When Photographs Create False Memories

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ABSTRACT—*Photographs help people illustrate the stories of their lives and the significant stories of their society. However, photographs can do more than illustrate events; in this article, we show that photographs can distort memory for them. We describe the course of our "false-memory implantation" research, and review recent work showing that photographs can sometimes increase—while other times decrease—false memories. First, we discuss research showing that a doctored photo, showing subjects taking a completely fictitious hot-air-balloon ride, can cultivate false memories for that experience. We hypothesize that the photograph helps subjects to imagine details about the event that they later confuse with reality. Second, we show that although photographs are indeed powerful sources of influence on memory, they are not necessarily as powerful as narrative. In fact, in certain circumstances, photographs might constrain imagination. Third, we discuss research showing that true photographs can also cultivate false memories. Finally, we present recent work showing that photographs can create false memories for current events.*

KEYWORDS—*memories; false memories; photographs*

Memory is the way we keep telling ourselves our stories, said the writer Alice Munro. People tell their stories in words and pictures; they write letters, pull out childhood photo albums at family reunions, and talk about what happened when, where, and to whom. Sometimes people are told stories by others—socially significant, newsworthy stories in the paper or on television. Whether they are the stories of individual lives or of society as a whole, important stories are often illustrated with photographs, which give the imprimatur of authenticity. In this paper, we review the research showing that photographs can create false stories. Photographs can distort memory.

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A decade ago, Loftus and Pickrell (1995) showed how easily people can be led to remember wholly false events. They asked subjects to read stories of some childhood events, one of which described each subject getting lost in a shopping mall. That event was false, but by the end of the study, 25% of subjects falsely remembered at least some details about it. In the scientific community, the paradigm has proven both popular and powerful, with nine similar narrative-based studies showing a mean false recall of 33% (see Garry & Wade, 2005, for a brief review).

Considered as a whole, research using this "lost in the mall" paradigm shows us how easy it is to implant false memories using remarkably simple technology. Yet we live in a world of increasingly sophisticated technology. For example, not so long ago, only Hollywood studios and advertising agencies had the skill and the equipment to doctor photographs. These days, it seems that everyone has a digital camera and image-editing software. While it may seem like harmless fun to airbrush an annoying ex out of a photo or to cobble together a photo of little Theo meeting his favorite action figure, recent evidence suggests that doctored photos can doctor memory, too.

FALSE PHOTOGRAPHS AND FALSE MEMORIES

"It isn't trustworthy simply because it's a picture," the photographer Pedro Meyer told *Wired* magazine. "It is trustworthy if someone we trust made it" (Rosenberg, 1995, p. 171). Meyer is right, of course—yet people do trust photos. People think they reliably capture the past. Yes, they may know that photographs can be doctored, and they may not trust the famous, allegedly doctored photo of Lee Harvey Oswald holding a rifle in his backyard,[1] but they still think their personal photographs are real. What might be the power of a doctored childhood photograph on memory?

To answer this question, Wade, Garry, Read, and Lindsay (2002) adapted the Loftus and Pickrell (1995) "Lost in the mall"

[1]This photograph is widely available on the Internet; for example, at John McAdams' JFK Assassination Home Page: http://mcadams.posc.mu.edu/photos.jpg

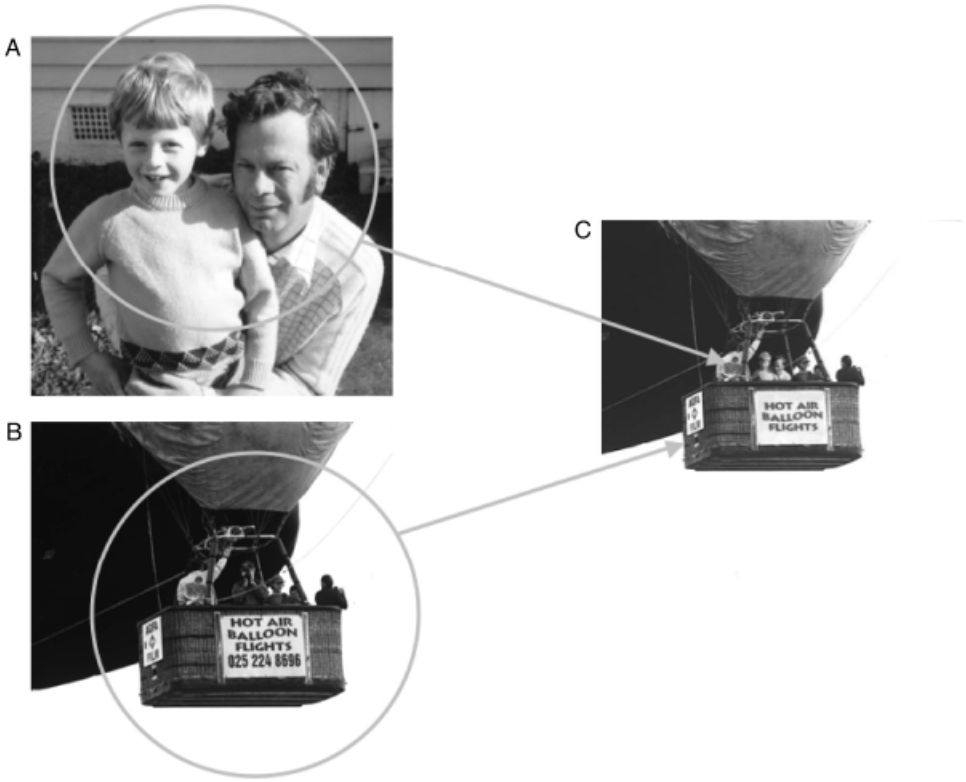

Fig. 1. Demonstration of the doctoring process as used in Wade et al. (2002). Subjects are ''cut'' from an original photo (A) and ''pasted'' into a dummy balloon photo (B). Subjects are shown the false photo (C) and asked how much they remember about the event over three interviews.

method, but replaced narratives with photographs. The question was simply whether showing subjects a doctored photograph—with no supporting narrative—would lead them to remember a false experience. They showed each subject four photos: Three were real childhood photos and one was fake, showing the subject taking a childhood hot-air-balloon ride. The doctored photos were created for each subject by using Photoshop and an assortment of additional childhood photos. Wade et al. "cut" the subjects and at least one family member out of these additional photos and "pasted" them into a dummy photo of a hot-air-balloon ride (see Fig. 1). Family-members verified that the balloon ride never happened. After subjects reviewed each photo three times over a maximum of 2 weeks, 50% remembered something about the ride. Often these reports were rich with detail, and at the end of the study, subjects tended to express genuine astonishment when they learned the photo was a fake.

Wade et al. (2002) speculated that photographs might give subjects some kind of cognitive "springboard," allowing them to generate thoughts, feelings, details, images—the hallmarks of genuine memories—more easily than is possible than with verbal descriptions. Subjects confused these mental products for genuine experience, a process called *source confusion* (Johnson, Hashtroudi, & Lindsay, 1993). In fact, the comparatively high rate of false recall led them to wonder which medium is better at cultivating false memories: photos or narratives? To answer this question, Garry and Wade (2005) combined the methods of Loftus and Pickrell (1995) and Wade et al. (2002) such that half the subjects saw a photograph of themselves taking a balloon ride while the other half read a description of the same false event. To make sure the description and the photo conveyed the same information, other researchers were asked to extract all the information they could from the balloon photo and use that information to create the narrative. By interview three, 80% of the subjects who read a false narrative reported memories of the event, compared to 50% of those subjects who saw a false photo. Moreover, when subjects were asked whether photographs or narratives were better at "jogging" their memories during the study, there was an interesting interaction: Narrative subjects said that photos were better memory joggers, while photo subjects said that narratives were better memory joggers.

Taken together, these studies suggest that photos alone are powerful enough to elicit false memories on their own but that they are not necessarily more powerful than narratives. In fact, they might be less powerful than narratives. If, as Wade et al. (2002) hypothesized, photographs do make it easier for people to imagine—and then come to believe—the false event depicted, then how do we account for Garry and Wade's (2005) finding that narratives actually elicited more false memories than photographs? The answer may lie in the fact that the photo provided a concrete visual depiction of the balloon ride, making it more

difficult for subjects to construct information about the trip. While narratives allowed subjects to generate their own details about their balloons, the detail in the false photographs demanded that subjects generate details about the experimenters' balloon. Thus, subjects who saw the photograph would have found it more difficult to produce information they later might take to be a real memory.

TRUE PHOTOGRAPHS AND FALSE MEMORIES

The fact that doctored photographs can elicit false memories does not help explain situations in which there is no real attempt to mislead. For example, it does not say much about whether there are dangers in looking at real family photos. However, a common psychotherapeutic technique directs clients to look at real photos so that the people, places, and experiences captured in them will jog memories of previously unremembered traumas (Dolan, 1991; Weiser, 2002).

Concerns about these techniques led Lindsay, Hagen, Read, Wade, and Garry (2004) to examine the effect of a real photograph to cultivate a false memory. Using a variation of the "lost in the mall" method, they asked subjects to remember three school experiences. Two of the experiences were real, and one was false; the false event described the subject putting Slime (the goopy green children's toy) into the teacher's desk drawer. All the subjects read a description of each event, and half also saw their real class photo to "help" them remember. While slightly fewer than half of the description-only subjects developed mental images of the Slime story or full memories, over 70% of the photo subjects did. These results show that even true photos can lead people to remember false events.

PHOTOGRAPHS AND MEMORY FOR THE MEDIA

In 2004, Britain's *Daily Mirror* newspaper published photos showing soldiers torturing Iraqi prisoners—photos the paper claimed to have received from other soldiers. Although accusations of such abuse were widespread, the photos were taken as proof that they were true. But the British Armed Forces noted a number of dubious details in the photos: They showed a vehicle never sent to Iraq, the prisoners looked too neat to have been beaten, and a trail of urine aimed at a prisoner by a soldier seemed to have had detail and shadows added to it. In short, the overall quality suggested trickery. A few weeks later, the *Daily Mirror*'s headline proclaimed, "Sorry . . . we were hoaxed" (2004, May 15, p. 1) and the editor lost his job.

Research shows that photographs are eminently believable, even though people know they can be faked. For example, Kelly and Nace (1994) showed subjects bogus news stories from the the *New York Times* and the supermarket tabloid *National Enquirer*. Although the *Times* was rated as a much more believable publication than the *National Enquirer*, the photographs in the *Enquirer* were rated as much more believable than the tabloid itself. More importantly, subjects who saw a lengthy video about Photoshop's image-manipulation capabilities still maintained their belief in the relative veracity of both publications' photographs.

People are also more likely to remember the content of a news story when it is accompanied by a photograph. David (1998) showed subjects news stories that were or were not accompanied by a photograph and found that subjects were more likely to remember the stories when the stories had photographs.

Considered as a whole, the research suggests that photos enhance both the credibility of the news and people's memory for it. These findings led Garry, Strange, Bernstein, and Kinzett (2005) to examine the effect of different photographs on memory for a newspaper story. They asked subjects to pretend to be a newspaper editor and to study three news articles. One of the stories—the target—described a hurricane that tore through a Mexican coastal town, causing major property damage. While acting as editors, subjects proofread the stories, identifying and correcting minor typographical errors. They also received a photo that would accompany the each article, and they had to mark on the article where in the layout of the newspaper they thought the photo would look best. For half the subjects, the photo accompanying the hurricane article showed part of the town before the hurricane struck; for the other half, the photo showed the exact same spot after the hurricane struck.

The next day, subjects returned to the lab for a surprise memory test. On the test, they read a number of statements and indicated whether they had read each statement in one of the articles the day before. There were two types of statements on the test: old statements, which really had been in the articles, and new statements, which had not been in the articles but were related. For the hurricane story, some of the new statements described severe injuries to people in the story—even though the hurricane story recounted only property damage and no personal injuries.

Garry et al. (2005) found that although subjects had equally good memories for statements in the other stories, those who saw the "after" photo for the hurricane story were far more likely to claim they had read the descriptions of serious personal injury. In fact, fewer than 10% of subjects who saw the "before" photo falsely remembered reading about personal injury, while approximately a third of subjects who saw the after photo did. The choice of photos did not affect memory for other kind of statements. This study suggests that photographs can influence the way people remember the news.

CONCLUSIONS

If memory is the way people keep telling themselves their stories, then photographs are one of the ways people keep those stories alive. We have shown that both doctored and true photographs can cultivate false memories for personal experiences, and true photographs can lead to false memories for the news.

The research on photographs and memory has raised significant questions that warrant attention from many areas of inquiry. For example, in the area of psychological science, we do not know if, or how, photographs affect source monitoring in different situations. Do photographs, for instance, enhance imagination in some circumstances while constraining it in others? Does it matter if a photograph depicts the event itself (such as in the balloon studies) or merely depicts the protagonists (such as in the Slime study)? How do these two issues affect fluency, the ease with which the fictitious event is processed and springs to mind?

People often mistake a rush of surprising fluency as an indicator of truth (Bernstein, Whittlesea, & Loftus, 2002). In cognitive philosophy, the close relationship between photographs and memory relates to a question Clark and Chalmers (1998) raised about where one's mind stops and the rest of the world starts. That is, when can one say that an external device is actually part of—an extension of—one's own memory? People rely on some technologies so much, they argued, that to dismiss them as extensions of memory simply because they are external to the physical body seems like nitpicking.

In the area of personal identity, the act of remembering experiences that do not fit with people's personal identity causes more change in how they see themselves than does remembering experiences that do fit with their identity (Neimeyer & Metzler, 1994). Perhaps that change would be accelerated or magnified if the incongruent remembering were accompanied by a doctored photograph as evidence. Real photos certainly can have this impact, particularly when they contain a mix of known and unknown information. For example, Wigoder (2001) describes the case of man who, nearly 50 years after WWII ended, came across a photo of himself as an emaciated young boy in a concentration camp. Confronted with the photo—evidence he recognized as being of a genuine experience but had never seen before—the man began to change the way he remembered life at the camp.

In the area of psychotherapy, can doctored photographs help clients reframe unpleasant personal history and, if so, is such a technique ethical? We know of at least one worrying example. Weiser's PhotoTherapy approach (Weiser, 2002) treats photographs as projective tests, with the therapist's job being to identify the client's common themes. Weiser eagerly anticipates the "exciting possibilities . . . for using photos as counselling tools with clients who have scanners . . . [and] photo-manipulation software" (p.24). On the other hand, doctoring images may lead to useful memory distortions. Kehle, Bray, Margiano, Theodore, and Zhou (2002) review research showing that when clients who engage in maladaptive behaviors—such as selective mutism (when a child speaks only in some contexts but not others), stuttering, or disruptive classroom behavior—view videos of themselves in which the unwelcome behaviors have been edited out, the maladaptive behaviors reduce. Kehle et al. propose a false-memory account of the effect: For example, stutterers who see manipulated videos of themselves speaking fluently may falsely remember speaking fluently more often than they really do, causing them to become more confident that they can speak well—and thereby reducing their stuttering.

Finally—and regardless of the psychological mechanisms at play—research on the ways doctored photos can tamper with memory raises important questions about what people might confess if they are confronted with false evidence that they did or saw something that never happened.

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Does Drinking Promote Risky Sexual Behavior?

A Complex Answer to a Simple Question

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ABSTRACT—*The present review argues that, popular lore notwithstanding, the well-documented association between usual patterns of alcohol use and risky sex reflects multiple underlying processes that are both causal and noncausal (spurious) in nature. It is further argued that even alcohol's acute causal effects on sexual behavior are more variable than they are commonly assumed to be. Drinking can promote, inhibit, or have no effect on behavior, depending on the interplay of factors governing behavior in a particular situation and the content of individually held beliefs about alcohol's effects.*

KEYWORDS—*alcohol; risky sex; condom use*

With the advent of AIDS, efforts to understand the causes of sexual risk-taking have assumed great urgency. In this context, alcohol and its potential disinhibiting effects have received much attention. In the past 20 years, more than 600 studies have been conducted on the link between drinking and risky sex, and drinking proximal to intercourse has become a standard target of intervention efforts aimed at reducing risky sexual behaviors. Targeting drinking as part of a strategy to reduce risky sex can only be effective if drinking causally promotes such behaviors, however. Does the evidence support this connection? Conventional wisdom aside, the answer to this question is surprisingly complex.

BACKGROUND

The belief that alcohol causally disinhibits sexual behavior is firmly ingrained in our culture. Most people believe that drinking increases the likelihood of sexual activity, enhances sexual experience, and promotes riskier sexual behavior. Many also attribute risky sexual experiences to the fact that they were drinking and report drinking (or plying their partner with alcohol) to exploit alcohol's alleged disinhibiting effects on sexual behavior.

Consistent with popular belief, the overwhelming majority of studies do find an association between the two behaviors (Cooper, 2002; Leigh & Stall, 1993). The typical study examines the cross-sectional association between usual patterns of drinking and risky sex. For example, in such studies, individuals who drink consistently report more partners than those who abstain do. Owing to design limitations, however, these studies tell us little about the underlying causal relationship. Such data cannot even establish a temporal link between drinking and risky sex, a minimum condition for attributing causality to acute alcohol effects. Thus, although people are quick to infer a causal connection between the two behaviors, multiple interpretations are possible. Three will be considered here.

THIRD-VARIABLE EXPLANATIONS

Third variable explanations that involve stable (possibly genetically based) features of the individual or of his or her life situation offer one important explanation. For example, a person might both drink and have risky sex to satisfy sensation-seeking needs, because of poor impulse control or coping skills, or in an effort to cope with negative emotions. Consistent with this possibility, Cooper, Wood, Orcutt, and Albino (2003) showed that one third of the statistical overlap (modeled by a higher-order factor) among diverse risk behaviors, including alcohol use and risky sex, could be explained by low impulse control and an avoidant style of coping with negative emotions. Thrill seeking accounted for a much smaller proportion of the overlap, and significantly predicted the overlap only among white (not black) adolescents. In addition, avoidance coping predicted the onset of drinking among initially abstinent youth, and in interaction with impulsivity it predicted the onset of sexual

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behavior among those who were initially virgins. Thus, avoidance coping and impulsivity appear to be important common causes that partially account for the link between drinking and risky sex. Although thrill seeking was not a strong predictor in our randomly constituted, biracial adolescent sample, closely related measures (e.g., sensation seeking) have been shown to fully account for the association between drinking and risky sex in some high-risk samples (e.g., heavy drinkers, gay or bisexual men).

An individual might also drink and have risky sex as part of a lifestyle, such as being single or living in a fraternity house, where both behaviors are tacitly or explicitly encouraged. Consistent with this possibility, perceptions of peer norms related to drinking and sex are among the most robust predictors of involvement in both behaviors among youth. Similarly, characteristics of one's home environment—e.g., living in a single-parent or conflict-ridden household—have also been found to predict both behaviors. Thus, direct evidence showing that covariation between the two behaviors can be explained by third variables, and indirect evidence showing that involvement in both behaviors is linked to the same putative causal factors, support the contention that the association between drinking and risky sex is at least partly due to the influence of underlying common causes.

REVERSE CAUSAL EXPLANATIONS

Reverse causal explanations posit that the intention or desire to engage in risky sex causes one to drink when sexual opportunity is perceived. Consistent with this possibility, surveys of college students reveal that up to one half of undergraduates report drinking more than usual to make it easier to have sex and giving their partners alcohol to increase the likelihood of sex (Cooper, 2002). Alternatively, an individual might plan a romantic evening and drink to enhance that experience or plan to pick someone up at a party and drink to provide an excuse (to oneself or others) for behavior that might later be seen as inappropriate. Although different motives (to disinhibit, enhance, or excuse) presumably underlie drinking in each scenario, all accounts nevertheless assume that people who drink strategically hold relevant beliefs about alcohol's capacity to facilitate the desired sexual outcome. Supporting this notion, Dermen and I (Dermen & Cooper, 1994) found that people who believe that alcohol enhances or disinhibits sex are more likely to drink, and to drink to intoxication, in sexual or potentially sexual situations (e.g., on a date). Thus, for at least some people, the intention or desire to have sex may precede and cause drinking, rather than the reverse.

CAUSAL EXPLANATIONS

Two prominent theories depict alcohol as a cause of disinhibited social behaviors: alcohol myopia and expectancy theories. Alcohol-myopia theory (Steele & Josephs, 1990) posits that disinhibited behavior results from an interaction of diminished cognitive capabilities and the specific cues that influence behavior in a given situation. Because alcohol narrows the range of cues perceived and limits the ability to process and extract meaning from these cues, intoxication renders a person susceptible to momentary pressures. Simple, highly salient cues (e.g., sexual arousal) continue to be processed, whereas more distal, complex ones (e.g., fear of pregnancy) are no longer adequately processed. Consequently, alcohol creates a "myopia" in which incompletely processed aspects of immediate experience exert undue influence on behavior and emotion. Accordingly, alcohol has its strongest effect when a behavior is controlled by instigating and inhibiting cues that are strong and nearly equal in force—a circumstance known as inhibition conflict.

In support of this model, Steele and Josephs conducted a meta-analysis (a method for statistically combining effects) of 34 experimental studies testing alcohol's effects on social behavior. Results revealed a small (.14) average standardized effect for alcohol under low-inhibition-conflict conditions versus a large effect (1.06) under high-conflict conditions. Thus, consistent with alcohol-myopia theory, intoxicated participants behaved more extremely than sober ones did primarily under high-conflict conditions.

Whereas alcohol-myopia theory emphasizes pharmacological mechanisms, expectancy theory emphasizes psychological ones. According to this view, an individual's behavior after drinking is driven by pre-existing beliefs (expectancies) about alcohol's effects on behavior, much like a self-fulfilling prophecy (Hull & Bond, 1986). The role of expectancies has been investigated experimentally in studies that independently manipulate alcohol content and expectancy set (the belief that alcohol has been consumed). In a meta-analysis of 36 such studies, Hull and Bond found that people who believed they had consumed alcohol (but had not) behaved similarly to those who had consumed alcohol (and didn't know it). Indeed, expectancy effects were significant and only slightly smaller than alcohol-content effects (.27 vs. .35). Expectancy theory thus highlights the role of individually held beliefs about alcohol's effects, and suggests by extension that alcohol effects on behavior may vary as a function of these beliefs.

The foregoing indicates that alcohol intoxication can cause more extreme social behavior through both pharmacological and psychological mechanisms. Contrary to popular opinion, these effects are not immutable, but are contingent on the nature of instigating and inhibiting cues governing momentary behavior, on the content of one's beliefs about alcohol effects, or possibly on a combination of both. Theoretically, then, alcohol intoxication should lead to riskier sexual behavior only under certain conditions or among certain people, a contention that existing evidence largely supports.

A SELECTIVE REVIEW OF NATURALISTIC STUDIES OF DRINKING AND RISKY SEX

From a public health perspective, one of the most important issues concerns alcohol's potential to facilitate the occurrence of intercourse, especially with new or casual partners. To investigate this issue, Orcutt and I (Cooper & Orcutt, 1997) examined the link between drinking and intercourse on two first-date occasions in a large, representative sample of adolescents. Although these data are correlational, the within-subjects design allowed us to compare a person's behavior on two occasions that, for many, differed in the presence versus absence of alcohol, thus helping us rule out stable individual differences between drinkers and nondrinkers as an alternative explanation for observed differences in sexual behavior. As Figure 1 illustrates, our results showed that rates of intercourse were higher when the male partner drank and lower when he abstained. Interestingly, however, parallel analyses revealed no such relationship for drinking by the female partner.

Drawing on alcohol-myopia theory, we reasoned that the psychological conditions necessary for alcohol-related disinhibition existed only among men. Specifically, if males experienced a type of conflict in which dominant cues favored behavioral action while peripheral cues favored behavioral inhibition, we would expect (due to the greater difficulty of accessing and processing peripheral cues) alcohol-related disinhibition. In contrast, if females experienced a type of conflict in which dominant cues favored inhibition and peripheral ones activation, then decreased processing of peripheral cues should not disinhibit behavior. Consistent with this logic, we found that men perceived more benefits relative to costs of having sex on their most recent first date, whereas women perceived more costs relative to benefits. Moreover, only the perception of increasing costs predicted conflict among men (for whom benefits were more salient), whereas the reverse was true among women. Thus, men and women appeared to experience qualitatively different forms of conflict about having sex on their most recent first date. Moreover, consistent with the idea that the type of conflict conducive to alcohol-related disinhibition occurred only among men, rates of intercourse on the date were significantly elevated only among highly conflicted men who drank alcohol (Fig. 2).

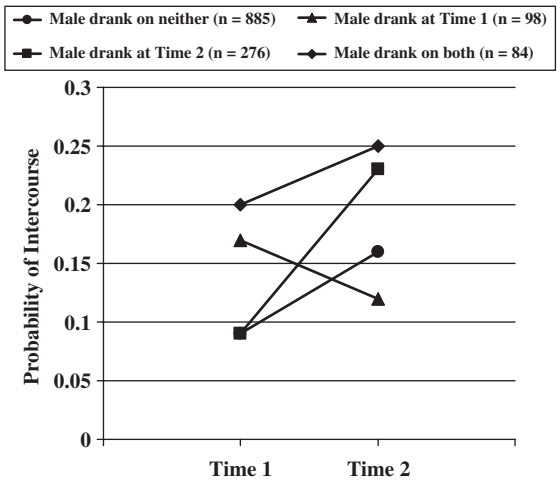

Fig. 1. Male couple-member alcohol use and probability of intercourse on two first-date occasions. From Cooper & Orcutt (1997).

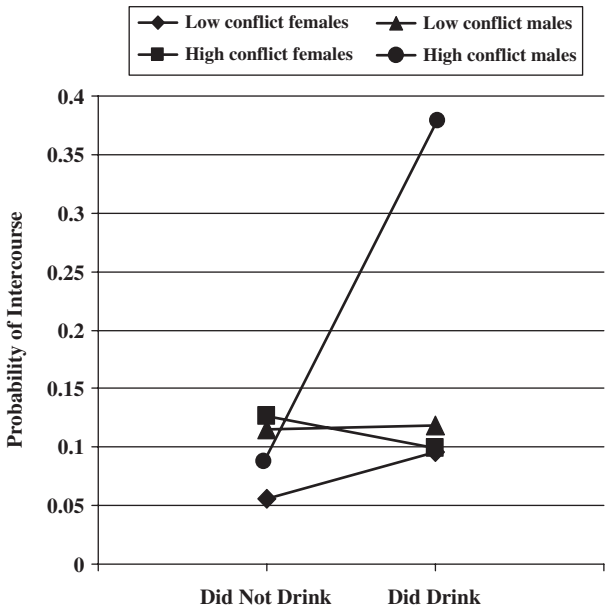

Fig. 2. Alcohol use, gender, and perceived conflict predicting probability of intercourse on the most recent first date. From Cooper & Orcutt (1997).

Together these data indicate that how alcohol affects sexual behavior is determined by the content and relative strength of competing cues that inhibit or activate behavior, and they raise the possibility that alcohol might even promote safer behavior under the right circumstances! Recent experimental evidence lends strong support to this idea, showing that when the potential costs of having sex with an attractive new partner were made salient, intoxicated individuals reported more cautious intentions than did sober ones (MacDonald, Fong, Zanna, & Martineau, 2000).

A second key question from a public health perspective is whether drinking reduces condom use. Somewhat surprisingly, most naturalistic studies directly testing the link between drinking on a specific intercourse occasion and condom use on that occasion find no relationship. Indeed in a quantitative analysis of 29 such tests (Cooper, 2002), alcohol was associated with lower rates of condom (and birth-control) use only under circumscribed conditions: at first intercourse but not on subsequent intercourse occasions, in younger but not older samples, and in studies conducted earlier rather than more recently (Leigh, 2002, reports similar results).

One plausible interpretation of these findings is that few people experience the type of conflict conducive to alcohol-related disinhibition of condom use, though such conflict may have been common in the past and may still be common among sexually inexperienced, younger adolescents. Although no study has directly tested these ideas, a study conducted by Dermen and me (Dermen & Cooper, 2000) provides indirect support. We examined feelings of conflict about using a condom on four occasions of intercourse across two different samples (one of college students; one of community-residing young adults, aged 19–25), and found that fewer than 15% of participants were highly conflicted about using a condom on each occasion. Moreover, although drinking did not predict lower overall rates of condom use on any of these occasions, it predicted significantly lower rates (in three of four tests) among those who felt conflicted about using a condom on that occasion.

In short, these data suggest that drinking can undermine safe sex behaviors, but that it does not invariably do so. Rather, alcohol can promote, inhibit, or have no effect on risky sexual behaviors depending on the specific constellation of salient cues in the moment.

THE ROLE OF ALCOHOL EXPECTANCIES

Although the preponderance of evidence suggests that inhibition conflict plays the larger role in accounting for alcohol's acute causal effects on risky sexual behavior, expectancies also appear important. As previously discussed, those who believe that alcohol disinhibits or enhances sexual experience are more likely to drink in (potentially) sexual situations, suggesting that expectancies are instrumental in setting up situations that may lead to alcohol-related disinhibition of sex. Expectancies (in the absence of alcohol) have also been shown to influence other aspects of sexual experience that could indirectly promote risky behaviors. For example, a recently conducted experiment in which participants were paired with previously unknown, opposite-sex partners found that participants who thought they had consumed alcohol (though none had been consumed) reported greater sexual arousal, perceived their partners as more sexually disinhibited, and showed erotic slides (presumed to be a behavioral analog of sexual interest) to their partners significantly longer, but only if they also held strong beliefs about alcohol's capacity to disinhibit or enhance sexual experience (George, Stoner, Norris, Lopez, & Lehman, 2000). These data suggest that expectancies, once activated by alcohol consumption, may strengthen instigating cues for sex, thereby bringing an individual for whom costs might otherwise greatly outweigh benefits into a state of high inhibition conflict. Finally, expectancies have also been shown to interact with feelings of conflict to jointly predict alcohol-related disinhibition of risky sexual behavior (Dermen & Cooper, 2000). Thus, expectancies and actual alcohol content might work in tandem to disinhibit risky sexual behavior in real-world situations where the two processes always co-occur.

CONCLUSIONS AND FUTURE DIRECTIONS

The relationship between alcohol use and risky sex is complex. It cannot be explained by a single mechanism, but instead reflects multiple underlying causal and noncausal processes. Moreover, even the causal portion of this relationship is not manifest as a main effect but as an interaction.

These complexities have important implications for both research and intervention efforts. The multiplicity of plausible causal mechanisms highlights the need for diverse methodological approaches for exploring alternative models, and for greater sophistication in framing research questions. Rather than focusing on which model better accounts for the link between drinking and risky sex, future research should focus on delineating the conditions under which, and the individuals for whom, different causal (and noncausal) processes are most likely to operate.

At the same time, researchers trying to unravel alcohol's acute effects must adopt more sophisticated methods for studying the complex interplay between drinking, individually held expectancies, and situational cues. Diary methods in which people report on both behaviors across multiple days provide an important and ecologically valid approach for examining this relationship. Such methods not only enable more accurate assessment of the behaviors themselves but also provide a window onto the motivations, emotions, and cognitions that subtly shape these behaviors and set the stage for alcohol's variable effects across individuals and situations.

The existence of multiple causal models also points to the need for diverse intervention strategies, and raises the possibility that different strategies will be optimally effective among individuals for whom different causal processes dominate. For example, among people who chronically drink and engage in risky behaviors, the relationship between drinking and risky sex may primarily reflect the influence of underlying common causes. For such individuals, universal change strategies targeting these common causes should be maximally efficacious. Alternatively, carefully designed interventions aimed at reducing drinking (or manipulating risk cues) in settings where drinking and encountering potential partners co-occur (e.g., college bars) could lower sexual risks associated with alcohol use among those who are most vulnerable to acute intoxication effects, situational influences, or both. To be maximally effective, interventions must be carefully tailored for different populations and circumstances in which different underlying causal processes predominate.

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Representation of Objects and Events: Why Do Infants Look So Smart and Toddlers Look So Dumb?

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Abstract

Research has demonstrated that very young infants can discriminate between visual events that are physically impossible versus possible. These findings suggest that infants have knowledge of physical laws concerning solidity and continuity. However, research with 2-year-olds has shown that they cannot solve simple problems involving search for a hidden object, even though these problems require the same knowledge. These apparently inconsistent findings raise questions about the interpretation of both data sets. This discrepancy may be resolved by examining differences in task demands.

Keywords

infant cognition; development; search tasks

A paradox has emerged in the developmental literature. On the one hand, a wealth of research from more than a decade of exciting studies shows that very young infants have knowledge of physical laws concerning continuity and solidity (Baillargeon, Graber, DeVos, & Black, 1990; Spelke, Breinlinger, Macomber, & Jacobson, 1992). On the other hand, recent work has revealed a surprising lack of such knowledge in children between 2 and 3 years of age (Berthier, DeBlois, Poirier, Novak, & Clifton, 2000; Hood, Carey, & Prasada, 2000). The question is raised: Are there true discontinuities, even regressions, in children's concepts of the physical world? Or can the discrepancies between the infant and the toddler data sets be resolved by pointing to differences in task requirements? Or perhaps the explanation lies in differences in methodology. For example, in the infant studies the dependent measure is looking, and in the toddler studies it is active search. Whatever the explanation, this paradox must be resolved before a comprehensive theory of early cognitive development can be constructed.

Beginning with the seminal article by Baillargeon, Spelke, and Wasserman (1985), the emerging picture of infants has been that 3- to 4-month-olds show a stunning sophistication in their perception of the physical world. The typical paradigm in this line of research entails the presentation of an event (e.g., a rotating screen in Baillargeon et al., 1985; a rolling ball in Spelke et al., 1992) during repeated trials (referred to as *habituation* trials). Test trials consist of equal numbers of "possible" (*consistent*) events, which accord with the natural laws of physics, and "impossible" (*inconsistent*) events, which break those laws. The assumption is that if infants look longer at inconsistent than at consistent events, they have detected an incongruence with the physical law.

INFANT STUDIES ABOUT OBJECT AND EVENT REPRESENTATION

The procedure in the infancy studies can be clarified by considering an example from Experiment 3 in Spelke et al. (1992). During habituation trials, 3-month-old infants saw a ball roll from the left and disappear behind a screen. A bright blue wall protruded above the screen. When the screen was lifted, the ball could be seen resting against the wall on the right side of the display. Following these trials, an obstacle was placed on the track to the left of the wall, with the topmost part of the obstacle, as well as the blue wall, showing above the screen. On test trials, the ball was again rolled from left to right. For the inconsistent event, when the screen was raised the ball was resting in the old place by the wall, so that it seemed to have violated rules of solidity (i.e., two solid objects cannot occupy the same space at the same time) and continuity (objects exist continuously and move on connected paths over space and time). By appearing at the far wall, the ball seemed to have moved through the solid obstacle or discontinuously jumped over it. For the consistent event, when the screen was raised the ball was resting against the obstacle, a novel position but one that conformed to physical laws. The infants looked significantly longer at the inconsistent event than at the consistent event. A control group saw the ball in the same positions when the screen was raised, but the ball's movement had not violated any physical laws. This group looked at the ball equally in the old and novel locations, thus indicating that they had no intrinsic preference for either display and no preference for the original position.

From this and other experiments, investigators have drawn the conclusion that very young infants reason about objects and events by drawing on some form of knowledge about solidity and continuity (Baillargeon, 1993; Spelke et al., 1992).

SURPRISING RESULTS FROM TODDLERS

The discordant results from toddlers come from experiments presenting the same type of physical event—a rolling ball that goes behind a screen and stops—but in this case the child's task is to actually find the ball (Berthier et al., 2000). The apparatus (see Fig. 1) features a wooden screen with four doors that hides the progress of the ball down the track. The ball is always stopped by a barrier, which can be positioned at any of the four doors. The cue to the ball's location is the top of the barrier protruding several centimeters above the screen. If the child understands physical laws of solidity and continuity, he or she should open the door by the barrier. Test trials consist of the experimenter placing the barrier on the track and lowering the screen to conceal the track. Then the experimenter draws the child's attention to the ball and releases it at the top of the track. Finally, the child is invited to open a door to find the ball.

In Figure 2, the columns labeled "opaque" show individual performance on this task in the study by Berthier et al. (2000). Children under 3 years old performed no better than would be expected if they were simply guessing at the ball's location. Of 16 children in each age group, no 2-year-old and only three 2.5-year-olds performed above chance levels; 13 of the 3-year-olds did so, however. (Note: Data for 3-year-olds are not displayed in Fig. 2.) The almost total lack of success for children under 3 years of age was quite surprising, and in a series of studies my colleagues and I have sought to understand why their performance is so poor.

Offering more visual information about the ball's trajectory seemed like a reasonable way to help the toddlers (Butler, Berthier, & Clifton, 2002). We replaced the opaque wooden screen with a transparent one of tinted Plexiglas, leaving four opaque doors to hide the bottom of the wall and the ball's final resting position. Otherwise we kept the procedure and the rest of the apparatus the same. Now children had a view of the ball as it passed between doors, with the additional cue of no emergence beyond the wall. Despite this substantial increase in visual information about the ball's whereabouts, 2-year-old children still had great difficulty in searching accurately: Only 6 out of 20 children performed above chance. Of the 12 children tested at 2.5 years of age, 10 were above chance, so this age group benefited notably from the additional information (see data in Fig. 2 labeled "clear").

We also recorded eye gaze, monitored from a digital video camera trained on the child's face. Children at both ages were highly attentive as the ball was released, and they tracked its movement down the ramp on 84% of trials. Two aspects of their tracking behavior predicted their response: the point where they stopped tracking the ball and whether they broke their gaze before choosing a door. For older children, tracking the ball to its disappearance was the most typical pattern, and this virtually guaranteed they would open the correct door. A different story emerged for the 2-year-olds. Like 2.5-year-olds, they typically tracked the ball to its final location, but this did not ensure success. If they looked away after correctly tracking the ball, they made errors, although this was not the case for 2.5-year-olds (Butler et al., 2002).

Fig. 1. View of the apparatus used for the toddler task. The child is opening the third door, and the ball, resting against the wall, is visible through the door. From "Where's the Ball? Two- and Three-Year-Olds Reason About Unseen Events," by N.E. Berthier, S. DeBlois, C.R. Poirier, J.A. Novak, and R.K. Clifton, 2000, *Developmental Psychology, 36*, p. 395. Copyright by the American Psychological Association. Reprinted with permission of the author.

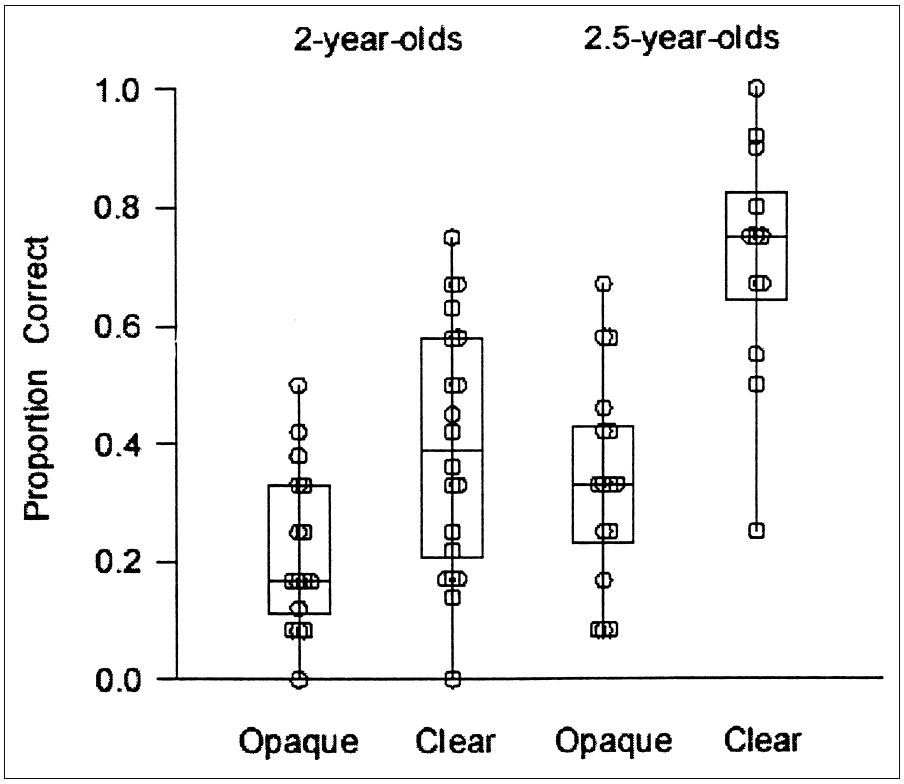

Fig. 2. Proportion of trials correct on the first reach for 2- and 2.5-year olds. Results are shown separately for trials with an opaque screen and a transparent screen. Each circle represents one child's performance. The boxes enclose the second and third quartiles of the distributions, and the horizontal lines in the boxes are the medians. From "Two-Year-Olds' Search Strategies and Visual Tracking in a Hidden Displacement Task," by S.C. Butler, N.E. Berthier, and R.K. Clifton, 2002, *Developmental Psychology*, *38*, p. 588. Copyright by the American Psychological Association. Reprinted with permission of the author.

IS THE PROBLEM KEEPING TRACK OF HIDDEN MOVEMENT?

A second visual manipulation was tried (Mash, Keen, & Berthier, in press). We hypothesized that if the children were given a full view of the ball's trajectory until it came to rest against a wall, they would be able to search correctly. In effect, we reversed the sequence of events that concealed the ball: In our previous studies (Berthier et al., 2000; Butler et al., 2002), the screen was first positioned in front of the ramp, hiding most of it from view, and then the ball was released at the top of the ramp, going out of sight while still moving. In this new study, the ball rolled down the ramp and came to a stop by a wall, then the screen was lowered to conceal both the ramp and the ball. At that point, the child's task was the same as in previous studies—open a door to find the ball. Note, however, that in this case the child did not have to reason about solidity and continuity in order to find the ball. Keeping track of its position behind the screen was all that was required.

Allowing complete access to the ball's movements benefited the older children somewhat, but the great majority of 2-year-olds still had enormous problems. Only two out of eighteen 2-year-olds tested performed above chance, whereas seven out of eighteen 2.5-year-olds did. As when we used the clear screen, gaze offered clues as to why children failed. If children looked at the ball as the screen was lowered and maintained this orientation until opening a door, they were correct about 90% of the time. Most children, however, broke their gaze, which resulted in errors. Merely watching as the screen was lowered over the ramp and ball did not aid search; only a continuous fixation up to the point of choosing the door led to success.

WHAT ABOUT TASK DIFFERENCES?

In the infant task, 3- to 4-month-old infants looked longer at physically impossible events than at possible events (Baillargeon et al., 1990; Spelke et al., 1992). No prediction was required on the infants' part, as they simply reacted to a visual array of an object in the wrong place or the right place. In contrast, the search task used with toddlers involved prediction and planning within a more complex apparatus. In order to make the infant and toddler tasks more comparable, we designed a looking-time task in which the same door apparatus was used, but the children never opened a door (Mash, Clifton, & Berthier, 2002). Instead, they observed the same events as before, but a puppet, Ricky the raccoon, opened the door.

Most of the time, Ricky opened the correct door and removed the ball. But on test trials, Ricky opened an incorrect door (no ball found, a physically possible, or consistent, event) or opened the correct door but found no ball (a physically impossible, or inconsistent, event). After the door was opened and no ball was found, the experimenter raised the screen to reveal the ball resting against the wall (consistent event) or beyond the wall (inconsistent event). This visual array is highly similar to what infants saw

on the test trials of Experiment 3 in Spelke et al. (1992), described earlier. Like the infants, the toddlers looked longer at the inconsistent placement of the ball than at the consistent placement. This result was independently corroborated by a looking-time study with toddlers that used a similar apparatus but a different procedure in which the experimenter opened the doors while the child watched (Hood, Cole-Davies, & Dias, 2003).

CONCLUSIONS

To interpret the results of these studies, first consider what can be ruled out as an explanation of toddlers' poor performance in this search task. The results from the original study using an opaque screen (Berthier et al., 2000; and from Hood et al., 2000, as well) suggested that toddlers have no knowledge of continuity or solidity. In the clear-screen study (Butler et al., 2002), 2-year-olds again failed to recognize the barrier's role in stopping the ball. Maintaining gaze on the spot where the ball disappeared was the behavior most predictive of correct door choice—more evidence that toddlers did not reason about this physical event. But unexpectedly, taking away the reasoning requirement did not lead to success. Observing the disappearance of a stationary ball should have enabled the children to select the correct door if the problem were either hidden movement or the necessity to reason about the barrier's role (Mash et al., in press). The fact that performance remained poor in this condition rules out these explanations of toddlers' poor search performance. The puppet study, which used looking as the response rather than reaching, found that 2-year-olds, like infants, looked longer at the inconsistent event (Mash et al., 2002). This study rules out the disconcerting possibility that infants are endowed with knowledge about physical events that gets lost during development, and is regained around 3 years of age. Finally, although infants and toddlers both fail in search tasks that require a reaching response, previous work not discussed here demonstrated that 6-month-olds will reach for objects hidden by darkness (Clifton, Rochat, Litovsky, & Perris, 1991). Thus, it is not the response of reaching, in contrast to looking, that is the cause of infants' and toddlers' failure, but rather a problem of knowing where to search.

What could be the toddlers' problem in the search task? A distinct possibility, already mentioned, is the requirement of prediction. In order to plan and execute a successful search, toddlers had to know the ball's location in advance. Moreover, they had to coordinate this knowledge with appropriate action. Further research is needed to determine if either or both of these aspects are critical. One means of exploring this possibility is to devise new tasks that require location prediction but have fewer spatial elements to be integrated than the ball-barrier-door task and require simpler action plans.

A second prime issue needing further investigation is the relation between gaze behavior and search. Choice of the correct door was associated with continuous gaze at the hiding event; gaze breaks before searching were fatal to success. These data imply that children did not use sight of the barrier's top as a cue for the correct door. Likewise, adults faced with an array of 20 identical doors with no further marker might well use unbroken gaze at the point of disappearance as a strategy. If confusion among identical doors is the children's problem, then making the doors distinct should help. This manipulation coupled with careful analysis of gaze could determine whether the toddlers' problem is simply spatial confusion among identical doors. If so, the interesting question remains as to why the barrier's top does not cue location.

Finally, a theoretical issue is unresolved. The results for the looking-time task indicate that toddlers, and even infants, have some knowledge about the ball's expected location, but the contents of their knowledge is unclear. According to Spelke (Spelke et al., 1992), the principles of continuity and solidity are part of a constant core of physical knowledge that infants are endowed with. Infants of 3 to 4 months in age mentally represent hidden objects and can reason about an object's motion being constrained by continuity and solidity. Spelke et al. (1992) did not claim, however, that the infants in their study could predict the ball's location, and the toddler data suggest that infants' and even 2-year-olds' reasoning may be limited to recognizing after-the-fact incongruent events. If so, perceptual recognition of implausible event outcomes seems like a valuable building block on which to construct further knowledge, and eventually prediction, about the physical world.

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Note

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Why People Fail to Recognize Their Own Incompetence

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Abstract

Successful negotiation of everyday life would seem to require people to possess insight about deficiencies in their intellectual and social skills. However, people tend to be blissfully unaware of their incompetence. This lack of awareness arises because poor performers are doubly cursed: Their lack of skill deprives them not only of the ability to produce correct responses, but also of the expertise necessary to surmise that they are not producing them. People base their perceptions of performance, in part, on their preconceived notions about their skills. Because these notions often do not correlate with objective performance, they can lead people to make judgments about their performance that have little to do with actual accomplishment.

Keywords

self-evaluation; metacognition; self-concept; overconfidence; performance evaluation

Real knowledge is to know the extent of one's ignorance.

—Confucius

Confucius' observation rings just as true today as it did 26 centuries ago. To achieve and maintain an adequate measure of the good life, people must have some insight into their limitations. To ace an exam, a college student must know when he needs to crack open his notebook one more time. To provide adequate care, a physician must know where her expertise ends and the need to call in a specialist begins.

Recent research we have conducted, however, suggests that people are not adept at spotting the limits of their knowledge and expertise. Indeed, in many social and intellectual domains, people are unaware of their incompetence, innocent of their ignorance. Where they lack skill or knowledge, they greatly overestimate their expertise and talent, thinking they are doing just fine when, in fact, they are doing quite poorly.

IGNORANCE OF INCOMPETENCE: AN EXAMPLE

Consider the following example. In a sophomore-level psychology

Math Anxiety: Personal, Educational, and Cognitive Consequences

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Abstract

Highly math-anxious individuals are characterized by a strong tendency to avoid math, which ultimately undercuts their math competence and forecloses important career paths. But timed, on-line tests reveal math-anxiety effects on whole-number arithmetic problems (e.g., 46 + 27), whereas achievement tests show no competence differences. Math anxiety disrupts cognitive processing by compromising ongoing activity in working memory. Although the causes of math anxiety are undetermined, some teaching styles are implicated as risk factors. We need research on the origins of math anxiety and on its "signature" in brain activity, to examine both its emotional and its cognitive components.

Keywords

anxiety; mental arithmetic; math competence; working memory; problem solving

My graduate assistant recently told me about a participant he had tested in the lab. She exhibited increasing discomfort and nervousness as the testing session progressed, eventually becoming so distraught that she burst into tears. My assistant remarked that many of our participants show some unease or apprehension during testing—trembling hands, nervous laughter, and so forth. Many ask, defensively, if their performance says anything about their overall intelligence. These occasionally extreme emotional reactions are not triggered by deliberately provocative procedures—there are no personally sensitive questions or intentional manipulations of stress. Instead, we merely ask college adults to solve elementary-school arithmetic problems, such as 46 + 18 = ? and 34 − 19 = ?

The reactions are obvious symptoms of anxiety, in this case math anxiety induced by ordinary arithmetic problems presented in timed tasks. On the one hand, it is almost unbelievable that tests on such fundamental topics can be so upsetting; knowing that 15 − 8 = 7 ought to be as basic as knowing how to spell "cat." On the other hand, U.S. culture abounds with attitudes that foster math anxiety: Math is thought to be inherently difficult (as Barbie dolls used to say, "Math class is hard"), aptitude is considered far more important than effort (Geary, 1994, chap. 7), and being good at math is considered relatively unimportant, or even optional.

In this article, I discuss what has been learned about math anxiety across the past 30 years or so, and suggest some pressing issues to be pursued in this area. An important backdrop for this discussion is the fact that modern society is increasingly data and technology oriented, but the formal educational system seems increasingly unsuccessful at educating students to an adequate level of "numeracy," the mathematical equivalent of literacy (Paulos, 1988).

MATH ANXIETY DEFINED AND MEASURED

Math anxiety is commonly defined as a feeling of tension, apprehension, or fear that interferes with math performance. The first systematic instrument for assessing math anxiety was the Mathematics Anxiety Rating Scale (MARS), published by Richardson and Suinn (1972). In this test, participants rate themselves on the level of anxiety they would feel in various everyday situations, such as trying to refigure a restaurant bill when they think they have been overcharged or taking a math test. My co-workers and I use a shortened version of the test, which yields scores that correlate well with scores obtained using the original test and also has very acceptable test-retest reliability (i.e., an individual who takes the test on different occasions generally receives similar scores). We have also found that for a quick determination, one can merely ask, "On a scale from 1 to 10, how math anxious are you?" Across at least a half-dozen samples, responses to this one question have correlated anywhere from .49 to .85 with scores on the shortened MARS.

There is a rather extensive literature on the personal and educational consequences of math anxiety, summarized thoroughly in Hembree (1990). Perhaps the most pervasive—and unfortunate—tendency is avoidance. Highly math-anxious individuals avoid math. They take fewer elective math courses, both in high school and in college, than people with low math anxiety. And when they take math, they receive lower grades. Highly math-anxious people also espouse negative attitudes toward math, and hold negative self-perceptions

about their math abilities. The correlations between math anxiety and variables such as motivation and self-confidence in math are strongly negative, ranging between −.47 and −.82. It is therefore no surprise that people with math anxiety tend to avoid college majors and career paths that depend heavily on math or quantitative skills, with obvious and unfortunate consequences.

Interestingly, math anxiety is only weakly related to overall intelligence. Moreover, the small correlation of −.17 between math anxiety and intelligence is probably inflated because IQ tests include quantitative items, on which individuals with math anxiety perform more poorly than those without math anxiety. The small correlation (−.06) between math anxiety and verbal aptitude supports this interpretation. However, math anxiety is related to several other important characteristics. As conventional wisdom suggests, it is somewhat higher among women than men. The gender difference is rather small, may be particularly apparent in highly selected groups (e.g., college students), and may be partly attributable to a greater willingness on the part of women to disclose personal attitudes. Nonetheless, when we recruited participants for research on math anxiety, we found fewer men than women at high anxiety levels, but just the reverse at low levels (Ashcraft & Faust, 1994).

Individuals who are high in math anxiety also tend to score high on other anxiety tests. The strongest interrelationship is with test anxiety, a .52 correlation. Despite the overlap among kinds of anxiety, however, the evidence is convincing that math anxiety is a separate phenomenon. For instance, intercorrelations between alternative assessments of math anxiety range from .50 to .70, but intercorrelations of math anxiety with other forms of anxiety range from .30 to .50. In a particularly clear display of the specificity of math anxiety, Faust (1992) found physiological evidence of increasing reactivity (e.g., changes in heart rate) when a highly math-anxious group performed math tasks of increasing difficulty. When the same participants performed an increasingly difficult verbal task, there was hardly any increase in their reactivity (e.g., Ashcraft, 1995, Fig. 6), and participants with low math anxiety showed virtually no increase in either task.

MATH ANXIETY AND MATH COMPETENCE

An obvious but unfortunate consequence of the avoidance tendency is that compared with people who do not have math anxiety, highly math-anxious individuals end up with lower math competence and achievement. They are exposed to less math in school and apparently learn less of what they are exposed to; as a result, they show lower achievement as measured by standardized tests (e.g., Fennema, 1989). The empirical relationship is of moderate strength (a correlation of −.31 for college students), but sufficient to pose a dilemma for empirical work. That is, when highly math-anxious individuals perform poorly on a test, their poor performance could in fact be due to low competence and achievement rather than heightened math anxiety. If the relationship between anxiety and competence holds for all levels of math difficulty, then variations in competence will contaminate any attempt to examine math performance at different levels of math anxiety.

Fortunately, there are ways out of this dilemma. One is to test additional samples of participants on untimed, pencil-and-paper versions of the math problems studied in the lab. For example, we (Faust, Ashcraft, & Fleck, 1996) found no anxiety effects on whole-number arithmetic problems when participants were tested using a pencil-and-paper format. But when participants were tested on-line (i.e., when they were timed as they solved the problems mentally under time pressure in the lab), there were substantial anxiety effects on the same problems.

We have also taken a second approach (see Ashcraft, Kirk, & Hopko, 1998). In brief, we administered a standard math achievement test to individuals with low, medium, or high math anxiety, and replicated the overall result reported by Hembree (1990; i.e., math achievement scores decrease as math anxiety increases). But we then scored the achievement test to take advantage of the line-by-line increases in difficulty. With this scoring method, we found that there were no math-anxiety effects whatsoever on the first half of the test, which measured performance on whole-number arithmetic problems. Anxiety effects were apparent only on the second half of the test, which introduced mixed fractions (e.g., 10 1/4 − 7 2/3), percentages, equations with unknowns, and factoring. For these problems, there was a strong negative relationship between accuracy and math anxiety. Thus, individuals with high levels of math anxiety do not have a global deficit in math competence, and they can perform as well as their peers on whole-number arithmetic problems. Investigations of higher-level arithmetic and math, though, do need to take the competence-anxiety relationship into account.

There is still reason to be somewhat suspicious of this relationship between anxiety and competence, however. Effective treatments for math anxiety (see Hembree, 1990,

Table 8) have resulted in a significant improvement in students' math achievement scores, bringing them nearly to the level shown by students with low math anxiety. Because the treatments did not involve teaching or practicing math, the improvement could not be due to a genuine increase in math competence. We suspect instead that these students' original (i.e., pretreatment) math competence scores were artificially low, depressed by their math anxiety. When the anxiety was relieved, a truer picture of their competence emerged.

COGNITIVE CONSEQUENCES OF MATH ANXIETY

Our original studies were apparently the first to investigate whether math anxiety has a measurable, on-line effect on cognitive processing, that is, whether it actually influences mental processing during problem solving. In our early studies (Ashcraft & Faust, 1994; Faust et al., 1996), we found that math anxiety has only minimal effects on performance with single-digit addition and multiplication problems. One anxiety effect we did find, however, was in a decision-making process sensitive to "number sense" (Dehaene, 1997)—when making true/false judgments, highly math-anxious individuals made more errors as the problems became increasingly implausible (e.g., 9 + 7 = 39), whereas low-anxiety participants made fewer errors on such problems.

Arithmetic problems with larger numbers (e.g., two-column addition or multiplication problems), however, showed two substantial math-anxiety effects. First, participants at high levels of anxiety routinely responded rapidly to these problems, sometimes as rapidly as participants with low anxiety, but only by sacrificing considerable accuracy. This behavior resembles the global avoidance tendency characteristic of highly math-anxious individuals, but at an immediate, local level: By speeding through problems, highly anxious individuals minimized their time and involvement in the lab task, much as they probably did in math class. Such avoidance came at a price, however—a sharp increase in errors.

Second, the results showed that addition problems with carrying were especially difficult for highly math-anxious individuals. In particular, the time disadvantage for carry versus no-carry problems was three times larger for participants with high anxiety (753 ms) than for those with low anxiety (253 ms), even aside from the difference in accuracy between the two groups. Our interpretation was that carrying, or any procedural aspect of arithmetic, might place a heavy demand on working memory, the system for conscious, effortful mental processing. In other words, we proposed that the effects of math anxiety are tied to those cognitive operations that rely on the resources of working memory.

In an investigation of this possibility, Kirk and I (Ashcraft & Kirk, 2001) tested one- and two-column addition problems, half requiring a carry. We embedded this test within a dual-task procedure, asking our participants to do mental math, the primary task, while simultaneously remembering random letters, a secondary task that taxes working memory. Two or six letters were presented before each addition problem, and after participants gave the answer to the problem, they were asked to recall the letters in order. We reasoned that as the secondary task became more difficult (i.e., when more letters had to be held in working memory), performance on the primary task might begin to degrade, in either speed or accuracy. If that happened, we could infer that the primary task indeed depended on working memory, and that the combination of tasks began to exceed the limited capacity of working memory.

When the addition problem involved carrying, errors increased substantially more for participants with high math anxiety than for those with low anxiety (Ashcraft & Kirk, 2001, Experiment 2). Moreover, as we predicted, this was especially the case when the secondary task became more difficult, that is, with a six-letter memory load. On carry problems (e.g., 6 + 9, 27 + 15), highly anxious individuals made 40% errors in the heavy-load condition, compared with only 20% errors for individuals with low anxiety in the high-load condition and 12% errors for both groups in the light-load condition. In the control conditions, with each task performed separately, the comparable error rates were only 16% and 8%. These results could not be attributed to overall differences in working memory. That is, we examined the participants' working memory spans (the amount of information they were able to remember for a brief amount of time) and found no differences between the groups when spans were assessed with a verbal task. But span scores did vary with math anxiety when they were assessed with an arithmetic-based task.

These results are consistent with Eysenck and Calvo's (1992) model of general anxiety effects, called processing efficiency theory. In this theory, general anxiety is hypothesized to disrupt ongoing working memory processes because anxious individuals devote attention to their intrusive thoughts and worries, rather than the task at hand. In the case of math anxiety, such thoughts probably involve preoccupation with one's dislike or fear of math, one's low self-confidence, and the like. Math anxiety lowers

math performance because paying attention to these intrusive thoughts acts like a secondary task, distracting attention from the math task. It follows that cognitive performance is disrupted to the degree that the math task depends on working memory.

In our view, routine arithmetic processes like retrieval of simple facts require little in the way of working memory processing, and therefore show only minimal effects of math anxiety. But problems involving carrying, borrowing, and keeping track in a sequence of operations (e.g., long division) do rely on working memory, and so should show considerable math-anxiety effects. Higher-level math (e.g., algebra) probably relies even more heavily on working memory, so may show a far greater impact of math anxiety; note how difficult it will be, when investigating high-level math topics, to distinguish clearly between the effects of high math anxiety and low math competence.

GAPS IN THE EVIDENCE

Math anxiety is a bona fide anxiety reaction, a phobia (Faust, 1992), with both immediate cognitive and long-term educational implications. Unfortunately, there has been no thorough empirical work on the origins or causes of math anxiety, although there are some strong hints. For instance, Turner et al. (2002) documented the patterns of student avoidance (e.g., not being involved or seeking help) that result from teachers who convey a high demand for correctness but provide little cognitive or motivational support during lessons (e.g., the teacher "typically did not respond to mistakes and misunderstandings with explanations," p. 101; "he often showed annoyance when students gave wrong answers . . . . He held them responsible for their lack of understanding," p. 102). Turner et al. speculated that students with such teachers may feel "vulnerable to public displays of incompetence" (p. 101), a hypothesis consistent with our participants' anecdotal reports that public embarrassment in math class contributed to their math anxiety. Thus, it is entirely plausible, but as yet undocumented, that such classroom methods are risk factors for math anxiety.

Other gaps in the evidence involve the cognitive consequences of math anxiety, including those that interfere with an accurate assessment of math achievement and competence. My co-workers and I have shown that the transient, on-line math-anxiety reaction compromises the activities of working memory, and hence should disrupt performance on any math task that relies on working memory. The mechanisms for this interference are not yet clear, however. It may be that intrusive thoughts and worry per se are not the problem, but instead that math-anxious individuals fail to inhibit their attention to those distractions (Hopko, Ashcraft, Gute, Ruggiero, & Lewis, 1998).

Finally, as research on mathematical cognition turns increasingly toward the methods of cognitive neuroscience, it will be interesting to see what "signature" math anxiety has in brain activity. The neural activity that characterizes math anxiety should bear strong similarities to the activity associated with other negative affective or phobic states. And our work suggests that the effects of math anxiety should also be evident in neural pathways and regions known to reflect working memory activity.

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Note

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Who Develops Posttraumatic Stress Disorder?

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ABSTRACT—*Nearly half of U.S. adults experience at least one traumatic event in their lifetimes, yet only 10% of women and 5% of men develop posttraumatic stress disorder (PTSD). Why this is so is among the most central questions in current PTSD research. This article reviews the current status of knowledge about who develops PTSD, discussing the strengths and weaknesses of the evidence. We describe the major models used to understand responses to traumatic events, as well as future research directions. We also propose that an exclusive focus on individual differences and individual intervention overlooks opportunities to reduce the prevalence of PTSD by modifying factors at the neighborhood, community, or national level.*

KEYWORDS—*PTSD predictor; dissociation; traumatic event; prevention*

The response to traumatic stress varies widely, ranging from transient disruption of functioning to the chronic clinical condition known as posttraumatic stress disorder (PTSD). Interest in and knowledge about PTSD increased dramatically after its diagnosis was formalized in 1980, but study of the effects of extreme stress has a long history, primarily focused on the effects of war (e.g., shell shock in World War I) and of sexual assault against women. According to generally accepted criteria, diagnosis of PTSD requires exposure to a traumatic event that causes feelings of extreme fear, horror, or helplessness. Traumatic events are defined as experiences that involve death, serious injury, or threat of death. The consequences of this exposure are manifested in three symptom clusters required for diagnosis: involuntary reexperiencing of the trauma (e.g., nightmares, intrusive thoughts), avoidance of reminders and numbing of responsivity (e.g., not being able to have loving feelings), and increased arousal (e.g., difficulty sleeping or concentrating, hypervigilance, exaggerated startle response).

Because PTSD requires the presence of an external event and symptoms linked to this event, it differs from virtually all other psychiatric disorders and raises intriguing issues regarding the definition of trauma, the role of individuals' appraisal of and responses to the event, the implications of a single versus repeated or ongoing exposure, and the role of community- and societal-level changes in attempting to prevent PTSD.

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PREVALENCE

Results from a nationally representative study indicated that over the life course, 10% of women and 5% of men in the United States experience PTSD (Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995). Moreover, approximately half of adults have experienced a traumatic event. In a national survey of Vietnam veterans conducted in the late 1980s, Kulka et al. (1990) estimated that 31% of males and 26% of females in this population had PTSD from their military service. Because PTSD symptoms wax and wane, especially in response to subsequent life events (not necessarily traumatic ones), many people experience *partial PTSD*, or clinically significant symptoms of PTSD that do not meet the diagnostic criteria for the disorder. Including individuals with partial PTSD resulted in an estimate of roughly 830,000 Vietnam veterans with significant posttraumatic distress or impairment approximately 20 years after service (Weiss et al., 1992).

The disparity between the 50% prevalence of exposure to trauma and the 7% lifetime prevalence of PTSD means that individual responses to trauma vary dramatically. This variability sparks what appears to be the key question in the field: Why do some people, and not others, develop PTSD? This issue has been of particular interest in recent years, leading to a search for systematic risk factors. Central questions have focused on the correlates or predictors of who develops the disorder and the strength of these effects. Current conceptualizations of PTSD symptoms provide potential explanatory frameworks for appreciating how predictors may influence the stress response and lead to differential risk for PTSD.

MODELS OF TRAUMA RESPONSE

Models Focused on Cognitive and Emotional Processes

The two most influential cognitively oriented formulations of trauma response and recovery highlight either the importance of beliefs and linked emotions about the self and the world (McCann & Pearlman, 1990) or the network of associations linking thinking about or reminders of a traumatic event to cognitive, emotional, physiological, and behavioral responses (Foa & Rothbaum, 1989). In the former formulation, a traumatic event is conceptualized as shattering the

previously held assumption that though the world is not always safe, the lack of safety affects other people only. Thus, the trauma victim's thinking about the world must be adapted to assimilate this shattered assumption and make sense of and integrate the event. The PTSD symptoms of intrusion and avoidance arise from this process, which is generally experienced as painful because it requires remembering the trauma and the accompanying distress. Recovery gradually occurs when this iterative process can be tolerated without avoidance or being overwhelmed emotionally. Thus, factors that reduce the likelihood of effective integration and assimilation would theoretically increase the likelihood of chronic stress-related symptoms and PTSD. These factors include characteristics of the individual, his or her environment, and the event itself.

In the latter cognitive formulation, the metaphor of a memory network is invoked to describe linked information about the traumatic event and subsequent cognitive, affective, physiological, and behavioral responses. Activation of one element in the network activates other aspects—almost always including fear—and this uninterrupted repetition accounts for the continuing symptoms. Recovery occurs if the strength of the associations among network components is reduced by a combination of desensitization and substitution of more adaptive associations.

Biologically Focused Models

Research on the biology of PTSD initially focused on studying psychophysiological arousal in the presence of reminders (sounds, images, or scripts) of the traumatic event. Results indicated that individuals with PTSD demonstrated heightened arousal and prolonged duration of arousal compared with control subjects (e.g., Keane et al., 1998). Recently, researchers investigating the biological substrates of PTSD have focused on the processes and structures of the brain. Research has centered on the amygdala and hippocampus, key brain areas involved in the fear response and in the consolidation of memory (e.g., LeDoux, 2000), as well as on the hypothalamic-pituitary-adrenal (HPA) axis, the parts of the neuroendocrine system that control reactions to acute stress.

Examination of parts of the brain involved in the fear response has been extensive because traumatic events usually generate fear, and because fear initiates the "flight or fight" physiological arousal associated with the hyperarousal symptoms of PTSD. Fear has also been implicated in the mechanisms establishing and maintaining traumatic memories. Research in animals has generally examined brain circuitry; research in humans has included neuroimaging studies of brain structures (Schuff et al., 1997) and processes (Rauch et al., 1996). New findings from animal studies have established direct neural pathways from sensory input to areas of the amygdala. In light of the known reciprocal neuronal connections between the hippocampus and amygdala, these findings suggest a powerful explanation for the automaticity of the fear response and the manner in which emotional memories occur and are transmitted to the hippocampus.

Careful study of individuals with PTSD indicates that they are characterized by an oversensitivity of the HPA axis. The HPA axis is involved in generating, maintaining, and shutting down increases in stress-related hormones in the face of danger, a central aspect of traumatic events. Evidence suggests that individuals with PTSD exhibit dysregulation in the activity of cortisol, a hormone regulated by the HPA axis. The destructive effects of the excessive production of cortisol are believed to be responsible for the atrophy of the hippocampus frequently found among individuals with chronic PTSD. The dysregulation in the HPA axis involves the feedback loop that puts the brakes on the arousal generated by the perception of fear (Yehuda, 1997). These findings have generated research aimed at exploring the use of medications such as beta-blockers to dampen initial arousal. With initial arousal dampened, the consolidation of emotional memories may be attenuated. The hope, therefore, is that the reduction of physiological arousal immediately after the traumatic event will interfere with the processes that lead to the development of PTSD.

PREDICTORS OF PTSD

Two major meta-analyses (statistical analyses combining the results of many studies) of the predictors of PTSD have recently been published (Brewin, Andrews, & Valentine, 2000; Ozer, Best, Lipsey, & Weiss, 2003). These studies examined four categories of predictors: (a) historical or static characteristics such as family psychiatric history, intelligence, childhood trauma, and other previous trauma; (b) trauma severity; (c) psychological processes during and immediately after the trauma; and (d) social support and life stress after the traumatic event. Both meta-analyses showed that there were significant predictors of PTSD in all four categories, but that the strength of prediction varied across the categories. Those factors closer in time to the traumatic event (i.e., proximal factors) showed a stronger relationship to PTSD ($r \approx .40$) than did characteristics of the individual or his or her history that were more distant in time (i.e., distal factors; $r \approx .20$). The strongest predictor (included only in Ozer et al.) was peritraumatic dissociation. Peritraumatic dissociation refers to unusual experiences during and immediately after the traumatic event, such as a sense that things are not real, the experience of time stretching out, and an altered sense of self. Feeling that one is watching oneself in a movie or play as the event unfolds is a common description of the experience of dissociation. The strength of the relationship between such dissociation and likelihood of developing PTSD was in the moderate-to-large range.

Several important points regarding the predictors of PTSD should be highlighted. First, because largest correlations were about .40, peritraumatic dissociation and other predictors are neither necessary nor sufficient for developing PTSD. Second, the explanation for why peritraumatic dissociation is a predictor requires considering a host of differences in both the people exposed and the nature of the exposure. It may be that the severity of the traumatic event influences the likelihood of peritraumatic dissociation, either through the level of psychophysiological arousal the individual endures during the event or through more complicated relationships involving the effects of the individual's temperament, prior experience, prior psychological functioning, and other genetic or environmental factors that affect his or her capacity to regulate the emotional response. Third, level of social support following the trauma was also a strong predictor, with more social support associated with lower likelihood of later PTSD symptoms. An individual's level of social support likely relates to his or her history and functioning prior to the trauma, factors that this literature has generally not investigated and that meta-analytic approaches cannot easily summarize.

PROBLEMS AND POTENTIAL SOLUTIONS

The main limitation of the research on predictors of PTSD is the heavy reliance on self-report measures and retrospective designs. This natu-

ralistic, retrospective approach makes sense considering the general unpredictability of exposure to trauma and the obvious ethical problems of exposing research participants to extreme stress in experimental or quasi-experimental designs. Prospective studies initiated prior to the occurrence of a major disaster or trauma, however, help address this limitation. For example, recent prospective research has assessed the psychological aftermath of the September 11 terrorist attacks in the United States (Silver, Holman, McIntosh, Poulin, & Gil-Rivas, 2002). Longitudinal research with individuals in high-risk jobs, such as jobs in the military, emergency services, and police force, also provides opportunities for prospective studies of possible predictors of PTSD.

Furthermore, the processes by which identified predictors may shape the development of PTSD remain largely unexamined. Systematic investigation of the ways in which these factors influence responses to trauma at multiple levels (e.g., behavioral, social, biological) could potentially inform interventions to attenuate or prevent PTSD. Future research should emphasize the more proximal mechanisms or processes—in psychological or physiological terms—that account for the relationship between PTSD symptoms and the more distal, static predictors such as prior trauma and family history of psychopathology. Evaluation of theory-based interventions with valid operationalization of critical variables could then provide data with which to evaluate current theory, an important area of study given the ethical prohibitions regarding experimental research in this field. Meta-analytic examination of the PTSD literature was useful in identifying simple, linear relationships between predictors and PTSD symptoms. It is likely, however, that some predictors influence each other in more complex ways; for example, a given predictor may strengthen the effects of another predictor on the development of PTSD (moderation) or may serve as the mechanism through which another predictor increases the likelihood of developing PTSD (mediation). Moreover, the unique meaning of exposure for a single individual may provide the most parsimonious explanation for why a person develops PTSD.

INTRIGUING ISSUES AND QUESTIONS

Definition of Traumatic Event

The definition of what constitutes a traumatic event is central to the diagnosis of PTSD and to all research regarding the disorder. Defining a traumatic event, however, is not simple; indeed, the diagnostic definition has changed over the past decade. Definitional issues raise interesting challenges for PTSD research as they call into question what kinds of experiences are traumatic and for whom. If two people experience the same event (e.g., encountering body parts) but only one reacts with fear, helplessness, or horror, has only one of them experienced a traumatic event?

Because traumatic events typically involve immediate horror and threat to survival (e.g., sexual assault at knifepoint, torture, combat), very high physiological arousal usually accompanies the experience. A broadening of the types of events that some people consider to be traumatic has led to inclusion in the PTSD literature of studies of highly distressing events (e.g., receiving a diagnosis of cancer) that may or may not invoke the same arousal that acute life-threatening situations do. The presence or absence of arousal may well become a key phenomenon that has implications for symptoms of PTSD and whether or not an event is deemed traumatic. If the subjective emotional and physiological response to the event is overlooked, research may not yield consistent findings that would perhaps emerge if arousal were required to identify an event as traumatic.

Ongoing Exposures and the Prototype of PTSD Symptoms

Early theories of trauma response and PTSD were largely based on individuals who lived in generally positive environments and experienced a discrete traumatic event or series of events within a discrete period of time (e.g., sexual assault, disaster, military service), so that the traumatic event or events signified a dramatic disruption of pretrauma life. It is unclear how well this model fits the experience of individuals subjected to pervasive traumatic stress, for example, in the contexts of chronic physical or sexual abuse, deadly civilian conflicts and genocide, or severe community violence in low-income urban areas. The impairments of such individuals, including problems in interpersonal relationships and affect and impulse regulation, may be complicated and difficult to treat (Herman, 1992). The self-perceptions of people who have experienced ongoing trauma seem to be dramatically worse than those of individuals who have experienced discrete traumatic events in the context of otherwise normal development. Some researchers have suggested that a separate term, such as "complex PTSD" or "disorders of extreme stress—not otherwise specified," should be used in place of PTSD to better describe this disorder. Much prior research did not examine whether the predictors of disorder differ depending on whether trauma is experienced as a discrete event or as an ongoing condition of life. Future research that investigates this distinction may find clearer patterns of predictive relationships than have been uncovered so far.

Prevention of PTSD

What are the implications of the research on predictors of PTSD for the prevention of the disorder? Secondary-prevention efforts that seek to reduce the likelihood of PTSD among individuals who have recently been exposed to traumatic stress could utilize these findings by developing early-intervention models that target processes associated with PTSD risk in the meta-analyses reviewed here (e.g., social support, peritraumatic dissociation if the affected individuals could be seen immediately following the event). Strategies for the primary prevention of PTSD would entail reducing the incidence of traumatic events. The most frequent types of traumatic events studied in the research literature have been combat exposure, interpersonal assaults, accidents, and disasters. Although some traumatic stressors, such as earthquakes, are beyond human control, action at the individual and community levels could clearly reduce the risk of exposure to many forms of traumatic stress and also shape the impact of even uncontrollable traumatic stressors on populations. Indeed, such efforts form the backbone of diverse disciplines and public-health policy efforts in areas including building and transportation safety, community violence prevention, domestic violence prevention, and international diplomacy.

There have been numerous investigations of the prevalence of PTSD in diverse communities that have experienced armed civil conflict or war, political repression, or other chronic violence. In such settings of collective trauma, it is particularly critical to look beyond the individual when considering both the effects of trauma and strategies for intervention and prevention. For example, severe political repression affects not just individuals but also the social

institutions and norms of a nation or community (Martin-Baro, 1994). Virtually all interventions for PTSD focus on the individual with symptoms and utilize medication or psychotherapy. Although these interventions may help alleviate individual symptoms, they are obviously inadequate for addressing the harm to social institutions or promoting long-term healing and mental health if the sources of persistent trauma are not addressed. When PTSD is a consequence of collective social and political conditions, primary prevention of this disorder involves social and political changes in the community or nation, as does repair of the social fabric. Thus, perhaps more than any other psychological disorder, PTSD forces consideration of advocacy and political action as primary (universal) prevention tools.

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The Perils of Perfectionism in Sports and Exercise

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ABSTRACT—*Perfectionism is a multidimensional personality construct that has been linked with various forms of maladjustment. In this article, we discuss the role of perfectionism as a maladaptive factor in sports and exercise, and we describe a phenomenon we identify as the perfectionism paradox. We note that even though certain sports require athletes to achieve perfect performance outcomes, the tendency to be characterized by perfectionistic personality traits and to be cognitively preoccupied with the attainment of perfection often undermines performance and fosters a sense of dissatisfaction with performance. We review existing findings in the literature on sports and exercise and demonstrate that the extreme orientation that accompanies perfectionism is antithetical to attaining positive outcomes. Finally, future research directions are outlined.*

KEYWORDS—*perfectionism; anxiety; sports; exercise; self-presentation*

Research on perfectionism has increased exponentially over the past two decades. This increased attention has led to an enhanced understanding of the perfectionism construct. For instance, it is now accepted generally that perfectionism is multidimensional, and it is important, both conceptually and empirically, to distinguish the various dimensions of the construct. This multidimensional approach began with the initial work in our laboratory (see Hewitt & Flett, 1991) and in the laboratory of Frost and his associates (Frost, Marten, Lahart, & Rosenblate, 1990). Our Multidimensional Perfectionism Scale (MPS; Hewitt & Flett, 1991) assesses three dimensions of the construct—self-oriented perfectionism (i.e., excessive striving and demanding absolute perfection from the self), other-oriented perfectionism (i.e., demanding perfection from other people), and socially prescribed perfectionism (i.e., the perception that other people demand perfection from oneself). The Frost et al. (1990) Multidimensional Perfectionism Scale (FMPS) assesses six dimensions, including personal standards, organization (i.e., needing to maintain a sense of order), concern over mistakes, doubts about actions, parental expectations, and parental criticism.

Although much has been learned about the perfectionism construct, the field has not been without controversy. The most controversial issue thus far has been whether certain perfectionism dimensions are adaptive rather than maladaptive. Some authors have concluded that some perfectionism dimensions contribute to positive rather than negative outcomes, and that it is important to distinguish between adaptive perfectionism and maladaptive perfectionism (see Slaney, Rice, & Ashby, 2002). That is, although dimensions such as socially prescribed perfectionism and excessive concern over mistakes have been associated with maladjustment, it has been suggested that other dimensions, such as self-oriented perfectionism and high personal standards, may, in fact, be positive factors (Slaney et al., 2002).

In the current article, we examine the adaptiveness versus maladaptiveness of perfectionism by reviewing findings on the role of perfectionism in sports and exercise. Research and theory on the role of perfectionism in sports and exercise is important in its own right, but it is also evident that research in this area has important implications for the adaptiveness-maladaptiveness issue. We adopt the view, consistent with our previous conceptualizations of perfectionism (Hewitt & Flett, 1991), that perfectionism is primarily a negative factor that contributes to maladaptive outcomes among athletes and exercisers. However, it is clear that this issue is complex because it cannot be denied that many sports require error-free performance in order for athletes to be successful. Nevertheless, we argue that a perfectionism paradox exists—that is, despite the fact there are many sports in which absolute perfection is required, negative, self-defeating outcomes and unhealthy patterns of behavior are evident among those athletes who are characterized by an extreme, perfectionistic personality and who are focused cognitively on attaining perfection.

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We present an overview of the literature on perfectionism in sports and exercise and relate existing studies back to our central theme that perfectionism is primarily maladaptive. Several questions are addressed: (a) What motivational orientations underlie perfectionism in athletes? (b) What is the link between perfectionism and self-esteem in athletes? (c) What role do perfectionistic self-presentational concerns play in sports and exercise? We conclude by discussing factors that may protect the perfectionistic athlete from experiencing negative outcomes and by outlining some fundamental themes that need to be explored in the literature on sports and exercise behavior.

PERFECTIONISM, ANXIETY, AND FAILURE ORIENTATION

The initial investigation of dimensions of perfectionism in sports was conducted by Frost and Henderson (1991). A sample of 40 women in varsity athletics completed the FMPS, along with measures assessing sports self-confidence, sports competition anxiety, thoughts before competitions, specific reactions to mistakes during competition, and the presence of a sports success orientation (e.g., "I feel a sense of pride when I play a good game") versus a failure orientation (e.g., "My mistakes usually interfere with my play"). Frost and Henderson found that concern over mistakes, as measured on the FMPS, was associated with several negative outcomes, including anxiety, low confidence, a failure orientation, and negative reactions to mistakes during competition. High personal standards were not associated significantly with the anxiety or self-confidence measures; however, athletes high in personal-standards perfectionism reported difficulty concentrating while performing, and they experienced worries about the reactions of the audience. In addition, high personal standards were associated significantly with both a success orientation and a failure orientation. Thus, it seems that individuals striving for high personal standards have strong reactions to both positive and negative responses from other people.

PERFECTIONISM AND GOAL ORIENTATION IN SPORTS

Unfortunately, there has not been extensive research on perfectionism and motivation in sports; however, important insights were provided in research by Hall, Kerr, and Matthews (1998). They assessed the associations among perfectionism, achievement goals, and competitive anxiety in 119 high school athletes. Participants completed the FMPS and provided ratings of their perceived ability. Anxiety in competitive situations was also assessed. Participants also completed a measure of task orientation (i.e., an emphasis on mastery that is believed to facilitate success) versus ego orientation (i.e., a self-focused, competitive stance that reflects a need to protect vulnerable self-esteem) in sports. Once again, it was found that several perfectionism dimensions, including concern over mistakes, were associated with anxiety. The presence of an ego orientation was associated with high scores on all FMPS subscales, including the personal-standards subscale, although scores on this subscale also had a weaker but significant association with task orientation. Thus, athletes who are extreme perfectionists have a pervasive ego orientation, and this should have debilitating effects if they also harbor doubts about their level of ability.

PERFECTIONISM AND SELF-ESTEEM

Gotwals, Dunn, and Wayment (2003) provided further evidence of the negative aspects of an excessive concern over mistakes. A sample of 87 intercollegiate athletes completed the FMPS, along with measures of general self-esteem, perceived athletic competence, and satisfaction with sports performance. Athletes who had low self-esteem, were dissatisfied with their performance, and gave comparatively low ratings to their competence (relative to the self-ratings of other athletes) tended to be concerned about their mistakes, doubted their actions, and perceived their parents as being critical of them.

Another recent investigation showed that the association between dimensions of perfectionism and self-esteem is quite complex (Koivula, Hassmén, & Fallby, 2002). Nevertheless, among their sample of Swedish elite athletes, Koivula et al. identified a subset of perfectionistic athletes with low self-esteem and a high sense that their self-esteem was contingent on meeting standards, and these athletes had high scores not only on the FMPS subscales assessing concern over mistakes and doubts about actions, but also on the personal-standards subscale. The authors concluded that a lack of success is a severe threat to such athletes, who already are vulnerable and are relatively low in self-esteem.

PERFECTIONISM AND PERFORMANCE SUCCESS VERSUS FAILURE

Empirical research in our laboratory has demonstrated the importance of distinguishing between perfectionistic athletes who experience success and those who experience failure. Perfectionists will be particularly at risk (e.g., susceptible to psychological distress and motivational deficits; see Hewitt & Flett, 2002) to the extent that they are experiencing failure as determined by objective measures or they have developed the perception that they are failing; moreover, a repeated series of failures in ego-involving life domains will have a strong, negative impact. Recent research with a sample of golfers indicates that self-oriented perfectionism is not maladaptive for relatively successful golfers who are performing at a relatively high level, but it is associated with negative thoughts and reactions to mistakes among less successful golfers (Wieczorek, Flett, & Hewitt, 2003). The deleterious effects of performance failure for self-oriented perfectionists were also illustrated by the results

of another recent experiment (see Besser, Flett, & Hewitt, 2004). A related issue is whether the perfectionist has a set of skills that make striving for perfection a somewhat realistic goal or an unrealistic goal because he or she is not capable of attaining this absolute goal.

PERFECTIONISM AND SELF-PRESENTATIONAL CONCERNS

Another key consideration when evaluating perfectionism among athletes is the extent to which they are focused excessively on self-presentational issues. Some individuals have a high concern for the impression they make on others, and when they are in social situations, they seek to portray themselves as positively as possible. Excessive self-presentational concerns can contribute to health problems, including eating disorders and a quest for bodily perfection. Although the link between perfectionism and self-presentational concerns in sports and exercise has not been investigated empirically thus far, we have identified an extreme form of perfectionistic self-presentation that may be quite relevant. Certain perfectionists are highly concerned with presenting an image of perfection to other people. Athletes with this tendency should be susceptible to a variety of negative outcomes.

With several of our colleagues, we developed the Perfectionistic Self-Presentation Scale (Hewitt et al., 2003) as a supplement to existing measures of perfectionism. Perfectionistic self-presentation involves striving to create a public image of flawlessness, either by highlighting one's success (i.e., perfectionistic self-promotion) or by minimizing one's mistakes (i.e., nondisplay or nondisclosure of imperfections). Initial research indicates that perfectionistic self-presentation is elevated in patients with eating disorders, and perfectionistic self-presentation accounts for a significant degree of various forms of psychological distress, including anxiety, depression, and negative feelings about physical appearance (see Hewitt et al., 2003).

The discovery that some individuals engage in extreme forms of perfectionistic self-presentation has a number of implications for research on sports and exercise behavior. For instance, athletes who are overly focused on perfectionistic self-presentation should be extremely self-conscious, anxious individuals who are preoccupied with public appearance and body image. Similarly, various maladaptive patterns are likely in exercisers. Some individuals may attempt to satisfy their needs for perfectionistic self-promotion by engaging in excessive, compulsive exercise. Indeed, our initial study of regular exercisers confirmed that the various dimensions of perfectionistic self-presentation are associated with compulsive exercise (Flett, Pole-Langdon, & Hewitt, 2003). These new data qualify earlier findings linking excessive exercise with dimensions of perfectionism such as self-oriented and socially prescribed perfectionism in patients with anorexia nervosa, competitive male bodybuilders, and university women (see Davis & Scott-Robertson, 2000; McLaren, Gauvin, & White, 2001) by suggesting that individual differences in perfectionistic self-presentation play a more deleterious role in exercise behavior and excessive striving than do general dimensions of perfectionism.

THE PERILS OF PERFECTIONISM: THE ROLE OF INTERVENING FACTORS

As we noted earlier, a central tenet that has guided our work on perfectionism and maladjustment is that perfectionism renders individuals vulnerable to negative outcomes such as depression if they experience personal failure (see Hewitt & Flett, 2002). By extension, perfectionists who experience success are less likely to experience distress. Additional research has investigated factors that influence the link between perfectionism and maladjustment. Key factors that have been identified include coping styles and perceived problem-solving ability (see Hewitt & Flett, 2002). Perfectionists are at greater risk if their perfectionism is accompanied by maladaptive forms of coping (i.e., avoidance-focused coping and emotion-focused coping involving rumination and self-blame) and negative appraisals of problem-solving ability. Perceptions of self-efficacy and perceptions of self-control are also potentially important influences on the link between reactions to performance outcomes and both self-oriented and socially prescribed perfectionism. At present, research on how perfectionism combines with stress and maladaptive coping to produce negative outcomes such as psychological distress has focused on general samples of psychiatric patients and university students, and little empirical research has evaluated intervening factors in athletes.

Perfectionistic athletes will be protected, to some degree, from the "perils of perfectionism" if they experience success and if they have developed a proactive, task-oriented approach to coping with difficulties and setbacks. A key aspect of the coping process for these athletes is to develop a sense of flexibility, so that they adjust their goals in accordance with situational demands and current levels of personal functioning. Moreover, the research we have summarized indicates that perfectionistic athletes with low levels of ego orientation, a sense of self-efficacy, and relatively low sensitivity to failure should be relatively resilient. In contrast, the inherent risks are higher for perfectionistic athletes who are defensively focused on mistakes and characterized by excessive fears of failure and self-doubts.

As we have noted, another key factor that needs to be considered when evaluating the perils associated with perfectionism is the individual's actual level of skill. Demands for perfection that emanate from the self or other people seem particularly irrational when they are imposed on an athlete who simply lacks the ability to approximate perfectionistic standards. Insufficient ability should magnify feelings of dissatisfaction. Athletes who overstrive to overcompensate for deficits in ability should feel particularly dissatisfied and should be especially prone to the negative effects of perfectionism.

DIRECTIONS FOR FUTURE RESEARCH

The potential intervening factors that we have outlined have not been evaluated in the context of perfectionism in sports, and research in this area is needed. In this section, we outline four other important issues that merit investigation. Most notably, there are virtually no data available on how perfectionistic athletes cope with injuries or with diminished capabilities as they age. Presumably, the all-or-none approach that characterizes perfectionism should be a deleterious factor when an athlete is seeking to cope with such challenges, and this could lead to burnout and overtraining. Another important issue that deserves attention is the impact of perfectionistic demands on children and adolescents in sports programs. How do they cope with unrealistic pressures to be perfect? A third issue concerns how athletes respond to coaches with exceptionally high levels of other-oriented perfectionism. At what point do the perfectionistic demands of these coaches contribute to a loss of motivation in the athletes? Finally, the recent creation of sports-specific measures of perfectionism (e.g., Dunn, Causgrove Dunn, & Syrotuik, 2002) leads inevitably to questions about the predictive usefulness of general versus specific measures of perfectionism in sports and exercise contexts.

CONCLUDING REMARKS

In this article, we have summarized contemporary research on perfectionism in athletes and exercisers, and concluded that perfectionism is primarily maladaptive. Moreover, the deleterious aspects of perfectionism in this context extend to dimensions (e.g., self-oriented perfectionism) that have been identified as potentially adaptive by other researchers in other contexts. We have also outlined several factors that may mitigate the association between perfectionism and maladaptive outcomes in athletes.

We conclude by noting the possibility that scholars who disagree with our position may point to several world-class elite athletes who have a demonstrated history of extreme perfectionism (e.g., Bobby Jones, John McEnroe, and Serena Williams); perfectionism seems to have worked for these individuals. However, often such athletes have documented forms of distress that can be attributed directly to their perfectionistic ways, and success emerges only following the development of emotional self-control. This observation underscores the value of a complex research strategy that examines perfectionism in conjunction with other factors of potential significance.

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The Formation of False Memories

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(Figures not included in this email version but the ms. is easy to understand without them)

For most of this century, experimental psychologists have been interested in how and why memory fails. As Greene2 has aptly noted, memories do not exist in a vacuum. Rather, they continually disrupt each other, through a mechanism that we call "interference." Literally thousands of studies have documented how our memories can be disrupted by things that we experienced earlier (proactive interference) or things that we experienced later (retroactive interference).

Relatively modern research on interference theory has focused primarily on retroactive interference effects. After receipt of new information that is misleading in some way, people make errors when they report what they saw3. The new, post-event information often becomes incorporated into the recollection, supplementing or altering it, sometimes in dramatic ways. New information invades us, like a Trojan horse, precisely because we do not detect its influence. Understanding how we become tricked by revised data about a witnessed event is a central goal of this research.

The paradigm for this research is simple. Participants first witness a complex event, such as a simulated violent crime or an automobile accident. Subsequently, half the participants receive new misleading information about the event. The other half do not get any misinformation. Finally, all participants attempt to recall the original event. In a typical example of a study using this paradigm, participants saw a video depicting a killing in a crowded town square. They then received written information about the killing, but some people were misled about what they saw. A critical blue vehicle, for instance, was referred to as being white. When later asked about their memory for the color of the vehicle, those given the phony information tended to adopt it as their memory; they said they saw white4. In these and many other experiments, people who had not received the phony information had much more accurate memories. In some experiments the deficits in memory performance following receipt of misinformation have been dramatic, with performance differences as large as 30 or 40%.

This degree of distorted reporting has been found in scores of studies, involving a wide variety of materials. People have recalled nonexistent broken glass and tape recorders, a clean-shaven man as having a mustache, straight hair as curly, stop signs as yield signs, hammers as screwdrivers, and even something as large and conspicuous as a barn in a bucolic scene that contained no buildings at all. In short, misleading post-event information can alter a person's recollection in a powerful ways, even leading to the creation of false memories of objects that never in fact existed.

Lost in a Shopping Mall

Most of the experimental research on memory distortion has involved deliberate attempts to change memory for an event that actually was experienced. An important issue is whether it is possible to implant an entire false memory for something that never happened. Could it be done in an ethically permissible way? Several years ago a method was conceived for exploring this issue; why not see whether people could be led to believe that they had been lost in a shopping mall as a child even if they had not been. (See Loftus & Ketcham, 5 for a description of the evolution of the idea for the study). In one of the first cases of successful implantation (Loftus & Coan, 6), a 14 year old boy named Chris was supplied with descriptions of three true events that supposedly happened in Chris's childhood involving Chris's mother and older brother Jim. Jim also helped construct one false event. Chris was instructed to write about all four events every day for five days, offering any facts or descriptions he could remember about each event. If he could not recall any additional details he was instructed to write "I don't remember".

The false memory was introduced in a short paragraph. It reminded Chris that he was five at the time, that Chris was lost at the University City shopping mall in Spokane, Washington where the family often went shopping. That Chris was crying heavily when he was rescued by an elderly man and reunited with his family.

Over the first five days, Chris remembered more and more about getting lost. He remembered that the man who rescued him was "really cool." He remembered being scared that he would never see his family again. He remembered his mother scolding him.

A few weeks later Chris was reinterviewed. He rated his memories on a scale from l (not clear at all) to ll (very, very clear). For the three true memories, Chris gave ratings of 1, 10, and 5. For the false shopping mall memory, he assigned his second-highest rating: 8. When asked to describe his getting lost memory, Chris provided rich details about the toy store where he got lost and his thoughts at the time ("Uh-oh. I'm in trouble now.") He remembered the man who rescued him as wearing a blue flannel shirt, kind of old, kind of bald on top.... "and, he had glasses."

Chris was soon told that one of the memories was false. Could he guess? He selected one of the real memories. When told that the memory of being lost was the false one, he had trouble believing it.

More recently we have completed a study that utilizes a procedure similar to that used with Chris. We asked 24 individuals to recall events that were supplied by a close relative. Three of

the events were true, and one was a research-crafted false event about getting lost in a shopping mall or other public place. We now describe this study in detail.

Lost again

Overview

The subjects in this study thought they were participating in a study of "the kinds of things you may be able to remember from your childhood." The subjects were given a brief description of four events that supposedly occurred while the subject and a close family member were together. Three were true events and one was the false "lost" event. Subjects tried to write about these events in detail. Later they were interviewed about the events, on two separate occasions.

Method

Subjects. Three males and 21 females, ranging in age from l8 to 53, completed all phases of the study. They were recruited by University of Washington students; each student provided a pair of individuals, which included both a subject and the subject's relative. The pairs consisted primarily of parent child pairs or sibling pairs, and the youngest member of the pair was at least l8 years of age. The "relative" member of the pair had to be knowledgeable about the childhood experiences of the "subject", the younger member of the pair.

Materials. Subjects were mailed a five page booklet containing a cover letter with instructions for completing the booklet and the scheduled interviews. The booklet contained four short stories about events from the subject's childhood provided by the older relative. In actuality, three of the stories were true, and one was the false event about getting lost. The order of events in the booklet and in the subsequent interviews was always the same, with the false event about getting lost always presented in the third position. Each event was described in a single paragraph at the top of the page, with the rest of the page left blank for the subject to record the details of his or her memory.

To see an example of the false memory paragraph, here is one created for a 20 year Vietnamese-American woman who grew up in the State of Washington: "You, your mom, Tien and Tuan, all went to the Bremerton K-Mart. You must have been five years old at the time. Your Mom gave each of you some money to get a blueberry ICEE. You ran ahead to get into the line first, and somehow lost your way in the store. Tien found you crying to an elderly Chinese woman. You three then went together to get an ICEE."

Procedure. Interviews with the relative for each subject were conducted to obtain three events that happened to the subject when they were between the ages of four and six. The stories were not to be family "folklore" or traumatic events that the subject with either remember easily or find painful to remember. In addition, the relative provided information about a plausible shopping trip to a mall or large department store in order to construct a false event where the subject could conceivably have gotten lost. The relative was asked to provide the following kinds of information: l) where the family would have shopped when the subject was about five years

old; 2) which members of the family usually went along on shopping trips; 3) what kinds of stores might have attracted the subject's interest; and 4) verification that the subject had not been lost in a mall around the age of five. The false event was then crafted from this information. The false events always included the following elements about the subject: l) lost for an extended period of time, 2) crying, 3) lost in a mall or large department store at about the age of five, 4) found and aided by an elderly woman, 5) reunited with the family.

Subjects were told that they were participating in a study on childhood memories, and that we were interested in how and why some people remembered some things and not others. They were asked to complete the booklets by reading what their relative had told us about each event, and then write what they remembered about each event. If they did not remember the event, they were told to write, "I do not remember this." After completing the booklet, they mailed it back to us in a stamped envelope that we had provided to them.

Upon receipt of the completed booklet, subjects were called and scheduled for two interviews. If it was convenient, the interviews took place at the University; otherwise, over the telephone. Initially we had planned to manipulate, as an independent variable, the time intervals between the receipt of the booklet and the two subsequent interviews, however scheduling difficulties created by subject unavailability prevented us from doing this. Thus, in the end, all subjects were first interviewed approximately 1-2 weeks after receipt of the booklet, and received a second interview approximately 1-2 weeks after that. Two interviewers, both female, conducted and recorded the interview sessions.

At the beginning of the first interview, subjects were reminded about each of the four events, one at a time, and asked to recall as much as they could about them. They were instructed to tell us everything they remembered about the event, whether or not they had already written the information in their booklets. We told the subjects we were interested in examining how much detail they could remember, and how their memories compared with those of their relative. The event paragraphs were not read to them verbatim, but rather bits of them were provided as retrieval cues. When the subject had recalled as much as possible, they were asked to rate the clarity of their memory for the event on a scale of one to ten, with one being not clear at all and ten being extremely clear. Next, subjects rated their confidence on a scale of one to five that given more time to think about the event they would be able to remember more details (1=not confident and 5= extremely confident that they would be able to remember more).

The interviewers maintained a pleasant and friendly manner, while pressing for details. After the first interview, the subjects were thanked for their time, and encouraged to think about the events and try to remember more details for the next interview, but not to discuss the events at all with their relative or anyone else.

The second interview session, conducted 1-2 weeks after the first, was essentially the same: subjects tried to remember the four events, they rated their clarity and confidence, but at the end of this session they were debriefed. The debriefing phase explained our attempt to create a memory for something that had not happened, and asked subjects to guess which event may have been the false one. We apologized for the deception and explained why it was necessary for the research.

Results

The 24 subjects were asked to remember a total of 72 true events, and succeeded in remembering something about 49 these 72 true events. Put another way, 68% of the true events were remembered. Figure 1 shows that this percentage held constant from the initial booklet stage through the two subsequent interviews. The figure also shows the rate of remembering the false event. In the booklet, 7 of the 24 subjects "remembered" the false event, either fully or partially. The partial memories included remembering parts of the event and speculations about how and when it might have happened. During the first interview, one subject decided she did not remember, leaving 6 of the 24 (25%) claiming to remember, fully or partially. This same percentage held for the second interview.

Subjects used more words when describing their true memories, whether these memories were fully or only partially recalled. For purposes of analysis, we calculated the mean number of words using only the 29% who produced a full or partial false memory in their initial booklets. The mean word length of descriptions of true memories was 138.0 whereas for descriptions of false memories it was 49.9. Six of the seven subjects used more words to describe their true than false memories, and the seventh used very few words to describe any memories (a mean of 20 for the true memories, and 21 for the false one).

During the first interview session, 17 subjects continued to maintain that they had no memory what-so-ever of the false event happening to them. One additional subject who had earlier accepted the event partially, now claimed that she did not remember being lost. Thus, 75% resisted the suggestion about being lost, and they continued to resist during the second interview.

We analyzed the clarity ratings for the subjects who embraced the false event during the first interview, and compared these clarity ratings to the ones given by these particular subjects for their true events. In general, the clarity ratings for the false events tended to be lower than for the true events. For purposes of analysis, we took five individuals who falsely remembered being lost and analyzed their mean and median clarity ratings. (Unfortunately, one subject could not be included in this analysis because clarity ratings were inadvertently not collected during the first interview). The mean clarity rating for the true memories of these five individuals was 6.3 during the first interview and also 6.3 during the second interview. The mean clarity rating for the false memory was 2.8 during the first interview and 3.6 during the second interview. (See figure 2). All five subjects had mean clarity ratings for their true events that exceeded the clarity rating for the false event. Three of the five subjects increased their clarity ratings for the false event, while two gave the same rating. Medians showed a similar pattern: higher ratings for the true than false events, and a modest rise in clarity from the first to the second interview for the false event only. The subject with missing data gave a median rating of 7.0 to her true memories and a rating of 4.0 to her false memory.

One subject's performance illustrates this pattern. She was a 20 year old woman who was convinced that she had been lost at K-Mart when she was about five. In her booklet, she used 90 words to describe her false memory, and a mean of 349 words to describe her true memories. During the two interview sessions her clarity ratings were mostly higher for the true memories than the false one, and only the clarity rating for the false memory rose from the first to the

second interview. More specifically, her false memory was initially rated a 3, then rose to 4. By contrast, her true memories were rated 7 then 2, 9 then 9, and 6 then 6.

Subjects also rated how confident they were they they would be able to recall additional details at a later time, using a scale from 1 to 5. We examined the confidence ratings for the subset of subjects embraced the false event during the first interview and who provided two sets of confidence ratings. In general the confidence ratings were low, but lower for the false event that the true ones. The mean confidence rating for the true memories for this set of people was 2.7 during the first interview and 2.2 during the second interview. The mean confidence rating for the false memory was 1.8, then 1.4. (See figure 2). All five subjects had mean confidence ratings for their true events that exceeded the confidence rating for the false one. Most of the subjects gave the same low confidence rating during the two interviews.

At the end of the second session, subjects were debriefed and asked to choose which event may have been the false one. Of the 24 total, 19 subjects correctly chose the getting-lost memory as the false one, while the remaining five incorrectly thought that one of the true events was the false one.

Even though subjects sometimes correctly choose the getting-lost memory as the false one, this does not mean that they were not previously misled into genuinely embracing the false event. Sometimes they correctly choose simply by a process of elimination. Here is an example from one subject who was led to believe that she had been lost at the Hillsdale Shopping Mall. She described her getting lost experience using 66 words (as opposed to a mean of 128 words for her true memories). During the second interview she said "I vaguely, vague, I mean this is very vague, remember the lady helping me and Tim and my mom doing something else, but I don't remember crying. I mean I can remember a hundred times crying..... I just remember bits and pieces of it. I remember being with the lady. I remember going shopping. I don't think I, I don't remember the sunglasses part." She went on to remember that the elderly lady who helped her was "heavy-set and older. Like my brother said, nice." She gave her false memory a clarity rating of 4. When the subject was debriefed and asked to tell which was the false memory, she said: "Well, it can't be Slasher, 'cause I know that he ran up in the...the chimney and I know that that cat got smashed and I know that we got robbed so it had to be that mall one." Despite the debriefing, she continued to mildly struggle with her persisting memory: "..I totally remember walking around in those dressing rooms and my mom not being in the section she said she'd be in. You know what I mean?".

Discussion

These findings reveal that people can be led to believe that entire events happened to them after suggestions to that effect. We make no claims about the percentage of people who might be able to be misled in this way, only that that we are providing an existence proof for the phenomenon of false memory formation. In addition to the current subjects, and those of Loftus and Coan (1994), we have successfully implanted the getting-lost memory in a number of other individuals, some of whom have taught us how fervently subjects will cling to their false memories even after debriefing. In two demonstration cases, supplied by The MacNeil/Lehrer News Hour, individuals were successfully led to create a false memory of being lost. The process

of memory implantation was filmed, with the subjects' full permission and cooperation, for purposes of demonstrating this scientific methodology to the public. One of the demonstration cases, Becca, was led to believe that she had been lost in the Tacoma Mall while she had been shopping with her mother and father. By her last interview, she thought she may have been looking at puppies at the pet store about the time she got lost. She rememebered "the initial panic when you realize that your mom and dad aren't there any more". She remembered the elderly lady who rescued her, and thought she may have been wearing a long-skirt. "I do remember her asking me if I was lost, and ...asking my name and then saying something about taking me to security." She remembered that she didn't cry while she was lost, but did cry when she saw her parents again. When we debriefed her at the end of the study, Becca found it so hard to believe that her getting-lost memory was false that she telephoned both of her parents to check. The parents, now divorced, independently confirmed that the episode in the Tacoma Mall had never happened.

A predictable comment about the false memories of getting lost is that people may have actually been lost in their lives, however, briefly, and they may be confusing this actual experience with the false memory description. But our subjects were not asked about any experience of being lost. They were asked to remember being lost around the age of five - in a particular location with particular people present, being frightened, and ultimately being rescued by an elderly person. This is not to say that the actual experience of being lost briefly or of hearing about someone else being lost (even Hansel and Gretel) is not important. The development of the false memory of being lost may evolve first as the mere suggestion of being lost leaves a memory trace in the brain. Even if the information is originally tagged as a suggestion rather than an historic fact, that suggestion can become linked to other knowledge about being lost (stories of others). As time passes and the tag that indicates that being lost in the mall was merely a suggestion slowly deteriorates. The memory of a real event, visiting a mall becomes confounded with the suggestion that you were once lost in a mall. Finally, when asked whether you were ever lost in a mall, your brain activates images of malls and those of being lost. The resulting memory can even be embellished with snippets from actual events, such as people once seen in a mall. Now, you "remember" being lost in a mall as a child. By this mechanism, the memory errors occur because grains of experienced events or imagined events are integrated with inferences and other elaborations that go beyond direct experience.

False memories of hospitalizations and other events

It could be argued that getting lost, however briefly, is a common experience and that fact enabled subjects to construct a false memory about a particular occasion of getting lost. Could false memories be constructed about events that were not so common in childhood experiences. Hyman et al (7) used a similar procedure to explore this issue. In their first experiment, college students were asked to recall actual events that had been reported by their parents, and one experimenter-crafted false event - an overnight hospitalization for a high fever with a possible ear infection. They were informed that they would be asked to recall childhood experiences based on information obtained from their parents. They thought the goal of the research was to compare their recall to the information supplied by the parents.

All events, including the false one, were first cued with an event title (family vacation, overnight hospitalization) and an age. If subjects couldn't recall the event they received brief additional cues, such as location or other people involved. After the first interview subjects were encouraged to continue thinking about the events, but not to discuss them, and to return for a second interview one to seven days after the first.

In the first interview, subjects recalled and described 62 of the 74 true events (84%), and in the second interview they provided memories for 3 of the 12 events that had not been remembered during the first interview. As for the false events, no subject recalled these during the first interview, but 4 of 20 subjects (20%) incorporated false information in an event description by the second interview. One subject "remembered" that the doctor was a male, but the nurse was female - and also a friend from church.

In a second study, Hyman et al tried to implant three new false events that were rather unusual. The first was attending a wedding reception and accidentally spilling a punch bowl on the parents of the bride. The second was having to evacuate a grocery store when the overhead sprinkler systems erroneously activated. The third was being left in the car n a parking lot and releasing the parking brake causing the car to roll into something. While the methodology was basically the same as in the first study, there were some minor variations. Instead of beginning by simply cueing subjects with an event title and an age, they were now given more cues at the start (age, event, location, actions, and others involved). In subsequent interviews, the researchers provided only the event title and age, and, only when subjects failed to recall the event were additional cues provided. Moreover, the experimental demands were intensified somewhat by, for example, pressures for more complete recall. There were three interviews spaced one day apart.

In the first interview, subjects recalled and described 182 of the 205 true events (89%). In the second interview they provided a bit more information, and by the third interview they had provided some recall for 95% of the events. During the third interview, subjects provided memories for 13 of the 23 true events that had not been remembered during the first interview. As for the false events, again no subject recalled these during the first interview, but 13 (or 25%) did so by the third interview. For example, one subject had no recall of the wedding "accident", stating "I have no clue. I have never heard that one before." By the second interview the subject said: "...It was an outdoor wedding and I think we were running around and knocked something over like the punch bowl or something and um made a big mess and of course got yelled at for it."

These results show that people will create false recalls of childhood experiences in response to misleading information and the social demands inherent in repeated interviews8. The process of false recall appeared to depend, in part, on accessing some relevant background information. The authors hypothesized that some form of schematic reconstruction may account for the creation of false memories. What people appear to do, at the time they encounter the false details, is to call up schematic knowledge that is closely related to the false event. Next they think about the new information in conjunction with the schema, possibly storing the new information with that schema. Now, when they later try to remember the false event, they recall the false information

and the underlying schema. The underlying schema is helpful for supporting the false event - it adds actual background information and provides the skeletal or generic scenes.

When false memories are created in this way, they can be thought about as a form of source confusion as described by Schacter and Curran (9). The false event is assumed to be a personal memory rather than as an event presented by the researchers as ostensibly coming from the parent. Schacter and Curran's patient, B.G. came to "remember" words that were never studied, probably because these words were represented in his long term memory prior to the experiment and this preexperimental familiarity was wrongly used as evidence that the word had recently appeared. Similarly, parts of the elements of the false memories created by us, and by Hyman and colleagues, are represented in long-term memory prior to the experiment. This pre-experimental familiarity can be wrongly used as evidence that the false event actually happened.

Final Comment

Nearly two decades of research on memory distortion leaves no doubt that memory can be altered via suggestion. People can be led to remember their past in different ways, and they even can be led to remember entire events that never actually happened to them. When theese sorts of distortions occur, people are sometimees confident in their distorted or false memories, and often go on to desscribe the pseudomemories in substantial detail. These findings shed light on casees in which false memories are fervently held- as in when people remember things that are biologically or geographically impossible. The findings do not, however, give us the ability to reliably distinguish between real and false memories, ofr without independent corroboration, such distinctions are generally not possible.

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