consensual and nonconsensual choices was observed also in between-participant comparisons: For each item, confidence was higher for participants who made the consensual choice than for those who made the nonconsensual choice. This was so even when confidence judgments were standardized to nullify chronic individual differences in confidence judgments.

These results are in line with the assumption that in all the tasks used—participants sample representations randomly from a commonly shared item-specific pool of representations and base their confidence on the degree of self-consistency. The generality of the results across the different tasks—word matching, general knowledge, social beliefs and attitudes, and perceptual comparisons—supports the assumption that confidence in a choice is based on mnemonic cues that are largely indifferent to the content of the domain-specific considerations that might have affected the choice.

Empirical Evidence: The Accuracy of Confidence Judgments

The discussion so far has avoided the question whether the answers chosen by a participant are correct or wrong, and focused exclusively on the extent to which the answers were selected consistently either across participants or within participants. This is, of course, the critical measure for SCM. I now turn to what have been the central questions about subjective confidence: To what extent do confidence judgments monitor the accuracy of the answer, and what are the reasons for the correspondence or miscorrespondence between confidence and accuracy?

As noted earlier, two aspects of monitoring accuracy have been distinguished: resolution and calibration. Resolution refers to the

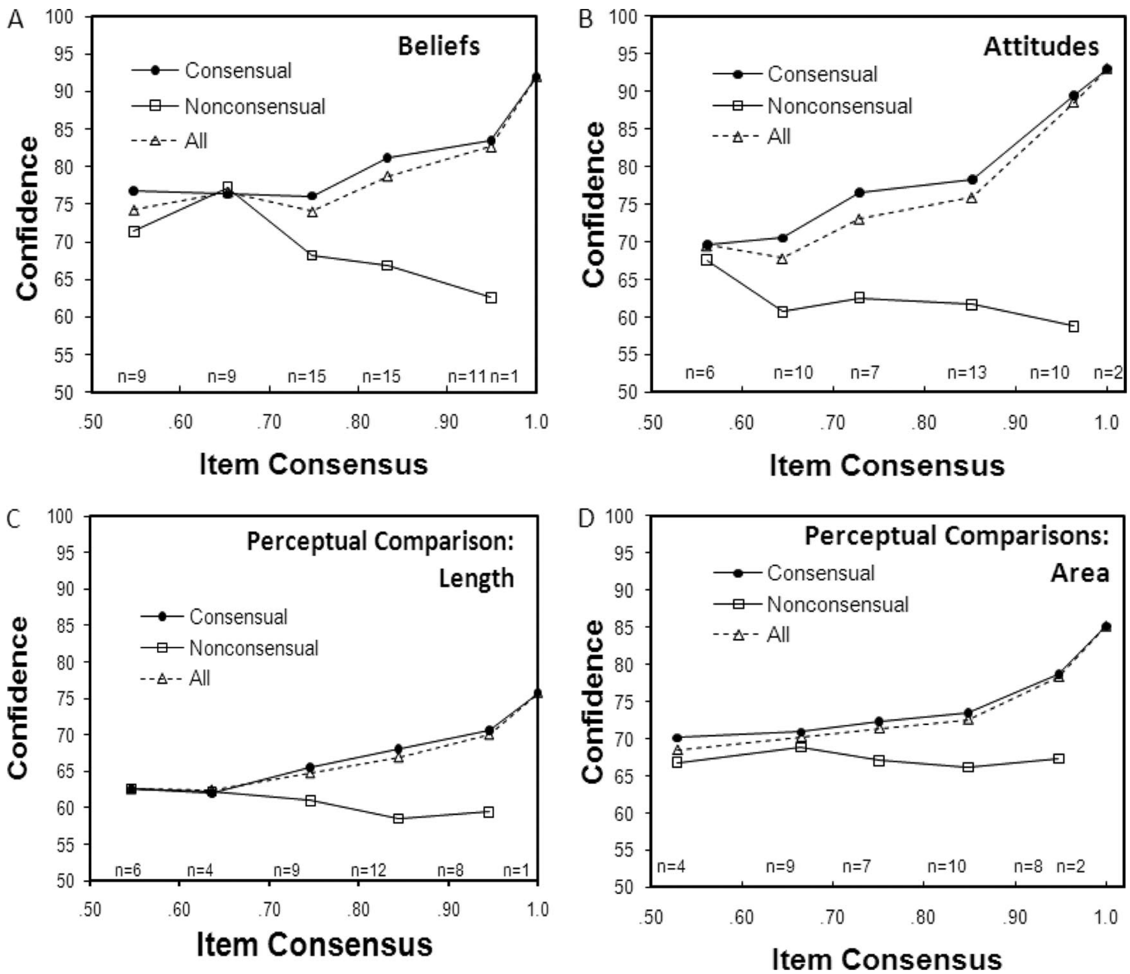

Figure 11. Mean confidence for majority and minority choices as a function of item consensus (the proportion of participants who chose the majority answer). The results are based on four studies (see text for details). Panel A is adapted from "Confidence in One's Social Beliefs: Implications for Belief Justification," by A. Koriat and S. Adiv, 2011a. Panel B is adapted with permission from "The Construction of Attitudinal Judgments: Evidence From Attitude Certainty and Response Latency," by A. Koriat and S. Adiv, 2011b, *Social Cognition*, *29*, p. 590. Copyright 2011 by Guilford Press. Panels C and D are adapted from "Subjective Confidence in Perceptual Judgments: A Test of the Self-Consistency Model," by A. Koriat, 2011, *Journal of Experimental Psychology: General*, *140*, p. 125. Copyright 2011 by the American Psychological Association.

extent to which confidence judgments discriminate between correct and wrong answers, whereas calibration refers roughly to the correspondence between mean confidence (assessed probability) and mean proportion correct (Lichtenstein et al., 1982). In the following three sections, I examine how SCM accounts for three phenomena that have been perhaps the most central in research on subjective confidence: resolution, calibration, and the hard-easy effect.

Resolution: Monitoring the Correctness of One's Answers

How do people discriminate between correct and incorrect answers? Unlike direct-access views, SCM, like other mnemonic-based accounts of confidence, faces the challenge of explaining the general accuracy of confidence judgments. This explanation, as noted earlier, is based on the general assumption that metaknowledge accuracy is a by-product of knowledge accuracy (see Koriat, 1993, 1995). Consider, for example, Koriat's (1993) accessibility model of FOK. According to that model, the accuracy of FOK judgments in predicting recall or recognition derives from the accuracy of memory itself: When recall of a memory target fails, the partial information that comes to mind is much more likely to be correct than wrong. Therefore, a monitoring mechanism that relies on the mere accessibility of information can discriminate between items that are more likely and those that are less likely to be recalled. Indeed, Koriat (1993) reported evidence indicating that the total number of partial clues accessible to a rememberer about a memory target (regardless of their accuracy) is as predictive of subsequent recognition performance as is the person's own FOK judgment. Thus, the accuracy of FOK judgments may be accounted for in terms of the accuracy of memory itself with no need to postulate privileged access to memory traces as a basis of FOK. The advantage of this account, of course, is that it can also explain illusory FOK judgments (Koriat, 1995).

In a similar manner, most of the clues that people draw upon in attempting to choose the answer to a general-knowledge question tend to be consistent with the correct answer by virtue of the basic correspondence between the probability structure of the natural environment and its internal representation (Dhami et al., 2004; Gigerenzer et al., 1991; Juslin, 1994). In terms of SCM, the implication is that different 2AFC items differ primarily in the proportion of representations that favor or lean toward the correct answer. Therefore, the answers that are chosen consistently are more likely to be correct than wrong, and degree of consistency is diagnostic of correctness. Thus, the C/A correlation is mediated by the general correlation between self-consistency and correctness.

The mediating role of self-consistency is suggested by the correlation between confidence and consensuality. In this section, I review briefly the results in support of the idea that confidence correlates with the consensuality of the answer rather than with its correctness. I first consider the results for word matching and general knowledge (see Koriat, 2008b, for more details) and then report the results from the other recent studies, which demonstrate the generality of the consensuality principle.

Figure 12A presents the results for word matching (Koriat, 1976), and Figure 12B presents the results for general knowledge (Koriat, 2008b). In both studies, items were classified ad hoc as CC and CW depending on which of the two answers was significantly endorsed by the majority of participants. The results indicate that the C/A correlation was positive for the CC items but negative for the CW items. (NC items, not included in the figure, yielded little difference between confidence in correct and wrong answers.) For the general-knowledge questions, for example, the within-person C/A gamma correlation averaged +.47 across the CC items, and −.24 across the CW items. An interactive pattern consistent with the consensuality principle was also reported by Brewer and Sampaio (2006) and Sampaio and Brewer (2009), who compared episodic memory for deceptive and non-deceptive sentences.

Extensions of SCM for the accuracy of confidence judgments. Figures 12C and 12D, in turn, present the results for the perceptual comparison tasks described earlier (length and area, respectively; see Koriat, 2011), using only the data from the first presentation. The stimulus pairs in these tasks had been formed deliberately to yield a large enough number of CW items. It can be seen that the results conform to the consensuality principle.

Of course, resolution could not be examined for the data on social beliefs and social attitudes for which the question of accuracy does not apply. However, in recent unpublished studies, we presented participants with the same two-alternative items assessing beliefs or attitudes, and we asked them to guess which of the two response options had been chosen by most participants in the previous studies in which participants had indicated their own beliefs and attitudes, and to indicate their confidence. The results conformed to the consensuality principle, yielding higher confidence for correct than for wrong guesses only for the CC items.

Finally, the results for the perceptual tasks also yielded support for a within-person "consistency principle," which is analogous to the consensuality principle. When items were divided for each participant between Consistently Correct and Consistently Wrong items according to the answer that was selected more often by the participant across the five presentations, the C/A relationship was positive for the Consistently Correct items but was negative for the Consistently Wrong items (see Figures 12E and 12F).

In sum, assuming that item consensus and item consistency are indicative of degree of self-consistency, the results accord with the assumption that confidence judgments are not inherently diagnostic of accuracy. Rather, the C/A correlation is generally positive because the consistently favored responses are largely correct. The results are in line with the idea that metaknowledge accuracy is a by-product of knowledge accuracy. Thus, SCM can account for the C/A correspondence without postulating access to a cue that is inherently diagnostic of the correctness of the response. It also provides a clue to the determinants of miscorrespondence.

Going back to the study on phonetic symbolism (Koriat, 1975), which spurred the present line of investigation, that study raised two questions. First, how could participants guess the meaning of words from noncognate languages? Second, how were they successful in monitoring the accuracy of their guesses? The results presented so far are consistent with the assumption of SCM that the answer to the second (metacognitive) question can be found in the answer to the first (cognitive) question. The first, cognitive question has been discussed in the context of theories about the evolution of language that assume some natural constraints on the ways in which sounds are mapped onto objects. For example, it has been proposed that a kind of sensory-to-motor synaesthesia involving cross-activation between sensory and motor maps in the brain played a pivotal role in the evolution of language (e.g., Ramachandran & Hubbard, 2001). The question of why people are successful in guessing the meaning of foreign words, however, is beyond the scope of the present article as is the question why people's responses to 2AFC general-knowledge or perceptual questions are generally correct. Thus, as Koriat (1993) argued with regard to the FOK, "the answer to the question of why FOK judgments are accurate ought to be found in the effectiveness of memory storage and retrieval, not in the accuracy of some specialized structure that is dedicated to the monitoring of memory storage" (p. 630).

From a methodological point of view, the results presented in this section support the plea (Gigerenzer et al., 1991; Juslin, 1994; also see Dhami et al., 2004) for using a representative sampling of items in assessing the accuracy of confidence judgments. This plea, however, has been made primarily in connection with calibration—the possibility that the overconfidence bias derives from a biased selection of items (Gigerenzer et al., 1991; Juslin, 1994). The results pertaining to resolution clearly indicate that resolution too varies greatly with characteristics of the sample of items used.

In addition, however, these results also bring to the fore the benefits that ensue from the deliberate inclusion of nonrepresentative items. Whereas the use of a random, representative sampling may be important for generalizing conclusions to the real world (but see later), the deliberate inclusion of nonrepresentative items is critical for clarifying the mechanisms underlying the successful monitoring of one's own knowledge (see Koriat, Pansky, & Goldsmith, 2011).

Calibration: The Overconfidence Bias

Previous accounts of overconfidence. The observation that has attracted much of the attention in the study of the calibration

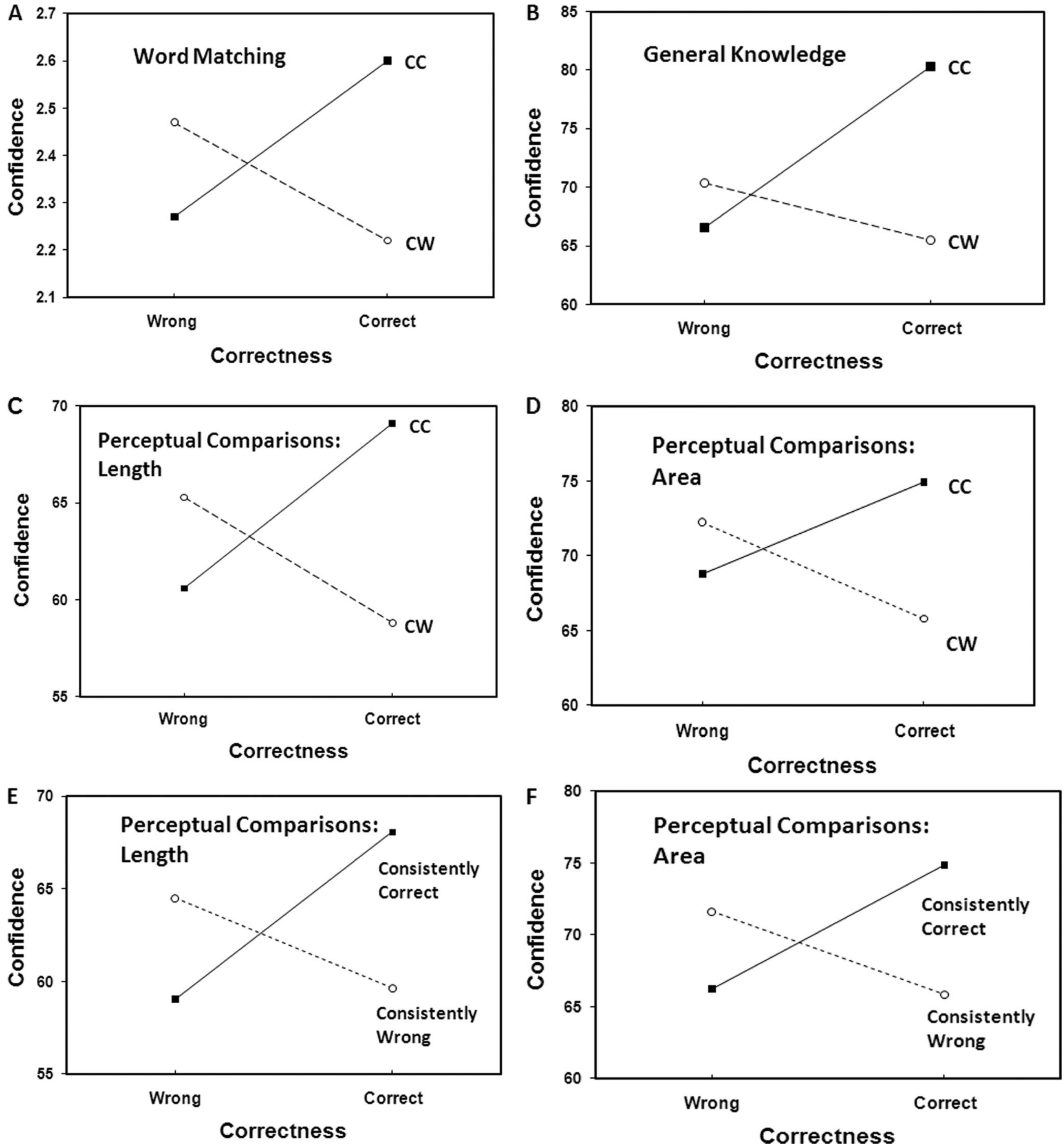

Figure 12. Panels A–D present mean confidence for correct and wrong responses for Consensually Correct (CC) and Consensually Wrong (CW) items. The results are based on data from four studies (see text for details). Panels E and F present mean confidence for correct and wrong responses for Consistently Correct and Consistently Wrong items, based on the data from the two studies involving perceptual comparisons (see text for details). Panel A is adapted with permission from "Another Look at the Relationship Between Phonetic Symbolism and the Feeling of Knowing," by A. Koriat, 1976, *Memory & Cognition, 4*, p. 247. Copyright 2011 by the Psychonomic Society. Panel B is adapted from "Subjective Confidence in One's Answers: The Consensuality Principle," by A. Koriat, 2008b, *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *34,* p. 950. Copyright 2011 by the American Psychological Association. Panels C–F are adapted from "Subjective Confidence in Perceptual Judgments: A Test of the Self-Consistency Model," by A. Koriat, 2011, *Journal of Experimental Psychology: General*, *140*, pp. 126, 128, 131. Copyright 2011 by the American Psychological Association.

of confidence judgments is the overconfidence bias. This bias was observed in many studies (Allwood & Montgomery, 1987; Arkes, Christensen, Lai, & Blumer, 1987; Koriat et al., 1980; Lichtenstein & Fischhoff, 1977; Ronis & Yates, 1987; Soll, 1996). Several explanations have been proposed for this bias, among them is that overconfidence reflects self-serving motivations (Taylor & Brown, 1988; also see Metcalfe, 1998; Nickerson, 1998), that it derives from overreliance on the strength rather than the weight of evidence (Griffin & Tversky, 1992), and that it is due to random noise in participants' judgments (Erev et al., 1994; Soll, 1996). Other researchers argued that the overconfidence bias represents a methodological artifact that should be explained away (Dawes & Mulford, 1996). Among the latter researchers, the position that has gained the strongest support is that the overconfidence bias derives from researchers' tendency to include tricky or deceptive items in the experimental sample. Indeed, several attempts to ensure a representative sampling of almanac questions succeeded in reducing or eliminating the overconfidence bias (Björkman, 1994; Gigerenzer et al., 1991; Juslin, 1993, 1994). Other researchers, however, reported an overconfidence bias even for a representative sample of items (Brenner, Koehler, Liberman, & Tversky, 1996; Griffin & Tversky, 1992).

The self-consistency account of overconfidence. According to SCM, the overconfidence bias stems largely from the basic discrepancy between reliability and validity. Whereas confidence judgments are assumed to monitor the degree of reliability with which a choice is supported across a sample of representations, their accuracy is evaluated in calibration studies against correctness. As stated in many textbooks, reliability sets an upper limit on validity so that reliability is practically always higher than validity. The evaluation of metacognitive judgments against correctness is not inappropriate because phenomenologically, these judgments are construed by participants as pertaining to correctness.

The testing of the consensuality principle for some of the tasks reviewed earlier (see Figure 12) required the deliberate inclusion of CW items, which prevents a fair assessment of the over/underconfidence bias for these tasks. Nevertheless, it is important to compare calibration when confidence judgments are evaluated against accuracy versus when they are evaluated against some index of self-consistency. In the following analyses, I carried out that comparison for two tasks: a general-knowledge task and a perceptual comparison task. The inclusion of both tasks in the same analysis allows examination of the generality of SCM account of overconfidence and is also important in view of the claims that different mechanisms underlie confidence in the two tasks (Björkman, Juslin, & Winman, 1993; Dawes, 1980; Keren, 1988; Winman & Juslin, 1993).

The analyses to be reported (for more details, see Koriat, 2011) were based on the results of Koriat (2008b) for general knowledge, and those of Koriat (2011, Experiment 2) for the comparison of line lengths. Only the results from the first presentation in both experiments were used. For each task, 36 items were selected that were matched in terms of the percentage of consensual answers. Calibration was then assessed for each of the two sets of items using the procedure of studies of the calibration of subjective probabilities (see Lichtenstein et al., 1982). The results ("Accuracy"), plotted for seven confidence categories (50, 51–60 . . . 91–99, 100), appear in Figure 13A for the knowledge task and in Figure 13B for the perceptual task. It can be seen that both tasks yielded a strong overconfidence bias of about the same magnitude (12.4 percentage points for the knowledge task and 15.9 percentage points for the perceptual task).

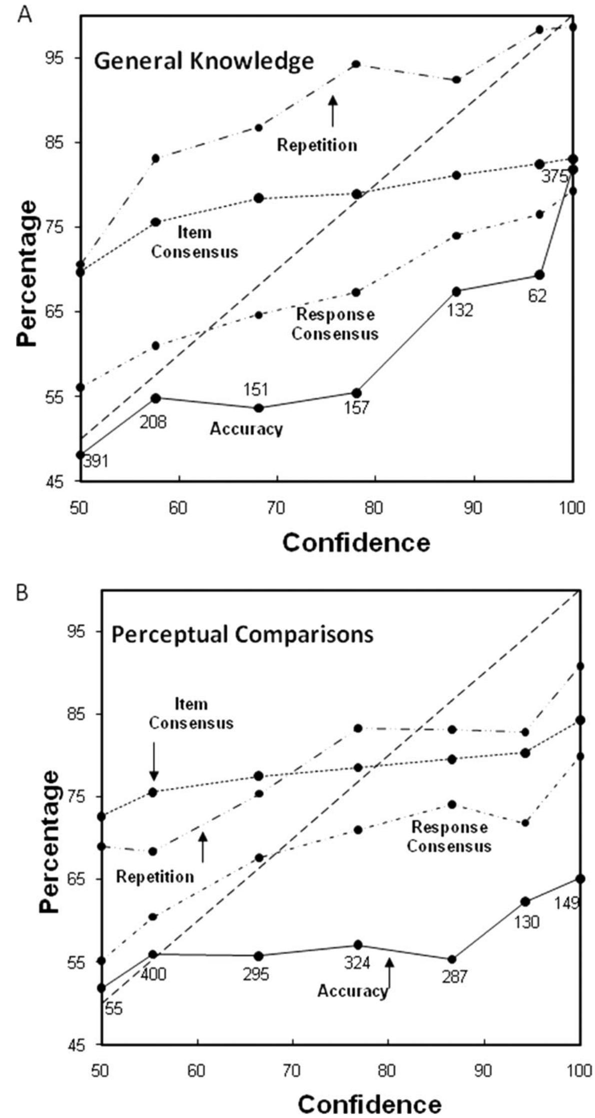

Figure 13. Calibration curves using four different criteria for assessing the appropriateness of confidence judgment: accuracy (the likelihood of choosing the correct answer), item consensus (the percentage of consensual responses), response consensus (the percentage of other participants who gave the same response as that made by each target participant), and repetition (the percentage of times that the Presentation-1 response was repeated in Presentation 2). The results are plotted for two sets of matched items: general-knowledge questions (Panel A; results based on Koriat, 2008b) and perceptual-comparison items (Panel B; results based on Koriat, 2011, Experiment 2). Reproduced from "Subjective Confidence in Perceptual Judgments: A Test of the Self-Consistency Model," by A. Koriat, 2011, *Journal of Experimental Psychology: General*, *140*, p. 132. Copyright 2011 by the American Psychological Association.

The same data were plotted in the same figures except that calibration was evaluated against three different indexes of self-consistency:

(a) Item consensus: For each confidence category, the percentage of consensual (majority) responses across all items in that category was calculated. For both sets, confidence yielded a small and comparable underconfidence bias, which amounted to 3.38 percentage points for the knowledge task, and to 5.21 percentage points for the perceptual task.

(b) Response consensus: For each participant and for each item, the percentage of *other* participants who gave the same response as him or her to that item was calculated across all items in that confidence category. For both sets, confidence yielded a small overconfidence bias, which amounted to 6.78 percentage points for the knowledge task, and 4.59 percentage points for the perceptual task.

(c) Repetition: Both studies included a second presentation of the task. Repetition was defined as the likelihood of making the Presentation 1 choice in Presentation 2. For both tasks, confidence yielded a marked underconfidence bias, which was stronger for the knowledge task (12.80 percentage points) than for the perceptual task (7.05 percentage points).

The conclusion from these results is that although the two matched sets of items yielded a strong overconfidence bias when confidence was evaluated against accuracy, the evaluation of confidence against any of the three indexes of self-consistency yielded a markedly smaller tendency toward overconfidence. This pattern is consistent with the idea that the overconfidence bias stems in part from the discrepancy between reliability and validity and is reduced or eliminated when confidence judgments are evaluated against some criterion of reliability or self-consistency. Only response repetition, which yielded a clear underconfidence bias, revealed a measurable difference between the two tasks, perhaps because participants can recall better their previous answer to a general-knowledge question than to a perceptual comparison item (see Finn & Metcalfe, 2007).

It is interesting that the calibration curves that were plotted against the three indexes of self-consistency generally exhibit the highest degree of overconfidence when confidence judgments are high. The inverse S-shaped pattern that they exhibit replicates the pattern of miscalibration that has been observed in previous studies (see Erev et al., 1994; Klayman, Soll, González-Vallejo, & Barlas, 1999)—a bias in the direction of underconfidence (or almost perfect calibration) when confidence is low, and a bias in the direction of overconfidence when confidence is high. This pattern has been explained in terms of a regression toward the mean that derives from imperfect correlation between the predictor and the criterion (Dawes & Mulford, 1996; Erev et al., 1994) and, thus, seems to apply regardless of which criterion is used in evaluating calibration. Note that a similar pattern was also obtained for JOLs (Koriat, Sheffer, & Ma'ayan, 2002).

It should be noted that in calibration studies, a distinction has been drawn between two methods of eliciting judgments. In the item-by-item (or confidence) method, participants assess the probability that the answer to each single item is correct, as was done in the studies reviewed in this article. In the aggregate (or frequency) method, in contrast, participants estimate the frequency of correct items across a series of items (Gigerenzer et al., 1991; Griffin & Tversky, 1992). The self-consistency account of overconfidence applies only to the item-by-item method, that is, to the confidence associated with individual responses. In fact, aggregate judgments, when transformed into percentages, do not exhibit overconfidence and sometimes even yield an underconfidence bias (Griffin & Tversky, 1992; Schneider, 1995). It is of interest to examine the possibility that the different results obtained with the two methods of assessing confidence derive specifically from the assumed reliance on self-consistency in the item-by-item method but not in the aggregate method.

The Hard-Easy Effect

Related to the overconfidence bias is the hard-easy effect: Overconfidence is reduced as the difficulty of the questions decreases (see, e.g., Lichtenstein et al., 1982; Suantak, Bolger, & Ferrell, 1996). In fact, easy items tend to produce a certain degree of underconfidence overall (e.g., Griffin & Tversky, 1992; Lichtenstein & Fischhoff, 1977; Yates, 1990). Although there is little doubt about the reality of this effect, there has been some dispute over its explanation.

Several researchers (Gigerenzer et al., 1991; Juslin, 1993) argued that like the overconfidence bias, the hard-easy effect derives from the inclusion of deceptive items. Indeed, they reported evidence indicating that this effect can be eliminated when item selection is random. Other researchers, however, reported a hard-easy effect even with representative sets of stimuli (Braun & Yaniv, 1992; Griffin & Tversky, 1992; Soll, 1996).

SCM also predicts a hard-easy effect when items are selected to represent the entire range of percentage correct from 0% to 100%. In that case, item consensus, and hence confidence, should increase with the deviation of percentage correct from 50%, so that the function relating confidence to accuracy should be U-shaped. The results of Koriat (2008b) are consistent with this expectation, as can be seen in Figure 14. This figure compares mean accuracy and mean confidence for the three classes of items in that study. The difference between these classes is much stronger in proportion correct than in mean confidence, and there is a slight indication of a U-shaped function between confidence and difficulty.

In sum, SCM provides a parsimonious account for findings concerning three aspects of the correspondence between confidence and accuracy: monitoring resolution, monitoring calibration

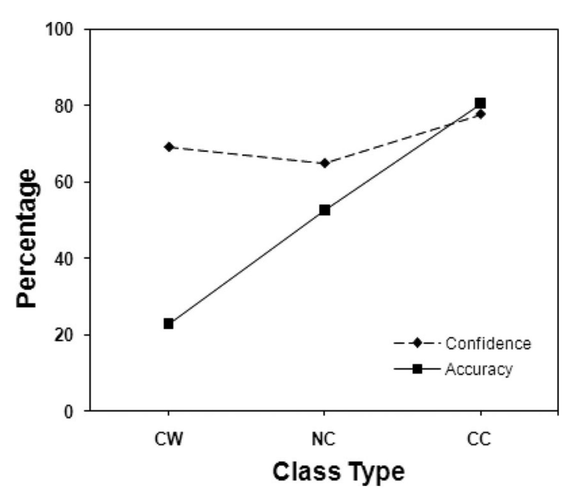

Figure 14. Mean confidence and accuracy for Consensually Wrong (CW), Nonconsensual (NC), and Consensually Correct (CC) items. The results are based on a reanalysis of the data of Koriat (2008b).

and the hard-easy effect. Specifically, it can explain when and why confidence judgments can discriminate between correct and wrong answers (the C/A correlation), why confidence judgments tend to be inflated in comparison with accuracy, and why the degree of over-/underconfidence tends to vary with item difficulty.

Choice Latency

As noted in the introduction, previous research has yielded evidence for the possible role of choice latency in mediating the accuracy of confidence judgments. On the one hand, confidence judgments in an answer have been found to increase with the speed of choosing or retrieving that answer (e.g., Kelley & Lindsay, 1993; Koriat, 2008b; Koriat et al., 2006; Robinson et al., 1997). On the other hand, response speed has been found to be diagnostic of the accuracy of the answer (Barnes et al., 1999; Costermans et al., 1992; Hertwig, Herzog, Schooler, & Reimer, 2008). Both of these effects have been found recently even for second-grade children (Ackerman & Koriat, 2011; Koriat & Ackerman, 2010). These results were taken to suggest that the C/A relationship is partly mediated by reliance on latency as a cue for correctness (Kelley & Lindsay, 1993; Robinson et al., 1997).

According to a version of SCM to be presented below, both of these relationships are mediated by self-consistency. First, it is proposed that choice latency is a faithful proxy for self-consistency: For a homogeneous set of 2AFC questions, differences in choice latency reflect differences in self-consistency both between items and between choices. Hence, the patterns of results observed for choice latency as a dependent variable should mimic those reported earlier for confidence judgments. Second, response speed is correlated with correctness when the correct response is the one that is consistently supported, but is counterdiagnostic when the wrong response is consistently supported. This hypothesis is tested using within-person consistency and between-person consensus as indexes of self-consistency.

Choice Latency as a Diagnostic Cue for Self-Consistency

How can SCM accommodate the latency–confidence relationship? Previous attempts to model this relationship in perceptual judgments assumed some version of a self-terminating sequential sampling model (see Baranski & Petrusic, 1998, for a review). SCM was modified to incorporate this assumption. This modification has not been introduced earlier because the model was sufficient for bringing to the fore the main predictions of the conceptual framework proposed. In addition, there are a number of ways in which the model can be modified to accommodate the choice latency results, and I leave open the choice of which specific modification is the most effective.

In what follows, one specific version is explored. According to this Run-3 version (see, e.g., Audley, 1960), once a series of draws yields the same subdecision three times in succession, the search is terminated, and the outcome of the Run-3 sequence determines the overt choice. Otherwise, the sampling process continues until a preset maximum sample size (n_{max}) has been reached—in which case the choice made corresponds to the majority subdecision. Confidence is always determined by the consistency of the subdecisions across the sample, and choice latency is assumed to increase monotonically with the actual sample size, n_{act}—the number of representations drawn before an overt choice is made.

To explore the predictions of this model, a simulation experiment was run. It assumed a vector of 18 binomial populations with p_{maj} ranging from .05 to .95 by .05 steps (with p_{maj} = .50 excluded). Maximum sample size, n_{max}, was set at 5, 7, or 11. For each population and for each n_{max}, 30,000 iterations of sampling were run. Figure 15A presents self-consistency for majority and minority choices as a function of pc_{maj} (using the pc_{maj} values that correspond to the respective p_{maj} values, as in Figure 3B). The results are presented only for n_{max} = 5 and n_{max} = 7. Figure 15B presents the respective results for actual sample size (n_{act}).

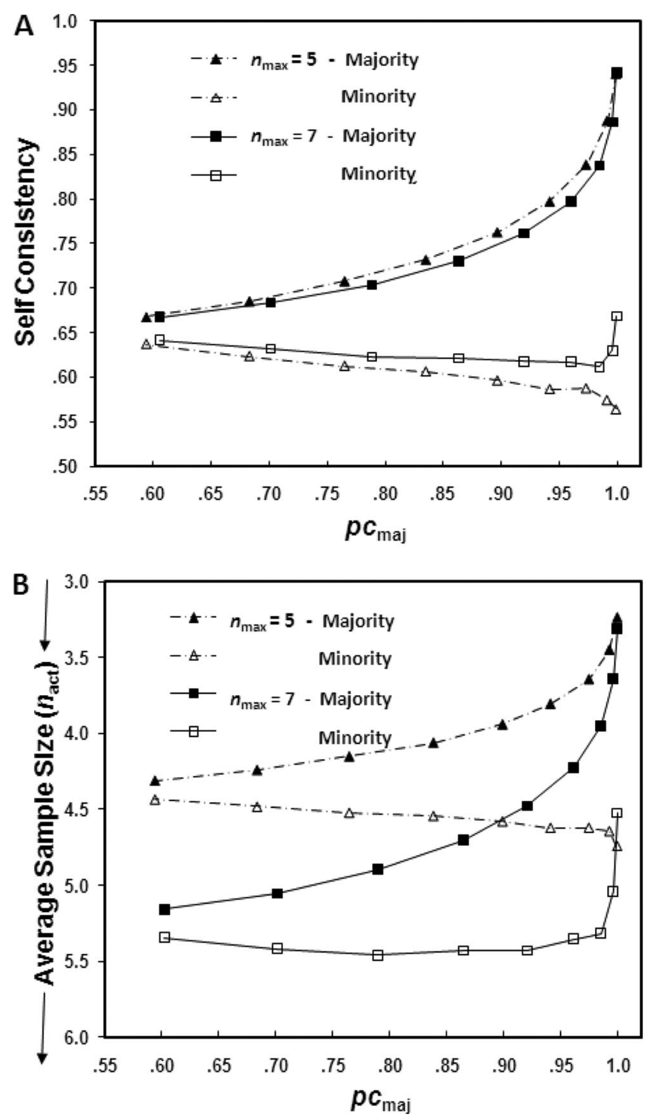

Figure 15. The results of a simulation of the Run-3 version of the self-consistency model. Panel A presents self-consistency for majority and minority answers as a function of item consensus (pc_{maj}) for maximum sample size (n_{max}) of 5 and 7. Panel B presents the respective results for actual sample size (n_{act}).

With regard to the results expected for confidence (see Figure 15A), it can be seen that the Run-3 modification does not affect considerably the pattern that was predicted by the model as depicted in Figure 3B. Majority responses are still expected to yield higher confidence than minority responses, and for majority responses, self-consistency and, hence, confidence are expected to increase monotonically with item consensus. The only discrepancy is that for extreme values of pc_{maj}, the relationship between confidence and pc_{maj} seems to vary somewhat with n_{max} for minority responses. In fact, for $n_{\text{max}} = 7$ (and also for $n_{\text{max}} = 11$, not shown), confidence in minority responses is expected to increase with item consensus for extreme values of item consensus.

Consider next the results expected for choice latency (n_{act}). These results (see Figure 15B) generally mimic those obtained for self-consistency (see Figure 15A), suggesting that response speed should yield a similar pattern to that observed for confidence judgments as far as the effects of item consensus and response consensuality are concerned. Most important, the results of the simulation indicate that minority choices are associated with a larger n_{act} on average than majority choices. The difference in n_{act} between majority and minority choices is not trivial; it implies that for the same question it takes longer to "reach" the minority answer than to reach the majority answer. Of course, when the consensual response is the correct response, as is typically the case, correct choices should be made faster than incorrect choices. In addition, the results suggest that for majority choices, n_{act}, and hence choice latency, should decrease steadily with increasing pc_{maj}.

These predictions were tested on the data of Koriat (2008b), and the results are presented in Figure 16. The results for majority answers accord with the pattern predicted from n_{act} (see Figure 15B), indicating that choice latency decreases monotonically with item consensus. Also, minority answers were associated with longer choice latencies than majority answers, and the trend is such that the function relating choice latency to item consensus is shallower for these answers than for the majority answers. The simulation results (see Figure 15A), however, suggest that for minority answers the shape of the function should differ for extreme pc_{maj} values depending on n_{max}. No data are presently available to test these detailed predictions.

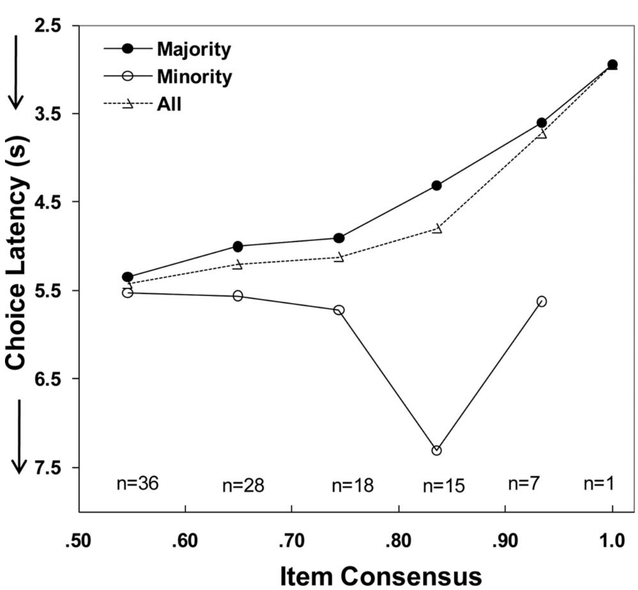

Figure 16. Choice latency as a function of item consensus for majority answers, minority answers, and all answers combined. The results are based on a reanalysis of the data of Koriat (2008b).

Extensions of SCM for Choice Latency

This section reviews briefly results supporting the generality of the predictions of SCM for choice latency. I first review the results that follow from the assumption that choice latency monitors self-consistency and then examine those pertaining to the validity of choice latency in monitoring the accuracy of the response.

The relationship between choice latency and within-person consistency. The results from the studies, mentioned earlier, on confidence in beliefs, attitudes, and perceptual judgments were used to examine the generality of the predictions of SCM for choice latency. In all four studies (see Figure 10), the task was presented between five and seven times, and choice latency was measured. We examined whether choice latency varies with item consistency for frequent and rare choices as would be predicted from SCM. The results are presented in Figure 17. It can be seen that they mimic largely the pattern observed for confidence judgments (see Figure 10). In particular, the frequent choice was associated with reliably shorter response times than the rare choice.

The relationship between choice latency and cross-person response consensus. We now examine the idea that choice latency monitors self-consistency when self-consistency is indexed by cross-person consensus. The results are presented in Figure 18. The pattern that emerges is consistent across the four studies and is also what would be predicted from SCM: A clear separation is observed between consensual and nonconsensual responses with the latter yielding reliably longer latencies. For consensual choices, response latency decreased monotonically with item consensus, whereas for nonconsensual choices, it was either indifferent to item consensus or increased somewhat with item consensus.

The relationship between choice latency and response accuracy. We turn next to the validity of choice latency in monitoring the accuracy of the response. According to SCM, choice latency, like confidence, should predict the accuracy of the response only when the correct response is the one that is consistently chosen. Figure 19 presents the pertinent results for the studies mentioned earlier (choice latency was not measured for the word-matching task). Consider first the results for general knowledge (see Figure 19A) which are reproduced from Koriat (2008b). They indicate that choice speed is diagnostic of accuracy only for the CC items, whereas for the CW items, wrong answers are associated with faster choice latencies than correct answers. The same pattern is observed for the perceptual comparison tasks (see Figures 19B and 19C). Although the latency–accuracy relationship differed for the CC and CW items, in all three studies, confidence decreased with increasing choice latency for both the CC and CW items. This pattern suggests that if participants relied on the choice-latency heuristic, they did so indiscriminately, assuming that faster choices are more likely to be correct than slower choices.

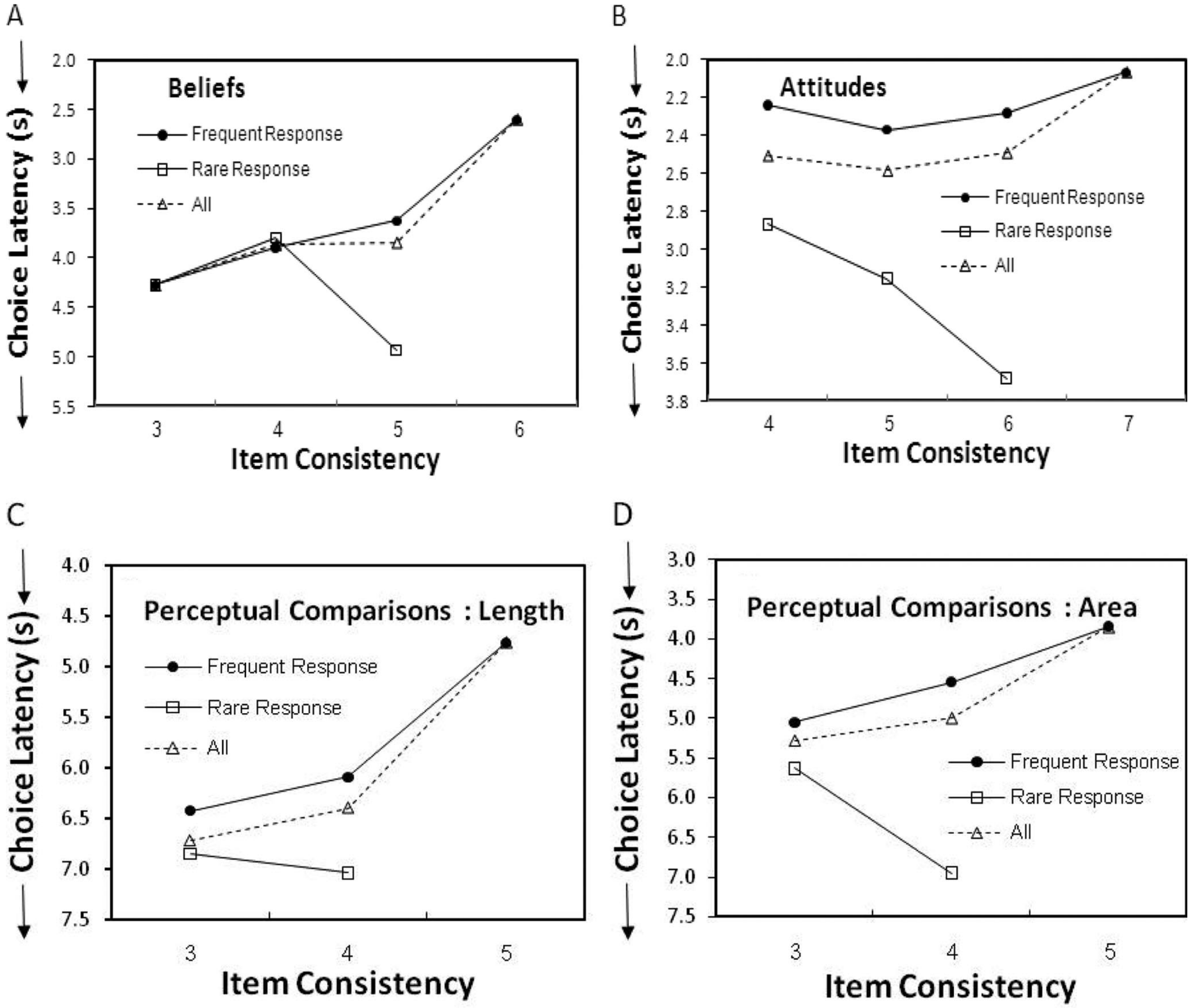

Figure 17. Mean choice latency for frequent and rare responses as a function of item consistency (the number of times that the majority response was chosen). The results are based on four studies (see text for details). Panel A is adapted from "Confidence in One's Social Beliefs: Implications for Belief Justification," by A. Koriat and S. Adiv, 2011a. Panel B is adapted with permission from "The Construction of Attitudinal Judgments: Evidence From Attitude Certainty and Response Latency," by A. Koriat and S. Adiv, 2011b, *Social Cognition*, *29*, p. 589. Copyright 2011 by Guilford Press. Panels C and D are adapted from "Subjective Confidence in Perceptual Judgments: A Test of the Self-Consistency Model," by A. Koriat, 2011, *Journal of Experimental Psychology: General*, *140*, pp. 124, 130. Copyright 2011 by the American Psychological Association.

Finally, the results for the perceptual tasks also supported the within-person "consistency principle" for choice latency (see Figures 19D and 19E). For items for which the answers were correct more often across the five repetitions of the task (Consistently Correct), correct answers were associated with shorter choice latencies than wrong answers. The opposite was true for items for which the answers were more often wrong.

In sum, the results for choice latency yielded consistent support for SCM and provide further evidence for the generality of SCM across different domains. They support the propositions that response latency is a frugal cue for self-consistency and that its cue validity is mediated by the validity of self-consistency.

Given that self-consistency and choice latency yield very similar effects on confidence, what is the causal relation between these two mnemonic cues? First, it should be stressed that the observation that choice latency it diagnostic of self-consistency suggests that some of the previously reported latency–confidence relationships may have been spurious, reflecting the effect of self-consistency (as gauged by other means) on confidence, rather than that of response latency. That is, although response latency can be

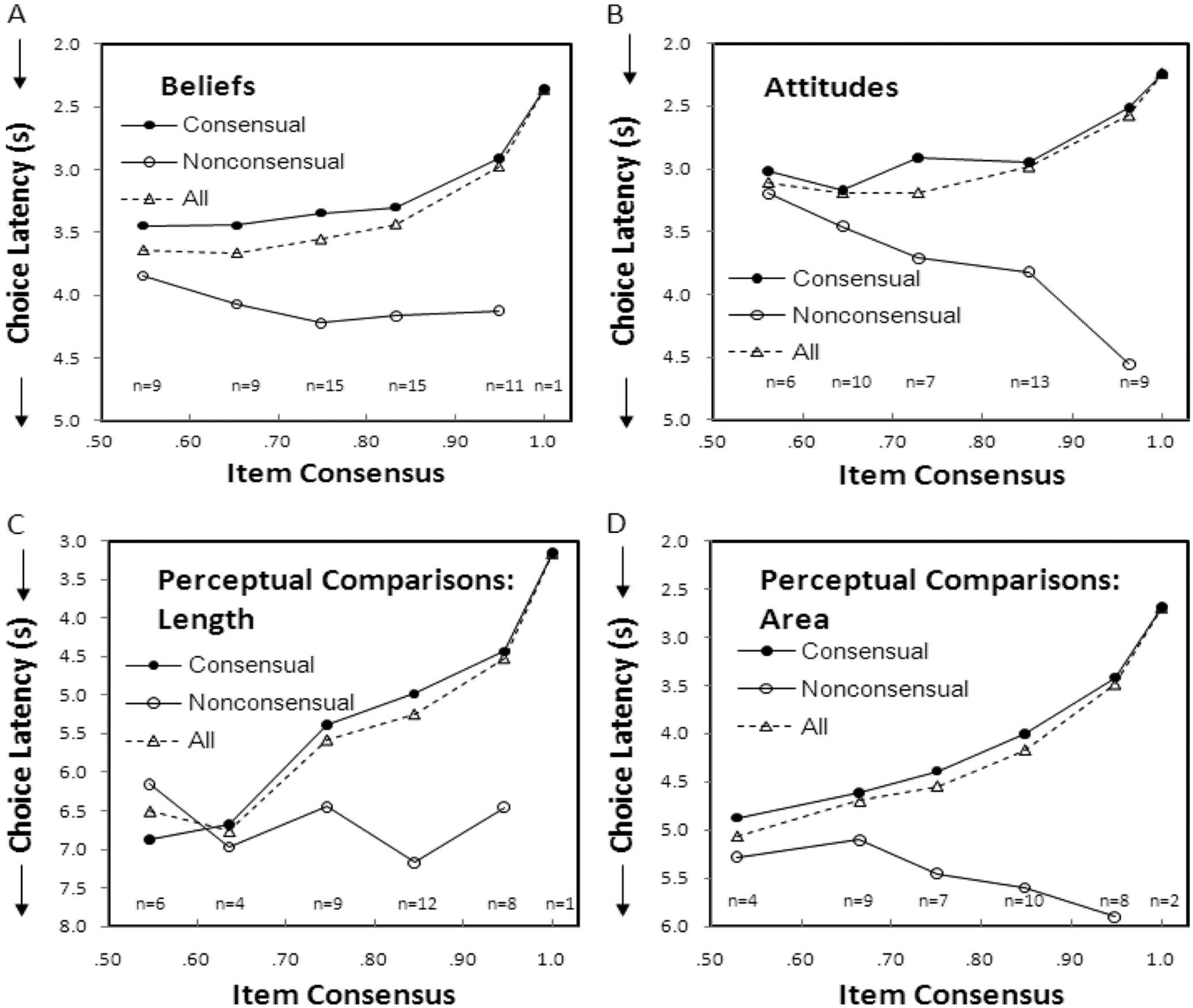

Figure 18. Mean choice latency for majority and minority choices as a function of item consensus (the proportion of participants who chose the majority answer). The results are based on four studies (see text for details). Panel A is adapted from "Confidence in One's Social Beliefs: Implications for Belief Justification," by A. Koriat and S. Adiv, 2011a. Panel B is adapted with permission from "The Construction of Attitudinal Judgments: Evidence From Attitude Certainty and Response Latency," by A. Koriat and S. Adiv, 2011b, *Social Cognition*, *29*, p. 590. Copyright 2011 by Guilford Press. Panels C and D are adapted from "Subjective Confidence in Perceptual Judgments: A Test of the Self-Consistency Model" by A. Koriat, 2011, *Journal of Experimental Psychology: General*, *140*, pp. 125, 130. Copyright 2011 by the American Psychological Association.

used by researchers as a frugal cue for self-consistency, this does not mean that it is used by participants as a cue for confidence. Second, however, if choice latency is used by participants as a basis for confidence, this cue may be assumed to represent a more proximal end point, so that self-consistency (as a rough estimate of the proportion of pro and con considerations) can affect confidence directly, but it can also affect confidence through its effects on choice latency. Choice latency, in turn, can be affected by other factors besides self-consistency (e.g., Kelley & Lindsay, 1993; Koriat et al., 2006).

The Effects of Accessibility

The results presented so far indicate that self-consistency and choice latency are intimately linked and can be considered jointly as the first factor that affects confidence. I now turn to the second factor—accessibility—that appears to make an independent contribution to confidence. A tentative idea is that whereas self-consistency corresponds to the component of variance in the calculation of SLC, accessibility corresponds to the component of sample size.

The effects of accessibility were suggested by the results on the CIC effect reported by Koriat (2008c). Item-based analyses indicated that 2AFC general-knowledge items differ reliably in their associated confidence judgments regardless of which answer is chosen. I describe the results briefly, and then examine the added contribution of CIC to the prediction of confidence judgments. Finally, I discuss how SCM can be modified to accommodate the CIC results.

The pattern depicted in Figure 3 suggests that across items, a negative correlation should be observed between mean confidence in the majority choice and mean confidence in the minority choice (the correlation is –.85 across the 10 data points in Figure 3A, and –.89 across the 10 data points in Figure 3B). Somewhat surprisingly, this correlation was found to be positive and highly significant across the studies reviewed by Koriat (2008c). To illustrate, in the study of Koriat (1976), the correlation between mean confidence in the majority response and mean confidence in the minority response was .60 across the 85 items. A reanalysis of the data in connection with the present article revealed that the correlation remained high (r = .65) when differences in item consensus were partialled out. A similar pattern was observed for the general-knowledge questions of Koriat (2008b). The respective correlations were .69 and .75 across 104 items. These results suggest that items differ reliably in the tendency to evoke low or high subjective confidence regardless of which response is chosen, and this tendency is due to a different property of the items from that underlying response consensus (or self-consistency).

One additional observation, not previously reported, should be mentioned. The CIC pattern was also observed in a within-person analysis of the data of Koriat (1981) in which three participants were presented 20 times with a word-matching task. For each item, confidence judgments were averaged across presentations for the more frequent and the less frequent choice. The correlation across items between the confidence in the frequent and infrequent response (using only items for which item consistency was other than 10 or 20) was .47 (n = 65) for Participant 1, .46 (n = 61) for Participant 2, and .46 (n = 74) for Participant 3—all significant beyond the .001 level. The respective correlations with item consistency partialled out were .42, .49, and .38. Thus, when participants were repeatedly presented with the same items, they were reliably more confident about some items than about others regardless of which answer they chose.

What is the interpretation of the CIC effect? Several results presented by Koriat (2008c) suggested that this effect reflects the amount of clues that an item brings to mind. Indeed, previous observations suggested that merely increasing the amount of knowledge available enhances confidence in judgments (Gill, Swann, & Silvera, 1998; Tsai, Klayman, & Hastie, 2008), sometimes even while decreasing accuracy (Hall, Ariss, & Todorov, 2007). Koriat (2008c) proposed that knowledge richness may affect confidence at any of several phases but is more likely to result from a confirmation bias that occurs after a choice has been made (Nickerson, 1998).

The Combined Contribution of Consistency and Accessibility to Confidence Judgments

I use the results of Koriat (2008b) to evaluate the combined contributions of self-consistency and accessibility to confidence judgments. First, I attempted to predict mean confidence in the majority answer from two variables: (a) the proportion of participants who chose that answer (as an index of self-consistency) and (b) the average confidence in the minority answer (as an index of accessibility). Note that the two predictors are experimentally independent, and the correlation between them (.084) was not significant, $p < .40$. The correlations between confidence and the two predictors are presented in Figure 20A. The multiple correlation was .815. A similar pattern of results was obtained with an arbitrary separation between a “first” and a “second” answer (rather than a majority and a minority answer). The multiple correlation in that case was .794. These high correlations suggest that a great deal about confidence judgments can be gained from the study of inter-item differences (see Koriat, 1995). The correlations also indicate that consideration of the CIC effect improves the prediction of confidence judgments markedly.

A somewhat different analysis brings to the fore another way of looking at the results. According to SCM, confidence is based essentially on the extent to which the activated clues support one choice rather than the other. The CIC effect, in contrast, implies that confidence also increases with the total amount of support for both choices. The combined effects of the two contributions could be examined using the results of Experiment 2 of Koriat (2008c). For each question, participants in that experiment were presented with each of the answers separately, and they were asked to estimate the number of people who would be likely to endorse that answer. For the purpose of the present analysis, the answers were classified as majority and minority answers on the basis of the results of Koriat (2008b). For each item, two scores were then calculated: (a) the *difference* between the mean estimate for the majority answer and the mean estimate for the minority answer in Experiment 2 of Koriat (2008c), and (b) the *sum* of the two estimates in that experiment. Whereas the difference score can be assumed to reflect roughly the consistency with which the majority answer was favored over the minority answer, the sum score can be assumed to reflect the total number of clues that the question brings to mind (the CIC effect). It can be seen (see Figure 20B) that both the difference and sum scores correlated positively across the 104 items with mean confidence in the majority answer in Koriat (2008b). The multiple correlation was .753, $p < .0001$. These results are also impressive given that the data for the criterion and predictors were derived from the results of two different experiments.

A final analysis examined the empirical effects of familiarity and self-consistency on confidence judgments. The items in Koriat (2008b) were divided at the median of the familiarity ratings obtained in Koriat (2008c). Figure 21 presents confidence judgments for majority and minority answers as a function of item consensus in Koriat (2008b), presented separately for the low- and high-familiarity items. As might be expected, the low-familiarity items did not yield high levels of item consensus as did the high-familiarity items. However, the pattern observed is largely consistent with the observations just mentioned. It suggests that familiarity adds a factor to subjective confidence without modifying the overall pattern of the results.

Incorporating the Effects of Accessibility Into the SCM

How can SCM be modified to accommodate the CIC effect? The parameter of the model that seems to capture best the CIC effect is sample size—the total number of clues that come to mind. Previous results on TOT and FOK judgments suggest that items differ reliably in the extent to which they bring many or few considerations to mind (Koriat, 1995; Koriat & Lieblich, 1977). Thus, perhaps sample size ($n_{\max}$) is data-driven, dictated by the item itself.

As mentioned earlier, an attractive hypothesis is that self-consistency and accessibility represent the two components that affect SLC: sample variance and sample size, respectively. Perhaps, participants give greater weight to the self-consistency index when it is based on a larger sample of representations than when it is based on a smaller sample. Although the results regarding the effects of sample size on judgment have been inconsistent (see Bar-Hillel, 1979; Reagan, 1989; Tversky & Kahneman, 1971), it seems that for tasks requiring a comparison of two frequency distributions, participants disclose the intuition that the results of larger samples are more credible than those of smaller samples (Sedlmeier & Gigerenzer, 1997; also see Sedlmeier, 2007). Because the process implied by SCM is like that tapped by frequency-distribution tasks, the CIC effect would seem to be in line with the idea that confidence is assumed to increase with increasing sample size.

The proposal that CIC reflects the effects of sample size is not necessarily incompatible with the suggestion of Koriat (2008c) that the effects of item richness are due specifically to a confirmation bias that occurs at a post-decisional phase. The appeal of this suggestion derives from the extensive findings suggesting that confidence in an answer is influenced more strongly by evidence that speaks for it than by evidence that speaks against it (Arkes et al., 1987; Koriat et al., 1980; McKenzie, 1997; Sniezek, Paese, & Switzer, 1990; also see Nickerson, 1998).[4] However, more work is needed to clarify the specific mechanisms underlying the CIC effect and how this effect can be integrated into SCM.

General Discussion

The work presented in this article concerns the two major questions about subjective confidence in 2AFC general-knowledge questions: the basis of confidence judgments and the reasons for their general accuracy. The theoretical framework that was proposed focuses on confidence in general-knowledge, but the other results reviewed in this article suggest that SCM may apply to other domains as well.

In what follows, I first attempt to place SCM with respect to the three general approaches to metacognitive judgments and then compare the model to other models of confidence judgments. I then discuss some of the implications of SCM for the basis of confidence judgments and for the C/A correspondence. I end with a few comments about the limitations of SCM.

Placing SCM in the Context of the Three Approaches to Metacognitive Judgments

Let me examine how SCM stands in relation to the three approaches to metacognitive judgments discussed in the introduction. Underlying SCM is a cue-utilization view of metacognitive judgments (Benjamin & Bjork, 1996; Jacoby, Kelley, & Dywan, 1989; Koriat, 2007) that assumes that these judgments are inferential in nature rather than being based on privileged access to memory traces. SCM subscribes specifically to the experience-based approach; it posits that confidence judgments in 2AFC tasks are based on mnemonic cues that derive from the process of making a choice. The main cue for confidence is self-consistency, that is, the extent to which the choice reached is supported across the representations sampled from memory.

The experience-based approach to confidence has been discussed in the literature mostly in connection with the confidence–latency relationship. Previous studies indicated that confidence increases with response speed, and that response speed is generally predictive of accuracy. The results presented in this study provide evidence suggesting that response speed is diagnostic of self-consistency, and its accuracy is mediated by the accuracy of self-consistency as a cue for correctness. Possibly confidence can be based either on self-consistency or on specific frugal cues (such as response latency) that reflect the amount of deliberation and conflict experienced in making a choice.

In addition to self-consistency and choice latency, a third mnemonic cue—accessibility—was found to exert strong effects on confidence judgments. What the three mnemonic cues have in common—self-consistency, response latency, and accessibility—is that they all reside in the on-line feedback from the process of making a choice. Their effects on confidence are consistent with the proposition that the processes that give rise to confidence are parasitic on the normal cognitive operations underlying choice rather than being dedicated to the assessment of one's performance (see Koriat et al., 2008): In deliberating between two answers, participants sample representations from memory. They then base their confidence on the number of clues that come to mind (accessibility), the extent to which these cues agree in supporting the choice made (consistency), and the time it took to reach that choice (latency).

Although SCM subscribes to the experience-based approach, it also accommodates features of the information-based approach. There is little doubt that information-driven, reasoned processes contribute to the choice between two answers (Gigerenzer et al., 1991; Koriat et al., 1980; Soll, 1996). Participants typically engage in an analytic-like process in answering a question, retrieving a variety of clues and considerations. However, once they have settled on the answer, their confidence rests primarily on such crude cues as the degree of deliberation and conflict experienced, and the amount of time and effort invested in making the choice. These cues, however, capture the gist of the processes underlying choice, particularly the balance of evidence in favor of the chosen answer. This view differs from the impression that one might get from the studies inspired by dual-process theories, which have tended to focus on conditions in which mnemonic cues divert metacognitive judgments away from analytic-based judgments

[4] It should be noted that the effects of accessibility are not reflected in response latency. For example, mean choice latency (in Koriat, 2008b) for the low-familiarity and high-familiarity items (defined according to the results of Koriat, 2008c; see Figure 21) were 5.01 s and 5.17 s, respectively, $t(40) = 1.31$, *ns*.

(Alter et al., 2007; Denes-Raj & Epstein, 1994; Jacoby, Kelley, & Dywan, 1989; Koriat et al., 2004; Rhodes & Castel, 2008). Unlike these theories, SCM emphasizes the idea that under natural conditions, back-end mnemonic cues generally mirror the front-end analytic processes underlying the choice of an answer.

The assumed relationship between information-driven and experience-driven processes is important for explaining the general accuracy of confidence judgments. As noted, SCM assumes that the accuracy of metaknowledge is a by-product of the accuracy of knowledge itself. Thus, the positive C/A correlation that has been generally observed is assumed to stem from the general accuracy or appropriateness of the considerations that are retrieved in making a choice. Because these considerations reflect the effects of learning and past experience, they contribute to the validity of the mnemonic cues underlying confidence judgments.

This analysis raises a question about the learnability of the self-consistency heuristic. It has been proposed that mnemonic cues are used according to their learned ecological validity (Unkelbach, 2006). For example, people learn that fluency and truth tend to be positively correlated, and therefore fluency enhances the truth ratings of statements. Indeed, a learning session in which the correlation between fluency and truth was reversed resulted in fluent processing enhancing "false" ratings (Unkelbach, 2007). It would be of interest to examine whether the effects of self-consistency on confidence can also be reversed by a similar experimental manipulation. What is clear, however, is that in real-life, self-consistency and response speed are valid cues for truth, as the foregoing analysis suggests. In the forensic system, the most frequently reported cue for the credibility of an eyewitness is the consistency of the report across repeated interrogations (Granhag & Strömwall, 2000). Thus, as noted earlier, learning and past experience not only provide learners with declarative information that is generally ecologically valid but also helps in educating subjective experience (Benjamin & Bjork, 1996).

This view departs from the common tendency in the literature to emphasize the "misleading" or "contaminating" effects of mnemonic cues. In fact, experience-based approaches have led to many demonstrations of sharp *dissociations* between metacognitive judgments and actual performance (e.g., Benjamin, Bjork, & Schwartz, 1998; Brewer & Sampaio, 2006; Busey, Tunnicliff, Loftus, & Loftus, 2000; Chandler, 1994; Koriat, 1995). Although these demonstrations argue against the direct-access approach, they fail to account for the very foundation of that approach—the accuracy of these judgments under natural conditions.

Unlike SCM, some of the theories assume that choice and confidence are determined directly by the content of the declarative information retrieved from memory. Consider the theory of probabilistic mental models (PMM) proposed by Gigerenzer et al. (1991). According to this theory (see also Juslin, 1993), when people have to choose between two answers, they test several cues in turn until they identify a cue that discriminates between the two answers. Associated with each cue is also a cue validity that describes how well that cue predicts the criterion. When the cue determines the choice, its cue validity is then reported as the confidence in the choice. Clearly, PMM is an inferential, information-based approach, although as far as confidence is concerned, the model is more like a trace-access model because confidence is read out directly from the stored validity of the cue that is used to infer the answer.

SCM, in contrast, assumes that people have little access to the validity of the mnemonic cues underlying metacognitive judgments—such as self-consistency, accessibility, familiarity and fluency—and are hardly aware of relying on these cues (see Koriat, Ackerman, Lockl, & Schneider, 2009). Indeed, the work on metacognition by memory researchers suggests that the processes underlying metacognitive judgments are much less analytic than is implied by PMM theory (e.g., Jacoby, Kelley, Brown, & Jasechko, 1989; Kornell et al., 2011). It is for this reason that the influence of cues such as mental effort and choice latency was discussed by Koriat and his associates (e.g., Koriat et al., 2006) in terms of *cue utilization*—the *actual* correlation between the cue and the judgment—rather than in terms of *perceived* cue validity.

The assumption that confidence judgments are based on contentless mnemonic cues receives support from the generality of SCM across different domains. Predictions from SCM were confirmed for a variety of tasks including general knowledge, word matching, perceptual judgments, social beliefs, and social attitudes. These tasks would seem to differ in the nature of the considerations underlying choice, but the results suggest that confidence in the choice is based on a structural cue—the agreement among the considerations that come to mind, irrespective of the content of these considerations.

Comparison With Other Models of Subjective Confidence

Let me now try to articulate the difference between SCM and some of the other models of confidence. It should be stressed that SCM in its present form is very Spartan in its assumptions in comparison with many other models of confidence judgments (see e.g., Dougherty, 2001; Juslin & Olsson, 1997; Vickers & Pietsch, 2001). Therefore, the comparison is general, emphasizing the basic features of SCM.

As noted earlier, SCM differs from many other models only in the specific conjunction of a few basic assumptions. This feature can be best illustrated using the conceptualization proposed by Juslin and Olsson (1997). They argued that qualitatively different models are needed to account for confidence in sensory discrimination tasks and confidence in general knowledge because sensory tasks are dominated by so-called Thurstonian uncertainty, whereas general-knowledge tasks are dominated by Brunswikian uncertainty (see also Dougherty, 2001; Vickers & Pietsch, 2001). SCM can be said to combine features of both types of models, and therefore makes similar predictions for perceptual and general-knowledge tasks as well as for other tasks.

Thurstonian uncertainty, according to Juslin and Olsson (1997), is characteristic of psychophysical tasks (e.g., a comparison between two weights) in which uncertainty stems from random noise in the nervous system. This noise occasionally results in incorrect responses, but the probability of a correct response typically exceeds .50. Because the variability is entirely random, little cross-person consistency or within-person consistency is expected in the tendency to make incorrect responses to a particular stimulus. Indeed, many models of confidence in psychophysical tasks incorporate the notion of random fluctuations that are due to internal noise (e.g., Audley, 1960; Merkle & Van Zandt, 2006; Vickers, 1970; for a review, see Baranski & Petrusic, 1998). According to

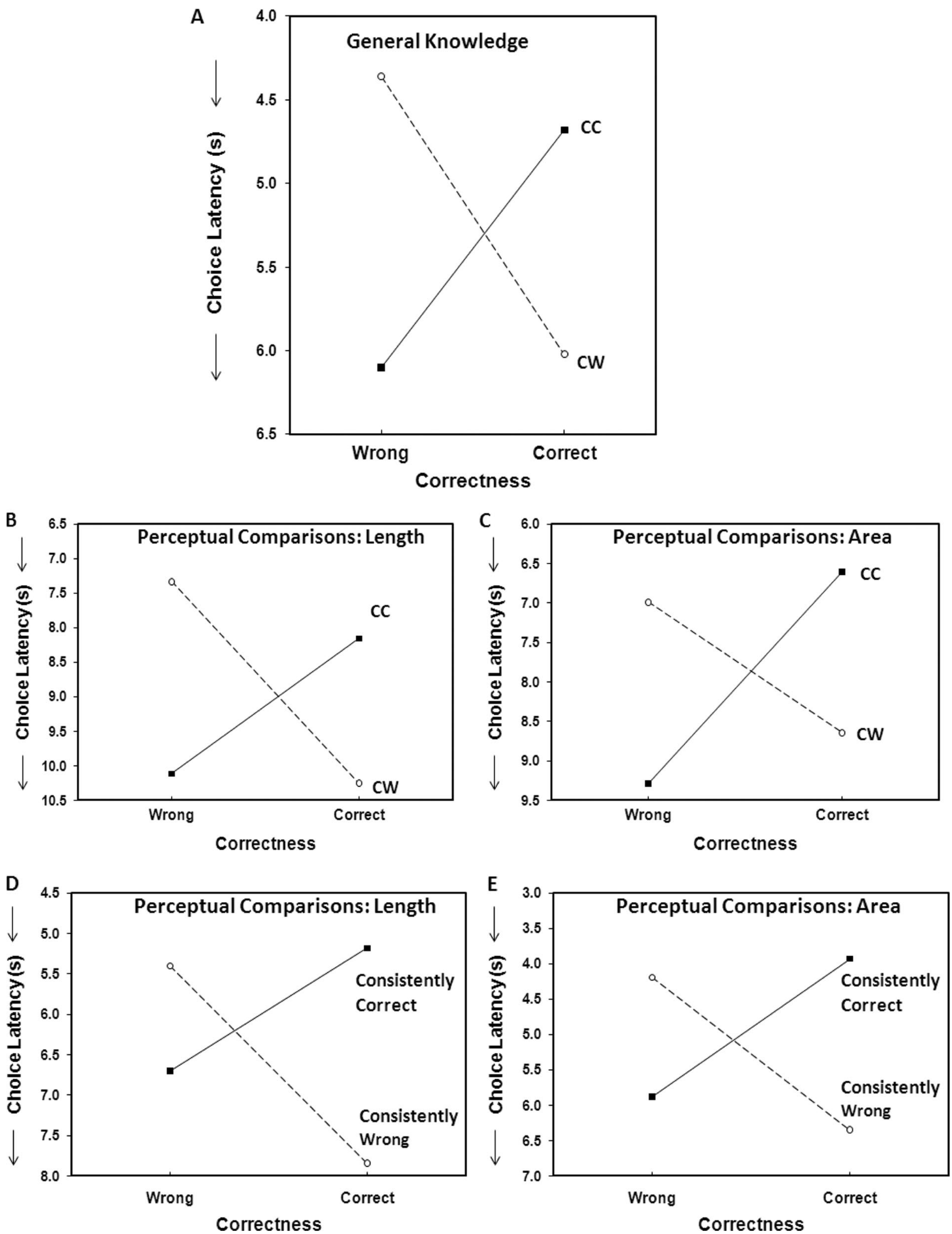

Figure 19 (opposite).

Juslin and Olsson, tasks dominated by Thurstonian uncertainty are expected to yield an underconfidence bias.

Brunswikian uncertainty, in contrast, was assumed to characterize general-knowledge tasks. For these tasks, the choice of an answer is based on inference from cues, and uncertainty stems from the limited validity of the cues that people use to infer the answer. Because participants have been exposed to the same associations between cues and events in the world, a between-participant correlation is expected in the proportion of incorrect answers to different items, and percent correct may vary across the full range from 0% to 100%.

SCM combines two basic assumptions that are part of the two classes of models. First, it incorporates the assumption of random variation. However, this variation is inherent in the sampling of a small number of representations on each occasion. Because of the limitations of the cognitive system, and the need to aggregate information across the sampled representations, the number of representations retrieved on each occasion must be relatively limited. It is assumed that the representations that come to mind on each occasion may differ depending on a variety of factors, resulting in variations in choice and confidence across participants and within participants. Such variations have been emphasized in theories of preference construction, which assume that preferences and judgments are constructed on the spot based on the information accessible at the time of elicitation (see Lichtenstein & Slovic, 2006).

Second, SCM also incorporates the assumption of within-individual and between-individual consistency in responding to the same items. This consistency was conceptualized in terms of the idea that in choosing an answer, participants sample representations from a population that is largely shared. It was proposed that this is true not only for general-knowledge and word matching tasks but also for perceptual tasks (Koriat, 2011) and for decisions involving beliefs and attitudes (Koriat & Adiv, 2011a, 2011b). Indeed, all of these tasks yielded within-person consistency and cross-person consensus in the choice made. For general knowledge, word matching, and perceptual judgments, the errors were correlated across participants so that for some items accuracy was significantly below 50%.

The combination of these two assumptions yielded the predictions that are unique to SCM. These predictions concerned differences in confidence between different types of *choices*. Consistent with SCM, systematic and marked differences were observed between consensual and nonconsensual choices and between frequent and rare choices across a variety of tasks.

Previous approaches to confidence judgments did not consider the possibility of such systematic differences. On the one hand, as noted, some models of confidence in simple sensory tasks incorporate the assumption of random sampling. However, these tasks, as noted correctly by Juslin and Olsson (1997), do not typically yield the kind of cross-person consistency that permits a principled separation between consensual and nonconsensual choices (independent of correctness). We observed such consistencies even for perceptual-comparison tasks (Koriat, 2011), but the tasks we used probably involve additional higher processing beyond sheer sensory encoding (Keren, 1988).

On the other hand, ecological (or Brunswikian) approaches to confidence have stressed inter-person consistencies in the probabilistic cues underlying judgments and confidence. These consistencies were seen to derive from the internalization of the statistical structure of the natural environment (see Dhami et al., 2004; Gigerenzer, 2008; Juslin, 1994). However, in these approaches, confidence is seen to reflect the perceived validity of a single cue that is used to distinguish between the two answers (Juslin, 1993; Gigerenzer et al., 1991), and it is unclear how the systematic differences between different choices can be explained.

With regard to the assumption of a "common knowledge" that is shared by all individuals, it should be noted that this assumption also underlies cultural consensus theory (Romney, Batchelder, & Weller, 1987; Weller, 2007) and the *wisdom of crowds* findings (see Surowiecki, 2005). Cultural consensus theory was motivated by the observation that when anthropologists study a new culture by presenting questions to informants, neither the correct answers to the questions nor the cultural competence of the informants is known. The theory, and its associated mathematical model, uses the pattern of agreement among members to extract an estimate of the shared knowledge as well as individual differences in cultural knowledge.

The *wisdom of crowds* findings, in turn, suggest that information that is aggregated across participants may be closer to the truth than the information provided by each participant. Thus, aggregating the estimates that are provided independently by different people generally yields an estimate that approximates very closely the true value (Galton, 1907; Mozer, Pashler, & Homaei, 2008; also see Wallsten, Budescu, Erev, & Diederich, 1997). Also, when the same person provides several estimates on different occasions, the aggregated estimate is more likely to be closer to the truth than any of the individual estimates so long as the noise contained in the individual estimates is at least somewhat independent (Herzog & Hertwig, 2009; Vul & Pashler, 2008). The *wisdom of crowds* principle was also confirmed for memory questions. For example, when participants were asked to reconstruct the order of events from memory, the aggregation of reconstructions across individuals yielded information that was closer to the truth than the data provided by any single individual (Miller, Hemmer, Steyvers, & Lee, 2009).

These results can explain the correlation between confidence and consensuality if the common wisdom is assumed to capture the

Figure 19 (opposite). Panels A presents mean choice latency for correct and wrong responses for Consensually Correct (CC) and Consensually Wrong (CW) items, based on the data of Koriat (2008b) on general knowledge. Panels B and C present the same data for perceptual comparison tasks. Panels D and E present mean choice latency for correct and wrong responses for Consistently Correct and Consistently Wrong items, based on the data from the two studies involving perceptual comparisons (see text for details). Panel A is adapted from "Subjective Confidence in One's Answers: The Consensuality Principle," by A. Koriat, 2008b, *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *34,* p. 951. Copyright 2011 by the American Psychological Association. Panels B–E are adapted from "Subjective Confidence in Perceptual Judgments: A Test of the Self-Consistency Model," by A. Koriat, 2011, *Journal of Experimental Psychology: General*, *140*, pp. 126, 128, 131. Copyright 2011 by the American Psychological Association.

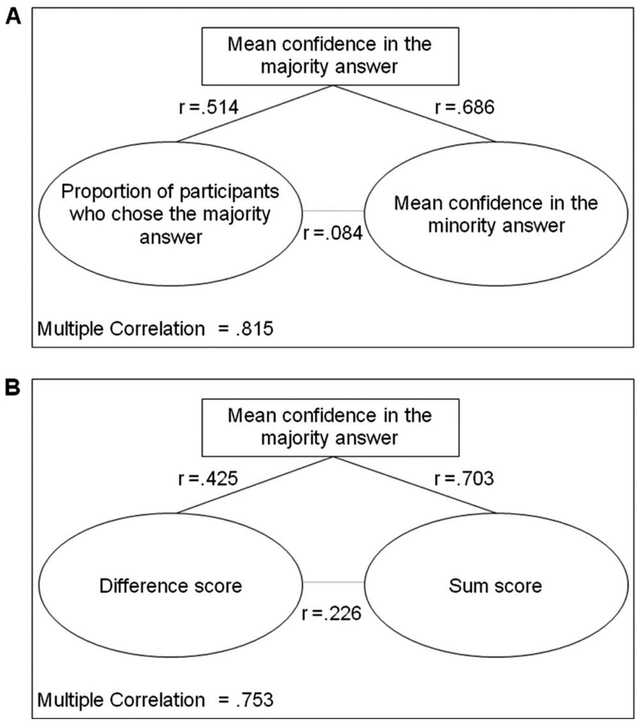

Figure 20. Intercorrelations between item properties across 104 items in Koriat (2008b). The multiple correlation refers to the prediction of mean confidence in the majority answer (in Koriat, 2008b). The predictors in Panel B are based on Koriat (2008c).

database from which most participants draw their samples in attempting to choose between two possible answers. The results also suggest that the commonly shared database tends to be largely biased in favor of the correct answer.

In sum, SCM shares with the Brunswikian approach the assumption of a common knowledge that is reflected in the cross-person consensus in choice, but it also incorporates the Thurstonian notion of a random sampling that may yield occasional deviations from that consensus. What is important is that confidence was shown to track both the stable and variable contributions to choice. The stable contributions are reflected in the systematic functions relating mean confidence to item consistency and item consensus. These functions are assumed to convey information about the populations from which representations are sampled. The variable contributions are disclosed by the systematic differences between majority and minority choices, which are assumed to convey information about the specific sample of representations underlying a particular choice (see Koriat & Adiv, 2011b).

Accuracy, Consensuality, and Self-Consistency

Let me turn now to a discussion of several general issues that emerge from the findings. The analyses presented in this article implicated three criteria with which confidence judgments can be compared: accuracy, consensuality, and self-consistency. The results of Koriat (2008b) as well as those reviewed in this article (see Figure 12) suggest that confidence judgments are correlated with the consensuality of the response and that the C/A correlation is a by-product of the confidence–consensuality correlation. SCM, however, assumes that confidence judgments monitor agreement with oneself rather than agreement with others so that both the confidence–consensuality correlation and the C/A correlation are by-products of the relationship between confidence and self-consistency.

The shift from consensuality (Koriat, 2008b) to self-consistency (the present article) has important implications regarding the theoretical status of agreement with others as distinct from agreement with oneself. The finding that one's confidence in an answer can be predicted quite strongly from the proportion of other participants who choose the same answer is actually in line with theories and findings in social psychology that suggest a *causal* relationship between social consensus and confidence. Several studies indicated that participants express greater confidence in their views when they learn that others share these views (Luus & Wells, 1994; Orive, 1988). Is it possible then that in our studies too perceived or actual agreement with others affects confidence judgments *directly*, as many social psychologists might contend?

This question can be addressed best with reference to Bassili's (2003) series of studies documenting the so-called "minority slowness effect." In these studies, people who hold the minority opinion were found to express that opinion less quickly than people who hold the majority opinion. Furthermore, the difference in response speed between the minority and majority opinions was found to increase as a function of the difference in the relative size of the minority and majority choices.

These results parallel closely those predicted and reported in this article with regard to choice latency for majority and minority responses (see Figure 18). However, Bassili's (2003) interpretation of his results attributes the effect to conformity pressures that cause subtle inhibitions in the expression of views that are not shared by others. That is, disagreement with others is assumed to play a *causal* role in the minority slowness effect. In contrast, SCM predicts a relationship between choice latency and confi-

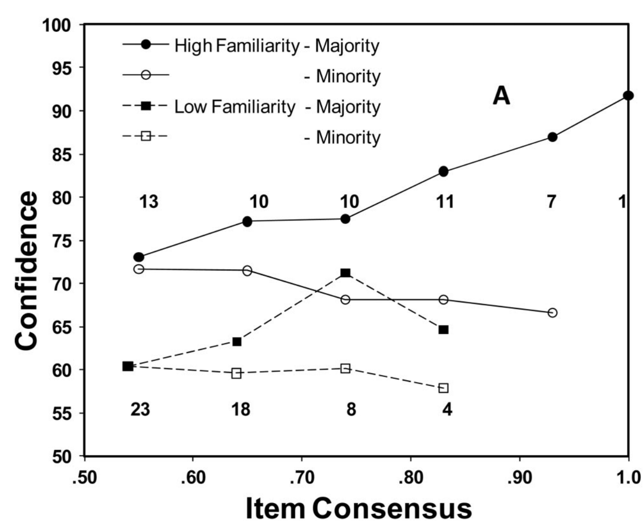

Figure 21. Confidence as a function of item consensus for majority and minority answers (in Koriat, 2008b) plotted separately for low-familiarity and high-familiarity items (defined on the basis of the results of Koriat, 2008c).

dence, on the one hand, and social consensus, on the other hand, independent of any direct influence of social consensus. The slower response time for minority responses (see Figure 17) is seen to derive from the lower self-consistency associated with minority samples, with no need to postulate an inhibition of expression of deviant views. Indeed, several findings lean toward the SCM interpretation of the minority slowness effect. First, the effect was also found for general-knowledge questions (see Figure 16) and for perceptual judgments (see Figure 18), for which the assumption of social pressure affecting an individual's judgment is not very plausible. Second, the effect was observed not only for response consensus but also for response consistency: Participants responded more slowly when their choice deviated from their own modal choice. Finally, the results of the simulation experiment (see Figure 15) yielded a minority slowness effect without attributing any causal role to agreement with others. Of course, it cannot be denied that conformity pressures might also cause some inhibition in the expression of deviant opinions.

The Appropriateness of Confidence Judgments: Monitoring Resolution

I turn next to the central concern in most studies of confidence judgments: the accuracy or "appropriateness" of these judgments. SCM attempted to account for findings pertaining to both resolution and calibration. In this section, I focus on resolution.

According to SCM, confidence judgments are not inherently accurate. Rather, participants are successful in discriminating between correct and wrong answers because correct answers are generally supported by a larger proportion of the representations that are considered when facing a 2AFC general-knowledge question. However, reliance on self-consistency may breed illusory convictions when the sampled representations favor consistently the wrong answer.

Several implications of this idea should be noted. First, whereas the focus on calibration has turned attention to systematic differences between *items*, the focus on resolution naturally draws attention to differences between different *choices*. Proponents of the ecological approach to confidence emphasized the importance of item selection and the need to sample items that are "representative" of their domain. SCM, in turn, suggests that choices can also be said to differ in representativeness—the extent to which the sample of representation on which they are based is representative of its parent population. Thus, previous studies that used so-called "deceptive" or "misleading" items (Brewer & Sampaio, 2006; Fischhoff, Slovic, & Lichtenstein, 1977) have pointed out that such items, which draw a high proportion of erroneous responses, tend to be associated with high confidence. SCM, in turn, indicates that a consensuality–confidence correlation also occurs across choices: For any given item, participants who chose the majority answer tend to make their choice faster and to express stronger confidence than those who chose the minority answer. In addition, when the same item was presented several times, confidence was higher for the more frequent choice than for the less frequent choice.

Second, the results speak to the challenge posed by Tulving and Madigan (1970): " . . . if there is ever going to be a genuine breakthrough in the psychological study of memory, . . . it will, among other things, relate the knowledge stored in an individual's memory to his knowledge of that knowledge" (Tulving & Madigan, 1970, p. 477). Indeed, the results reviewed in this article document a strong relationship between knowledge and metaknowledge, supporting the proposition that metaknowledge accuracy is a by-product of knowledge accuracy (see Koriat, 1993).

Finally, the results have implications for the concept of error in judgment and memory. Koriat (2008b) noted that so-called *deceptive* items had been characterized as items that induce not only a cognitive error (a tendency to choose the wrong answer) but also a metacognitive failure (a failure to realize that the answer is wrong; e.g., Brewer & Sampaio, 2006). However, in terms of SCM, there is nothing special about the process underlying confidence in "deceptive" or "tricky" items. The process underlying confidence in the choice of Sydney as the capital of Australia is the same as that underlying confidence in the choice of Paris as the capital of France. In fact, in trying to explain the reasons for people's extreme, unwarranted confidence in their answers to some of the "deceptive" items, Fischhoff et al. (1977) focused more on why people do not know (i.e., endorse the wrong answer) than on why people do not know that they do not know (inflated confidence). In retrospect, their focus is not inappropriate, because according to SCM, what makes people confident about an erroneous answer is what makes them choose that answer in the first place. Thus, at least as far as the effects of self-consistency are concerned, metacognitive errors are intimately linked to cognitive errors. A similar proposal was advanced by Dunning, Johnson, Ehrlinger, and Kruger (2003), who examined individual differences in performance on an exam. They noted that the skills needed to produce correct responses are virtually identical to those needed to evaluate the accuracy of one's responses. Therefore, poor performers are doubly cursed: They do not know and do not know that they do not know.

The Appropriateness of Confidence Judgments: Calibration

I turn next to calibration. Much of the work on calibration has focused on the overconfidence bias (Griffin & Brenner, 2004; Hoffrage, 2004). There is no question that this bias is considerably reduced when a representative sample of items is used (Gigerenzer et al., 1991; Juslin, 1993). What SCM offers is a specification of the conditions that may give rise to inflated confidence judgments, and a principled account of this inflation when it occurs. Needless to say, other factors besides those implied by the model can also affect the occurrence and magnitude of this bias (Metcalfe, 1998; Nickerson, 1998).

The overconfidence bias is assumed to follow from the basic assumption that confidence judgments rely on reliability as a cue for validity. Reliance on reliability—the consistency with which a choice is supported—may instill inflated confidence because reliability is practically always higher than validity. Indeed, although confidence judgments yielded an overconfidence bias when evaluated against correctness, these judgments were not markedly inflated when evaluated against several indexes of self-consistency. It should be stressed that the SCM account of overconfidence does not postulate a specific bias like the biases proposed in previous discussions (Koriat et al., 1980; Ronis & Yates, 1987; Taylor & Brown, 1988). Rather, the bias is assumed to stem from the very basis of confidence judgments.

Given that the overconfidence bias is reduced considerably when items are sampled randomly, why should non-representative, deceptive items be included in the experimental study of confidence? One reason has already been mentioned: These items help disentangle variables that go hand in hand in real life, and their inclusion helps in specifying the basis of metacognitive judgments. A second reason is no less important. If metacognitive judgments are based on the clues that come to mind, then what needs to be represented is not so much the probabilistic structure of the external environment but the structure and dynamics of the "internal ecology" (Koriat, 2008a). Marked differences may be expected between the two structures. First, the samples of information to which individuals are exposed are virtually never random. Fiedler (2007; see also Fiedler & Juslin, 2006) documented many biases in the selectivity of information to which people are exposed and argued that these biases alone can explain some of the biases that have been attributed to cognitive heuristics. Second, the clues that come to mind (the representations "sampled") are further constrained by many factors, including activations from recent, irrelevant sources, primed categories, and (of course) beliefs, attitudes, and motives. For example, Ross (1997) noted that in attempting to validate their recollection of a particular event, people may retrieve mnemonic cues (e.g., vivid details) to support the occurrence of that event but may find it difficult to retrieve such cues to support the decision that the event had not occurred. Consequently, rememberers may judge positive instances of remembering to be more credible than claims that an event did not occur. In addition, the information that comes to mind in responding to an item concerning a social belief or a social attitude is likely to differ for people with different systems of attitudes, motivations, and goals (e.g., Webster & Kruglanski, 1994). Consider, for example, a person with strong anti-Muslim attitudes. The fact that thinking about Muslims always brings to his/her mind memories of terrorist attacks does not prove that all Muslims are terrorists but may underlie and reinforce his/her conviction that such is indeed the case. Thus, the representative, random sampling of items that has been praised by some researchers is quite unrepresentative of the unrepresentative sampling of information that occurs as people attempt to reach a decision or judgment and to assess confidence.

Limitations of the SCM and Future Refinements

In this final section, I note some of the limitations of SCM. SCM is rather rudimentary even when it is supplemented with a self-terminating rule, but it was quite successful in generating predictions and in accounting for a large spectrum of observations. However, it is clear that the model does not capture the complexities of the processes underlying choice and confidence, so that further developments of the model may prove valuable.

SCM did not pretend to model the processes underlying choice itself, but to focus only on the *feedback* from these processes. This feedback was assumed to be rather crude, reflecting the feeling of coherence and agreement versus conflict and ambivalence. Thus, the process was conceptualized to involve the sampling of representations, with each representation making an independent contribution and all representations are of equal weights. Clearly, however this is an oversimplification. The question remains whether a model that assumes a richer feedback, and which takes into account the limitations of sampling information from within might improve predictions.

Perhaps some considerations or representations might be assigned greater weight than others in affecting confidence. Many models in decision making and psychophysics assume differential weights that affect confidence (e.g., Griffin & Tversky, 1992; McKenzie, 1997; Vickers, 1970). For example, Yonelinas (2001) reported evidence indicating that in a yes/no recognition memory test, recollection-based responses are endorsed with higher confidence than familiarity-based responses. The assumption of equal weights underlying SCM simplified greatly the derivation of predictions. However, perhaps different representations are assigned different weights in affecting confidence.

Related to this possibility is the idea that some answers and their associated strong confidence are based on a single, very strong consideration or on "direct retrieval" (Juslin, Winman, & Olsson, 2003; Metcalfe, 2000; Unkelbach & Stahl, 2009). Confidence in such answers might be accounted for if strength differences are taken into account, but perhaps the validation of these propositions involves a different process than that postulated by SCM.

Consider next sample size. When information is drawn from within, there are constraints on sample size that derive from two sources: the richness of the question (some questions do not allow the generation of too many representations) and the limitations of the cognitive system. The version of SCM that was adopted in this article assumed a fixed maximum sample size. However, in all likelihood, sample size is data-driven, dependent on the nature of the item, as suggested by the effects of accessibility on confidence (Koriat, 2008c). It might also differ for different persons and different conditions. It should be of interest to examine the factors that affect sample size (see Hourihan & Benjamin, 2010).

Another factor, as noted earlier, is that the "environment" from which representations are drawn differs systematically from the external environment. The *internal ecology* (Koriat, 2008a)—the effective population from which representations are drawn—possibly differs for different people depending on experience and personal inclinations. Two questions suggest themselves. First, what are the effects of such systematic biases on subjective confidence and its calibration and resolution? Second, what are the consequences of these differences for analyses in which the results are pooled across different subgroups?

A further factor still involves biases in the sampling process itself. Many discussions suggest that the sampling of representations from within is further constrained by a variety of factors. For example, research on the availability heuristic (Tversky & Kahneman, 1973) indicates some of the biases that occur in retrieving information from within. Personal inclinations as well as momentary activations can also affect the thoughts that come to mind (Clark, Wegener, Briñol, & Petty, 2009; Kelley & Lindsay, 1993; also see Fiedler, 2007, for a review).

Another way in which samples may depart from randomness is that different representations are possibly not independent. The associative nature of thought yields biases similar to those that seem to underlie primacy effects in impression formation. Having retrieved a representation with a given valence probably affects the likelihood of retrieving another representation with the same valence. Such a pattern has been assumed to contribute to an overconfidence bias that develops in the course of making a choice (Koriat et al., 1980) and may result in premature decisions.

A final factor is the stop rule used. In this article, SCM was supplemented with a stop rule (Run 3) that is quite arbitrary. But in all likelihood, the stop rule may differ depending on a variety of factors, such as personality (Webster & Kruglanski, 1994) and instructions (Baranski & Petrusic, 1998), and may also be dynamically adjusted depending on the specific item in question (Saad & Russo, 1996).

In sum, the factors just mentioned suggest some amendments and extensions to SCM. Their effects are worth investigating and may help in the refinement of the model. This refinement may also help in specifying the link between the processes underlying the choice of an answer and those underlying confidence in that answer.

In conclusion, the conceptualization presented in this article and the associated empirical findings open new and promising venues for the study of subjective convictions. In addition to clarifying the processes underlying accurate and illusory convictions, the present work brings within one theoretical framework several issues that have been studied traditionally in disparate areas of psychological research.

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Correction to Adelman (2011)

In the article "Letters in Time and Retinotopic Space" by James S. Adelman (*Psychological Review*, Vol. 118, No. 4, pp. 570–582), the link to access supplemental materials was missing. Supplemental materials are available at: http://dx.doi.org/10.1037/a0024811.supp. The online version of this article has been corrected.

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