Discriminating memories for actual and imagined taste experiences: A reality monitoring approach

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Blindfolded subjects tasted 4 common fruits and imagined the taste of 4 others while focusing on either a few (low sensory detail [SD]) or many (high SD) of the fruit's sensory qualities. One week later, subjects judged whether each of 12 fruit names represented a fruit that was previously tasted, imagined tasted, or new (reality monitoring). The major finding was a significant interaction between source (imagined, perceived) and SD level (low, high). Source monitoring was accurate for imagined and perceived fruits in the low SD condition and for perceived fruits in the high SD condition. As predicted, subjects tended to misattribute memories for imagined fruits to perception in the high SD condition. The findings are discussed with reference to the Johnson–Raye reality monitoring model and recent work on memory source confusions.

For many of us, the following scenario is all too familiar: You recall closing the garage door, but then wonder whether you really closed the door or only imagined you did. *Reality monitoring* is the term Johnson and Raye (1981) coined to describe the decision processes used to distinguish memories of actual experiences and memories of imagined experiences, and to explain why reality monitoring sometimes fails (see Johnson, Hashtroudi, & Lindsay, 1993 for a review of related research).

According to Johnson and Raye (1981), reality monitoring is influenced by two major factors: the qualitative characteristics of the memory trace and the decision strategies applied in evaluating the memory. The present study is concerned with the first of these factors and, specifically, with how increasing the similarity in the qualitative characteristics of memories for imagined and perceived experiences increases the difficulty of reality monitoring.

Assumptions of the reality monitoring model

According to the reality monitoring model, memories for perceived events typically include more perceptual, spatial, semantic, and affective information than do memories for imagined events (Johnson, Fo-

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ley, Suengas, & Raye, 1988; Johnson, Raye, Foley, & Kim, 1982), and memories for perceived events are more often associated with supporting memories (Suengas & Johnson, 1988). Memories for imagined events, on the other hand, typically include more information about the cognitive operations used to generate the memory. Cognitive operations are the reasoning, decision, and imagery processes engaged when the memory was originally established (Johnson & Raye, 1981). Previous studies have established that information about cognitive operations is an important cue that a memory probably originated with imaginal processes (Johnson, Raye, Foley, & Foley, 1981; Raye, Johnson, & Taylor, 1980). In addition, reality monitoring accuracy is improved by increasing the amount of cognitive operations associated with the generation of an imagined event (see, especially, Johnson, Kahan, & Raye, 1984; Johnson et al., 1981).

According to the Johnson–Raye reality monitoring model, the characteristic qualitative differences between memories for actual and imagined experiences are the basis for heuristics that often help a person differentiate memories for imagined and actual experiences (Johnson & Raye, 1981; Johnson et al., 1993). Heuristic judgments "involve criteria such as 'if the amount of perceptual detail exceeds X, the event was probably perceived'" (Johnson et al., 1993, p. 5). For example, you might decide that you closed the door by remembering sensory and perceptual details such as the touch of the remote control or the distinctive sound of the motor as the door drops down. Or you might decide that you merely imagined closing the door because your recollection includes little sensory or perceptual detail.

Factors contributing to memory confusions

In the present study, we were interested in the types of reality monitoring errors that can occur when a person confuses the sources of memories for perceived and imagined events, called internal/external source confusions by Johnson et al. (1993). These memory source confusions are especially common when the qualitative characteristics of memories for imagined or perceived events are highly similar, that is, when memories derived from internal or external sources are atypical of their class (see Johnson & Raye, 1981).

A memory of an imagined event is considered atypical of the class of imagined events if that memory includes very little information about cognitive operations. A number of studies have demonstrated that memories for imagined events that include little information about cognitive operations are likely to be misattributed to perception (see especially Finke, Johnson, & Shyi, 1988; Johnson et al., 1984; Intraub & Hoffman, 1992; Johnson et al., 1981; Kahan, 1996).

A memory of an imagined event would also be atypical if that memory included a great deal of sensory or perceptual detail (Johnson & Raye, 1981). A number of studies have demonstrated that memories for imagined events that include heightened SD are often misattributed to perception (Johnson, Foley, & Leach, 1988; Johnson, Raye, Wang, & Taylor, 1979; Kahan & Johnson, 1990; Kahan, 1996). For example, Johnson et al. (1988a) had subjects discriminate between words they heard and words they imagined hearing. When the subjects imagined themselves saying the words, they had little difficulty discriminating memories of the words they said and the words spoken by the experimenter. However, when the subjects imagined the words in the speaker's voice or in another voice, they tended to confuse the words they imagined and the words they heard. These source confusions presumably occurred because the memory for the imagined event contained auditory characteristics typical of actually hearing the words spoken.

Memory source confusions also have been explored with the visual modality (Finke et al., 1988; Johnson et al., 1979; Kahan & Johnson, 1990; Kahan, 1996). Across all of these studies, source confusions tended to be asymmetric; memories for imagined events were more likely to be misattributed to perception than were memories for perceived events likely to be misattributed to imagination (see Kahan, 1996, for a discussion of this issue). It is possible that the *pattern* in reality monitoring confusions is related to the particular sensory modalities highlighted by the experimental situation (Johnson & Raye, 1981).

EXPERIMENT

The purpose of the present study was to extend previous research on the reality monitoring model and memory source confusions to a sensory modality that had not previously been investigated: taste. Our aim was to increase subjects' tendency to confuse memories for perceived and imagined events by manipulating the number of SDs that subjects focused on while tasting common fruits.

Blindfolded subjects experienced one of two SD levels. In the high SD condition, the subjects focused on 10 sensory qualities during the actual or imagined tasting of particular fruits (e.g., texture, smell, weight, shape, and the sensation of handling the fruit). In the low SD condition, the subjects considered four sensory qualities of the fruit as they tasted or imagined the taste. Subjects actually tasted four fruits and imagined the taste of four other fruits, in one of two randomized orders. After each fruit was tasted or imagined, subjects evaluated the fruit's appeal on the dimensions of taste, smell, color, and texture. One week later, subjects were presented with the names of the fruits experienced in Session 1 intermixed with the names of four new fruits. For each fruit, subjects judged whether the memory was of a fruit that was actually tasted, imagined tasted, or new. This constituted our measure of reality monitoring. An imagery posttest was included that allowed us to statistically control for the subject's visual imagery ability (Johnson et al., 1979; Paivio, 1978).

In the low SD condition, subjects should have little difficulty discriminating memories for the imagined and perceived tastes because the memories for the perceived and imagined tastes should be typical of their class. The memories for the perceived fruits should be richly embellished with SD because the subjects actually tasted/smelled/touched the fruits in the perceived condition and only imagined these sensations in the imagined condition. Memories for the imagined tastes should also include considerable information about cognitive operations; subjects were instructed to imagine the taste experience as vividly as possible and they were given ample time to construct the imagined event. Thus, subjects should be able to discriminate memories from the two sources on the basis of the greater SD associated with memories of actual fruit tastes or on the basis of more information about cognitive operations associated with the memories for imagined fruit tastes.

In contrast to the low SD condition, the high SD condition should produce memories for imagined events that include an unusually high SD level; subjects were instructed to vividly imagine many different sensory qualities of the fruit, including smell, shape, texture, weight, color, and taste. The memories for imagined tastes should be more typical of memories for *perceived* events with respect to sensory information and, thus, likely to be misattributed to perception. Memories of imagined tastes should also include considerable information about cognitive operations. Thus, we might predict that subjects would be good at identifying the source of the memories of the imagined fruits in the high SD condition on the basis of increased information about cognitive operations (Johnson et al., 1981; Johnson et al., 1984). However, previous research on memory source confusions, using the auditory and visual modalities, suggests that if the cognitive operations engaged during the generation of memories for imagined events increase the sensory information preserved in memory for those imagined events, subjects will be inclined to misattribute these memories to perception (see especially Johnson et al., 1988a).

In sum, we expected more memory source confusions in the high SD than in the low SD condition. Furthermore, we predicted that memory source confusions in the high SD condition would be asymmetric; memories for imagined tastes should be misattributed to perception more often than memories for actual tastes are misattributed to imagination.

METHOD

Subjects

The subjects were 9 male and 27 female undergraduates (mean age 20) from Santa Clara University. Subjects from introductory psychology courses received credit toward a research participation requirement and subjects from upper-division courses received extra credit in their courses.

Materials

Four pairs of fruit were used and each pair contained similar fruits. The pairs were orange and tangerine, pear and green apple, red grapes and green grapes, and strawberry and raspberry. The pairs were chosen based on their similarity so that subjects did not determine the source of an event based on an inherent characteristic of a particular fruit, such as the skin of an apple versus the skin of an orange. Two stimulus sets were developed. For Set 1, one member of each fruit pair was randomly assigned to the imagined or the perceived condition; the other member of the pair was then placed in the other condition. For example, if the orange was randomly assigned to the imagined condition, the tangerine was assigned to the perceived condition. All fruit pairs were assigned to imagined and perceived conditions in this manner. The order of the fruits was then randomized with the restriction that no event (perceived or imagined) occur three times in a row. A second stimulus set was developed by reversing stimulus Set 1; fruits that were perceived in Set 1 were imagined in Set 2 and fruits that were imagined in Set 1 were perceived in Set 2. For example, in Set 1, the pear, orange, raspberry, and green grapes were eaten; therefore, in Set 2, they were imagined. Block randomization was used to assign an equal number of subjects in the low and high SD conditions to Set 1 and Set 2. Across subjects, each stimulus set occurred equally often, which ensured that a particular fruit was imagined and perceived an equal number of times in the low and high SD conditions.

A blindfold was used to prevent the subject from seeing the fruit. Flashcards with the names of the fruits printed on them (in black ink and size 24 font) were used to introduce the fruits. Rating sheets were constructed to assess the appeal of each fruit with respect to four characteristics (taste, smell, color, and texture) using a five-point scale (1 = not appealing, 5 = most appealing). The rating exercise was intended to encourage the subject to take the experimental task seriously and to attend to each fruit.

Four color stimuli were used for the imagery test: mauve, brown, green, and purple. A color chip was made for each color by printing one shade of the color on a 4″ × 6″ index card. A corresponding color spectrum was prepared on a separate card. The spectrum card included 10 shades of the target color, ordered (left to right) from the lightest to the darkest hue.

Design and procedure

A 2 × 2 × 2 mixed design was used, with two SD levels (low, high), two event sources (imagined, perceived), and two stimulus sets (1, 2). The SD level and the stimulus set were varied between subjects and event source was varied within subjects. The SD level was manipulated via instructions to subjects. The dependent measures were source monitoring accuracy (identifying the source of memories as perceived, imagined, or new) and overall recognition accuracy (discriminating fruits as old or new, without regard to source).

The experiment involved two sessions, 1 week apart. Session 1 averaged 25 min and session 2 averaged 10 min. Experimenters wore latex gloves throughout Session 1. Fruit to be tasted was thoroughly washed and dried before the session. The experimenter also peeled the orange (or tangerine) immediately before presenting it to the subject. In Session 1, the subject entered a lab room (6′ × 8′), was greeted by the experimenter, and was asked to read and sign the consent form. The subject was told that the purpose of the experiment was to determine to what extent imagination enhanced the taste of foods, and that the results would help researchers interested in how to facilitate weight loss. The subject was given a blindfold and told to wear it at all times unless instructed to do otherwise.

For each event, whether imagined or perceived, the subject first viewed a white 4″ × 6″ index card with the name of the fruit printed on it, such as *green apple* or *tangerine*.[1] The subject then put on the blindfold and listened to the instructions that declared whether he or she was to imagine the taste of the fruit or to taste it. If the subject was to taste the fruit (e.g., a green apple), it was placed in front of him or her on a napkin, and the instructions began with "Here is a green apple. I want you to visualize it. Now, pick it up." In the imagined event, the subject's instructions began with, "I want you to visualize a green apple. Now imagine picking it up." In the high SD condition, the orienting instructions then focused subjects on a total of 10 different SDs of the fruit-tasting experience and included having the subject taste (or imagine tasting) the fruit twice. The SDs were, in order, the fruit's appearance, color, feel in the hand, shape, smell, weight, first taste, texture, feel in the mouth, second taste, and appeal of the taste. In the low SD group, subjects focused on four SDs (after picking up the fruit): the fruit's appearance, smell, taste, and appeal of the taste.[2] Approximately the same amount of time was spent per fruit in the low SD and high SD groups. After each fruit, the subject lifted the blindfold and completed the rating task.

Subjects rated the appeal of the fruit with respect to taste, smell, color, and texture, using a five-point scale (1 = not appealing, 5 = most appealing). For example, if the subject liked the taste of the pear very much, he or she circled 5. After rating the characteristics of the imagined or perceived fruit, the subject took a sip of water to take away possible carryover tastes of the fruit. Then, the card with the next fruit name was presented, and the subject was instructed to lower his or her blindfold. This procedure was repeated for all eight fruit events. After the fourth fruit, the subject was given a filler task that asked, "What is/are your favorite sport(s) to watch or to participate in?" This task both gave subjects a short break (1–2 minutes) and prevented rehearsal of the events during the break. The remaining four fruit events followed. The session concluded with our thanks and a reminder of the next session. Subjects were unaware that Session 2 would involve a memory test.

In Session 2, 1 week later, the subject's source monitoring abilities were tested. The cards with the fruit names presented in Session 1, plus four cards with new fruit names, were used. The new fruits were blueberry, red apple, plum, and cherry. These were chosen because they were thought to be common fruits similar to the eight used as target events in Session 1. The order of the 12 cards was randomized, with the restriction that none of the new fruits succeed each other. The subject was told that a memory test of the first session was going to be given. After each card, the subject received a small piece of paper that instructed him or her to decide whether he or she had tasted the fruit, whether he or she had imagined the taste of the fruit, or whether the fruit was new, and to circle the corresponding word (perceived, imagined, or new). The subject was given time to think before answering, but was not allowed to change his or her answers.

Following the source monitoring task, the subject described, in writing, *how* he or she determined his or her responses in the source monitoring task. Finally, the subject was given a test of visual imagery. A color chip was presented for 3 s. The subject closed his or her eyes and visualized the color for another few seconds. Next, the subject was shown a color spectrum of 10 shades and was asked to identify the color he or she remembered seeing and visualizing. Subjects were tested on their imagery abilities using four colors: mauve, brown, green, and purple. A subject's imagery score was determined by assessing how close his or her answers on the spectrum were to the target shades. Imagery scores were entered as a covariate in each of the data analyses reported next.

RESULTS

Visual imagery ability

An imagery score was calculated for each subject. For each of the four color stimuli, the subject's choice of which color on the color spectrum matched the previously viewed color was translated into a number representing the number of spaces to either side of the correct shade the subject selected (range was 0 [perfect match] to 3). The subject's scores for the four color stimuli were then averaged. Table 1 presents the mean imagery scores.

ANOVA was used to determine whether the subjects' mean imagery scores varied across the low and high SD groups and the two stimulus

Table 1. Mean imagery scores for subjects in relation to level of sensory detail (SD) and stimulus set

	SD		
Stimulus set	Low SD	High SD	[Marginal]
1	1.30	2.08	[1.69]
2	1.25	1.42	[1.34]
	[1.28]	[1.75]	

Note. The possible range of means was 0 to 3; higher means indicate lower accuracy in the memory for color imagery task.

sets. The analysis revealed a marginally significant effect of SD level, $F(1, 35) = 3.51$, $MSE = 2.04$, $p = .07$. Imagery scores tended to be higher (poorer performance on the imagery task) for subjects in the high SD group ($M = 1.75$) than for subjects in the low SD group ($M = 1.28$), $F(1, 35) = 3.51$, $MSE = 2.05$, $p = .07$. Imagery scores did not vary with stimulus set and the interaction between SD and stimulus set was not significant, $ps > .10$. To control for possible correlations between imagery ability and our primary dependent measures, each subject's imagery score was entered as a covariate in the analyses reported here.

Recognition

For each subject, a proportion was calculated as our index of old/new recognition. The number of perceived and imagined fruits judged *either* perceived or imagined (correct recognition of old events) plus the number of new fruits identified as new (correct rejection of new events) was divided by the total number of items presented during the source monitoring task ($N = 12$). Analysis of covariance (ANCOVA) was used to evaluate the effect of the two between-subject variables (SD level and stimulus set) on the mean proportion of correct recognition of fruit names. Each subject's imagery score was entered in the analysis as a covariate to control for visual imagery ability. Subjects' old/new recognition was highly accurate and was not influenced by the SD level or by the stimulus set, $ps > .10$ (see Table 2).

Source monitoring of perceived and imagined events

Our primary interest was in subjects' accuracy in identifying the source of memories for the perceived versus the imagined fruits as a function of the SD manipulation. Therefore, two proportions were calculated for each subject. First, a measure of accurate source monitoring for perceived events was calculated as follows: The number of perceived items correctly identified as perceived was divided by the number of perceived items that were correctly recognized (perceived items that were judged either perceived or imagined): [P | P] / [P | P + I | P].

Table 2. Mean proportion correct old/new recognition as a function of level of sensory detail (SD) and stimulus set

	SD		
Stimulus set	Low SD	High SD	[Marginal]
1	.97	.91	[.94]
2	.91	.90	[.91]
	[.94]	[.91]	

We calculated a similar proportion for imagined items: The number of imagined items correctly identified as imagined was divided by the number of imagined items that were correctly recognized (imagined items that were judged either imagined or perceived): [I | I] / [I | I + P | I].

ANCOVA was used to analyze the mean proportion correct source identification as a function of the within-subject variable (source: perceived, imagined) and the two between-subject variables (SD: low, high; stimulus set: one, two). Subjects' imagery scores were again entered as a covariate to control for imagery ability.

Our major finding was the significant source × SD interaction effect on subjects' ability to discriminate memories for fruits that were actually tasted and fruits that were imagined tasted, $F(1, 32) = 6.83$, $MSE = .02$, $p = .01$ (see Figure 1). Source monitoring of perceived items did not differ for the high SD (.79) and low SD (.85) conditions, $p > .05$, whereas source monitoring of imagined items was less accurate in the high SD (.57) than in the low SD (.80) condition, $F(1, 35) = 8.22$, $MSE = .33$, $p = .007$. For subjects in the low SD group, source monitoring accuracy was

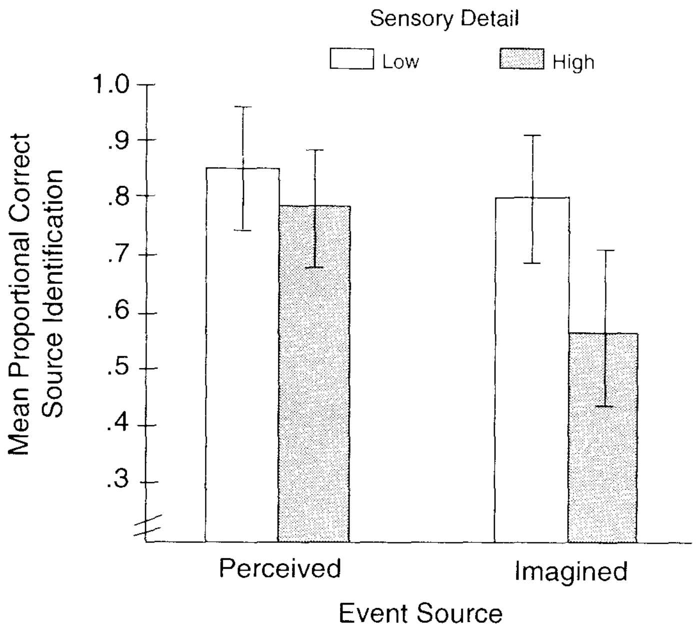

Figure 1. Source monitoring of memories for perceived and imagined taste experiences as a function of level of sensory detail. Error bars indicate the 95% confidence interval for the means

similar for perceived ($M = .85$) and imagined ($M = .80$) fruits, $p > .05$. For subjects in the high SD group, fruits that were perceived were more often attributed to the correct source ($M = .79$) than were fruits that were imagined ($M = .57$), $F(1, 17) = 23.03$, $MSE = .02$, $p = .0001$.

The two-way SD × stimulus set interaction was also significant, $F(1, 31) = 5.53$, $MSE = .32$, $p = .03$. The difference in source monitoring accuracy between subjects receiving stimulus Set 1 and those receiving stimulus Set 2 was greater for subjects in the high SD group than for subjects in the low SD group.[3]

The accuracy of source monitoring also depended on the stimulus set, $F(1, 31) = 9.26$, $MSE = .54$, $p = .005$. In general, source monitoring was better for subjects assigned to Set 1 ($M = .83$) than for subjects assigned to Set 2 ($M = .68$). Finally, the source monitoring accuracy was generally higher for perceived fruits ($M = .82$) than for imagined fruits ($M = .69$), $F(1, 32) = 15.58$, $MSE = .33$, $p = .0001$.

Neither the source × order interaction nor the three-way interaction (source × SD × stimulus set) was significant, $ps > .10$.

Analysis of false positives

We also analyzed subjects' responses to the new items to determine whether there was a bias to respond either imagined or perceived when new items were misidentified as having occurred (false positives). This analysis addressed the question of whether subjects' tendency to misidentify imagined items as perceived, as was observed in the high SD condition, was possibly caused by a general bias to respond "perceived" when the subject judged an item's source.

For each subject, two proportions were calculated: the proportion of new items ($n = 4$) judged imagined and the proportion of new items judged perceived. ANOVA was used to analyze the mean proportion false positive responses as a function of one within-subject variable (judgment: perceived, imagined) and two between-subject variables (SD: low, high; stimulus set: 1, 2).

Subjects' tendency to misjudge new items as imagined or perceived interacted with the SD level, $F(1, 32) = 3.96$, $MSE = .09$, $p = .05$. For the low SD condition, subjects were more likely to misjudge new items as having been imagined ($M = .17$) than as having been perceived ($M = .04$), $F(1, 17) = 9.00$, $MSE = .02$, $p = .008$. For the high SD condition, subjects were no more likely to misidentify new items as imagined ($M = .08$) than as perceived ($M = .10$), $F(1, 17) = .06$, $MSE = .03$, $p = .80$.

Overall, subjects were no more likely to claim new items had been perceived ($M = .07$) than to claim new items had been imagined ($M = .12$), nor did the false positive rate differ with SD level (high, low) or across stimulus sets (1, 2), $ps > .10$.

Subjects did evidence a bias to respond "imagined" to new items, but only in the low SD condition. There is a chance that this response bias could have contributed to the consistently accurate source monitoring observed in the low SD condition. A bias to respond "imagined" could have reduced the source monitoring accuracy associated with perceived items and elevated the source monitoring accuracy associated with imagined items. However, the source monitoring accuracy of perceived items did not differ across the low and high SD conditions, suggesting that the source monitoring accuracy of perceived items in the low SD condition was probably not depressed by a response bias to say "imagined." The fact that subjects were not biased to misjudge new items as perceived in the high SD condition indicates that the source monitoring confusions observed for imagined items in the high SD condition were not the result of a general bias to respond "perceived."

DISCUSSION

As predicted, there were more source confusions under the high SD condition than under the low SD condition, and source confusions were asymmetric; memories for the imagined tastes were more susceptible to source confusion than were memories for actual tastes (see Figure 1). Subjects in the high SD condition often claimed they had actually tasted the fruits that they had only imagined tasting, whereas subjects were not prone to misattributing their memories for actual tastes to imagination.

Discussion of findings in relation to the Johnson–Raye reality monitoring model

The Johnson–Raye reality monitoring model provides a framework for understanding our pattern of results. First, how does the reality monitoring model account for the accurate discrimination of memories for perceived and imagined events under the low SD condition? Here, subjects were asked to focus on only four sensory qualities while they imagined the taste of, or actually tasted, the various fruits. Memories for the perceived tastes would include a high level of sensory information because the subjects actually tasted/smelled/touched the fruits and simply imagined these sensations in the imagined condition. Thus, subjects could discriminate memories for the actual and imagined tastes on the basis of class-characteristic differences in sensory information preserved in memory. In addition, memories for the imagined tastes should include considerable information about cognitive operations because subjects were instructed to vividly imagine the taste experience. Later, subjects could discriminate memories for the actual and imagined tastes on the basis of these class-characteristic differences in information about cognitive operations. In short, the results for the low SD condition are consistent with Johnson and Raye's (1981) proposition that, typically, reality monitoring accuracy will be high when memories for imagined and actual experience differ in class-characteristic ways (also see Johnson et al., 1993).

Second, how does the reality monitoring model account for the accurate source identification of perceived events but source confusion for imagined events under the high SD condition? Here, subjects focused on 10 sensory qualities as they imagined the taste of, or actually tasted, the various fruits. Based on the Johnson–Raye (1981) reality monitoring model, the resulting memories for the imagined tastes should include an unusually high SD level, more typical of perceptual experience than of imagined experience. Later, when subjects were asked to reason about the source of their memories for the taste experiences, the memories for the imagined tastes probably included so much SD that subjects were inclined to claim they had actually tasted fruits they had only imagined tasting. Memories for the actual tastes were accurately attributed to perception on the basis of class-typical SD information.

As discussed previously, the memories of the imagined tastes should also include considerable information about cognitive operations, as is typical of memories of imagined experience (Johnson & Raye, 1981; Johnson et al., 1993). This information about cognitive operations should later serve as a cue that the memory originated with imagination. However, the present findings clearly suggest that subjects were relying more heavily on sensory information than on information about cognitive operations when judging the source of the memory. This is consistent with Johnson et al.'s (1993) claim that different dimensions or qualities may be weighted differently when subjects are asked to identify the source of particular memories.[4]

It is possible that subjects used both sensory information and cognitive operations information when they judged the source of the taste memories, but that the information about cognitive operations did not provide a useful cue that the memory originated with imagination.

Certainly, increased cognitive *effort* associated with the imagined events could have provided a useful cue that the event originated with imagination (Finke et al., 1988; Johnson et al., 1981). However, although generating more SDs (high SD condition) may require more cognitive operations than generating fewer SDs (low SD condition), there is no clear theoretical basis for claiming that generating more SDs is more *difficult* (effortful). Even if generating the imagined experience required more cognitive effort in the high SD condition, the results imply that these operations served primarily to increase the salience of the SDs, rendering the imagined experience more like a typical perceptual experience. As a result, the memories for the imagined events were susceptible to later confusion with memories for similar, actual experience (also see Kahan, 1996).

Another reason that information about cognitive operations may not have provided a useful cue as to the source of the memories for imagined tastes was that the orienting instructions did not call the subject's attention to the process of generation per se. In other words, the subjects were not compelled to add their own (metacognitive) analysis of the experience in which they noted that the event was imagined. The subjects did not know that later they would be asked to identify the source of their memories for the fruit events, so there was no reason for the subjects to intentionally add a metacognitive analysis (e.g., "Here I am imagining the taste of red grapes; now I'm imagining how the grapes smell and I notice I find this difficult"). That type of cotemporal thought could have provided a useful cue that the event originated with imagination (e.g., Johnson et al., 1988b; Johnson & Raye, 1981).

In the present study, the greater SD level apparently did more to make the imagery less distinguishable from perception than greater cognitive operating did to make it more distinguishable.

SUMMARY AND CONCLUSIONS

Our results indicate that memories for imagined events are especially likely to be misattributed to perception when memories of imagined and actual events are highly similar in SD, even when the memories of imagined events may include considerable information about cognitive operations.

Future research should investigate whether reality monitoring accuracy is improved if the cognitive operations engaged during the encoding of an imagined experience focus a subject on *both* the SDs of the experience (which would help tag the event as having been perceived) and the metacognitive processes associated with the activity of imagining (which could help tag the event as having been imagined).

The present study also adds to the accumulating evidence that memory source confusions are typically asymmetric; we are more likely to claim that something we imagined actually happened than vice versa (also see Johnson et al., 1993, pp. 11–12). Whereas previous studies used the auditory modality (Johnson et al., 1988a) or the visual modality (Durso & Johnson, 1980; Finke et al., 1988; Kahan, 1996), the present study extends this principle to the taste modality.

This work has direct implications for false memory syndrome and eyewitness testimony. If one embellishes an imagined experience with a lot of SDs, as often happens in the guided reconstruction of an event during psychotherapy or eyewitness testimony, the resulting memory may be especially susceptible to misattribution to actual experience (also see Dobson & Markham, 1993; Loftus, 1979). One may have an unreliably high degree of confidence in the veridicality of memories for imagined experience when those memories include many SDs, the person does not explicitly remember having imagined the event, and memory for source is tested after a substantial delay.

Notes

The research reported in this article is an extension of an earlier study conducted by Raania Mohsen, Jeanette Tandez, and Jennifer McDonald under the supervision of Tracey Kahan. Some of the results of the present study were reported by Raania Mohsen and Tracey Kahan at the annual meeting of the Western Psychological Association, April 1996.

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1. We introduced each fruit with the name of the fruit printed on a card in order to make the name of the fruit comparably salient for imagined and tasted fruits, ensure that the subjects attended to the fruit's name, and systematize the presentation of the fruit names for the subsequent reality monitoring test. Fruits could have been identified verbally, but we felt that there was a greater risk of inattention and misunderstanding of the fruit name with an auditory presentation.

2. In the low SD group, the orienting instructions focused subjects on only 4 sensory qualities of the fruit. The rating task, which subjects completed after tasting (or imagining the taste of) a fruit, required subjects to rate 2 qualities that had not been included in the orienting task: color and texture. Thus, the low SD group would have considered a total of 6 sensory qualities of each fruit over the course of the orienting and rating task, in comparison with the 10 sensory qualities considered by the high SD group. Therefore, across the orienting and rating tasks, the total number of sensory qualities considered by the high SD and low SD groups was 10 and 6, respectively.

3. We have no logical explanation for why the Set 2 fruits that were imagined under the high SD condition should be more confusable with the fruits that were actually tasted than were the Set 1 fruits. (Subjects who experienced stimulus Set 2 tasted a strawberry, a tangerine, a green apple, and red grapes. These same subjects imagined the taste of an orange, a raspberry, green grapes, and a pear. For subjects assigned to stimulus Set 1, the fruits that were tasted/imagined were the reverse of Set 2.) The two stimulus sets occurred equally often across low

and high SD groups; thus, stimulus set was not confounded with SD level. Although stimulus set interacted with SD level, Set 2 fruits that were imagined under the low SD condition were *not* more likely to be misattributed to perception than were Set 1 fruits. Most important, SD was the only variable with which the source factor (imagined, perceived) interacted. The three-way interaction (SD × source × stimulus set) was not significant and the two-way interaction between SD (low, high) and event source (perceived, imagined) held for *both* stimulus sets. Thus, differences in source monitoring for perceived and imagined fruits cannot be accounted for by the effect of stimulus set.

4. The informal results from the postexperimental interview, in which subjects were asked to describe briefly how they decided whether a target event originated with perception or imagination, also suggest that subjects were relying heavily on sensory information during the source monitoring task. Seventy-one percent of the subjects in the low SD condition and 75% of the subjects in the high SD condition mentioned using information about how the fruit tasted or felt to identify the memory's source. In both the low and high SD conditions, 20% of the subjects mentioned basing their judgments on other sensory qualities of the fruit experiences (e.g., color and smell), and the remaining 5% mentioned using semantic qualities of the memories or extended reasoning to identify the source.

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