

Attention, Researchers! It Is Time to Take a Look at the Real World

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Abstract

Theories of attention, too often generated from artificial laboratory experiments, may have limited validity when attention in the natural world is considered. For instance, for more than two decades, conceptualizations of “reflexive” and “volitional” shifts of spatial attention have been grounded in methodologies that do not recognize or utilize the basic fact that people routinely use the eyes of other people as rich and complex attentional cues. This fact was confirmed by our novel discovery that eyes will trigger a reflexive shift of attention even when they are presented centrally and are known to be spatially nonpredictive. This exploration of real-world attention also led to our finding that, contrary to popular wisdom, arrows, like eyes, are capable of producing reflexive shifts of attention—a discovery that brings into question much of the existing attention research. We argue that research needs to be grounded in the real world and not in experimental paradigms. It is time for cognitive psychology to reaffirm the difficult task of studying attention in a manner that has relevance to real-life situations.

Keywords

attention; eye gaze; situated cognition; ecological validity

The researcher remote from immediate practical pressures may indeed be free to study major variables in which at this instant society does not seem to be interested; but he should not use this freedom in order to study minor variables, until there are no major ones within reach of our techniques. The necessity for some relevance to real life is a worthwhile intellectual discipline. (Broadbent, 1971, p. 4)

Broadbent is one of the most significant researchers in experimental psychology. His research and writings on attention helped to initiate and fuel the paradigm shift known as the cognitive revolution. Broadbent was adamant that psychological theory must be grounded in real-life experiences. We argue, in part on the basis of recent findings from our lab, that cognitive psychology has, over time, lost touch with this foundation. The result is that theories of attention, often arising out of artificial laboratory experiments, fail to generalize to the real world. Thus, researchers are often unable to ask, let alone answer, many major questions regarding the everyday functioning of attention.

THE CLASSIC ATTENTION PARADIGM

In the late 1970s (Posner, 1978) and early 1980s (Jonides, 1981), a methodology that would come to

be known as the Posner cuing paradigm was introduced. Since then, it has been used routinely to study human spatial attention. In this paradigm, a central fixation dot is flanked by two squares (boxes). The task is to make a key press as quickly as possible when a target item appears inside one of the boxes. This target event is preceded by a cue (the flashing of one of the boxes or the appearance of a central arrowhead pointing toward one of the boxes; see Figs. 1a and 1b). The standard finding is that the target is detected faster when it appears in the cued box than when it appears in the uncued box. Because the brain processes attended items more quickly than unattended items, it is concluded that target detection time is speeded because attention is committed to the box that was cued.

Thus, there are two different ways that attention can be directed in the Posner paradigm. One way is to flash one of the boxes (Fig. 1a). In this case, attention is directed to the cued box that flashed. This attention shift is considered *reflexive* because people are faster to detect a target in the cued box even when the flashing does not predict where the target will occur (i.e., the target appears in the cued box 50% of the time and in the uncued box 50% of the time).

The other way to direct attention in this paradigm is to present a central arrowhead pointing left or right (Fig. 1b). In this case, attention is directed to the cued box that the arrowhead pointed toward. It has been assumed, however, that this happens only when the arrowhead predicts where the target will appear (e.g., the target appears in the cued box 80% of the time and in the uncued box 20% of the time), and not when the arrowhead is nonpredictive (Fig. 1c). Thus, the attentional shift associated with a central directional cue is considered *voluntary*.

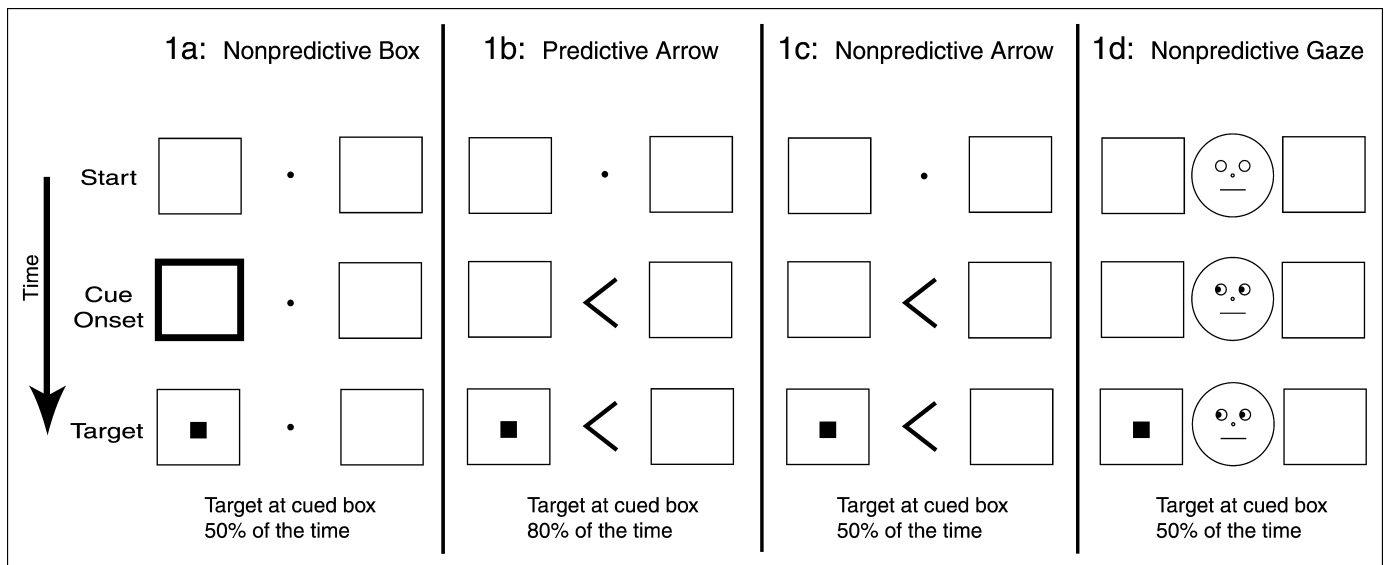


Fig. 1. Variations of the Posner paradigm. Each panel presents three stages of a typical trial (start, cue onset, and target onset); in these examples, the target (a small black square) appears at the cued box. In one variation of the paradigm (a), at the start of each trial, a central fixation dot is flanked by two squares (boxes). The left or right box is cued by a brief flash (illustrated by the thick black line), and then a target (the black square) is presented. The task is to press a key as quickly as possible when the target appears. The target appears in the cued (flashed) box 50% of the time and in the uncued (not flashed) box 50% of the time. Thus, the cue does not predict where the target will appear. In another variation (b), the left or right box is cued by an arrow pointing toward it, and the target appears in the cued box 80% of the time and in the uncued box 20% of the time. Thus, the cue predicts where the target will appear. In a third variation (c), the arrow cue is nonpredictive, as the target appears in the cued box 50% of the time and in the uncued box 50% of the time. In a fourth variation (d), the left or right box is cued by eyes looking toward it, and the target appears in the cued box 50% of the time and in the uncued box 50% of the time. Thus, the cue does not predict where the target will appear.

To what extent do these laboratory studies of simple attentional functions, such as detecting a light at cued or uncued boxes, have to do with the many experiences that people share every day, such as going to work, talking with friends, or eating a meal? On the face of it, not very much. Nevertheless, the assumption is that the principles of human attention and behavior studied in the laboratory do in fact have important implications for these everyday situations. In the words of Broadbent (1971, p. 3) "A man does not use one brain in the laboratory and another in the rest of his life." In other words, although there are many differences between the paradigms used in the laboratory and real-life situations, the assumption is that laboratory research exposes fundamental principles of human thought, attention,

and behavior that will generalize to the everyday environment.

However, this assumption is not always valid. Indeed, our research suggests that laboratory studies conceived and interpreted in isolation from real-world experience may do far worse than fail to generalize back to the natural environment; they may *generate* fundamental misunderstandings of the principles of human attention. Specifically, our results demonstrate that, contrary to the accepted view, directional cues (such as arrows) that are centrally presented and spatially nonpredictive do lead to reflexive shifts of attention. It was our studies of attention as it might operate in the real world—namely, our studies of the role of eye gaze in directing attention—that ultimately revealed this fundamental error in the traditional view, as well as a basic error in scien-

tists' understanding of how human attention is directed in the world.

ATTENTION TO EYES

Where other people look can reveal where they are attending, and thus indicate sources of potential interest in the environment. Gaze direction is such a powerful stimulus that the human eye, with its white background and darker iris, may have evolved to allow easy discrimination of small shifts in the eye direction of another individual (Kobayashi & Kohshima, 1997). And the human brain may have evolved to be especially good at picking up these signals, with cells specialized for processing gaze information. Such processing is demonstrated at a very early age in

healthy infants, with babies as young as 2 to 3 months old looking preferentially at eyes and discriminating changes in eye direction. Conversely, failures in gaze processing are linked to deficits in social cognition such as autism (Baron-Cohen, 1995).

We (Friesen & Kingstone, 1998) hypothesized that because eyes are so important to human attention, shifts in eye direction might automatically trigger attention to gazed-at locations. We tested this idea by modifying the Posner paradigm in two significant ways. First, arrows pointing to the left and right were replaced by a schematic face that looked left or right. Second, the predictive value of the central cue was eliminated; that is, eye direction did not predict where a target item would appear (see Fig. 1d). Note that because the eyes were centrally located and nonpredictive, the traditional line of thinking predicted that they would not lead to shifts of attention.

Remarkably, and contrary to the traditional way of thinking, eye gaze did trigger shifts of attention; target detection was faster for items at the gazed-at location than for items at the other location. This result led us to conclude that the attentional shift was reflexive because it emerged rapidly and in response to eyes that were spatially nonpredictive.

OPENING ONE'S EYES TO THE WORLD

Our experiments on eye gaze highlight the importance of studying attention with regard to the real world. What was taken as gospel—that a central directional stimulus must be spatially predictive to produce a shift in spatial attention—was found to be in error when tested with gaze cues.

This new perspective led us to reconsider the fundamental assumption underlying the role of arrows in directing attention. Since a classic study by Jonides (1981, Experiment 2), which failed to reject the null hypothesis that nonpredictive central arrows do not trigger orienting, researchers have assumed that arrows do not produce a shift in attention unless they predict where an item will appear. From the perspective of the real world, however, it would seem that arrows, like eyes, should produce automatic shifts in attention. This is because arrows are obviously very directional in nature, and, like eyes, they have a great deal of social significance. Indeed, it is a challenge to move through one's day without encountering any number of arrows on signs and postings.

We tested whether arrows produce reflexive shifts of attention by replacing spatially nonpredictive eyes with spatially nonpredictive arrows (Fig. 1c; Ristic, Friesen, & Kingstone, 2002). The results were unequivocal. People attend to where arrows point even when they know that the arrows do not predict where a target will appear. In other words, like eyes, arrows produce a reflexive shift in attention to the cued location. The conclusion to be drawn from this finding is that any directional cue with social significance might produce a reflexive shift in spatial attention.

WHAT HAVE ATTENTION RESEARCHERS BEEN MEASURING?

If arrows produce reflexive shifts in attention when they are spatially nonpredictive, then what exactly have researchers been measuring for the past 20 years with predictive arrows? Were they measuring volitional attention, as they assumed? To answer this question,

we (Ristic, Olk, Ho, & Kingstone, 2003) compared pure measures of reflexive orienting and volitional orienting with a measure of orienting to predictive arrows. We measured reflexive orienting using spatially nonpredictive arrows and volitional orienting using predictive central cues that were not inherently directional. The attention effect with predictive arrows was greater than the effect with predictive nondirectional cues. The implication is that the effect found with a central predictive arrow cue does not reflect solely volitional orienting. Indeed, the effect with the predictive arrows was far greater than the sum of the measures of reflexive and volitional orienting, which suggests that this effect reflects some interaction that exceeds what is produced by two pure measures of volitional and reflexive attention, or perhaps some qualitatively unique form of attentional orienting.

CONCLUSIONS AND FUTURE DIRECTIONS

By adopting a real-world perspective, the research discussed here has demonstrated three major new findings, all contrary to what traditional thinking would have predicted: (a) Central nonpredictive eye gaze produces reflexive shifts of attention, (b) central nonpredictive arrows also produce automatic orienting, and (c) central predictive directional stimuli produce an attention effect that exceeds anything that could be expected by volitional orienting alone. Together, these findings raise several important practical and theoretical issues.

Perhaps the most fundamental issue raised by the research discussed here pertains to the validity of laboratory findings in real-world situations. Specifically, the evidence suggests that laboratory

studies that have lost touch with real-life context may generate fundamental misunderstandings of the principles of human attention and behavior. It would be a mistake to think that our message applies only to the Posner paradigm. The same conclusion holds for many other laboratory paradigms used to study attention, such as the popular visual search paradigm, in which individuals look for a target hidden among a number of nontargets.

Studies of visual search have typically used very impoverished stimuli (e.g., colored rectangles) and have led to the development of several models in which attention is thought to be oriented only to primitive stimulus features (e.g., a unique color or shape) or some special combination of these primitive features (e.g., Treisman & Gelade, 1980). In contrast, visual search studies that have used real-world stimuli have led to a much different conclusion. There is now a growing body of evidence showing that in visual search, attentional orienting can be triggered not only by primitive features but also by complex object properties like social significance. For instance, we have shown that attention can be oriented by the emotional expressions of faces (Eastwood, Smilek, & Merikle, 2001). Thus, studies of visual search provide another illustration of how laboratory studies devoid of real-life context may generate fundamental misconceptions regarding the mechanisms underlying attention. Given this general problem, future research should focus on identifying which laboratory findings do, and do not, generalize to real-world situations. This seems especially relevant for studies that involve unnaturally controlled situations (e.g., neuroimaging investigations of brain activity investigations).

Another issue raised by the research we have discussed is that laboratory studies that are not mo-

tivated or informed by real-life experience run the serious risk of excluding the exploration of questions that are crucial to a fuller understanding of human attention and behavior. We believe that many interesting and yet unexplored questions about attention arise when attention is considered from the perspective of the real world. For example, what is the function of attention in everyday situations? How do people learn to orient their attention to common directional stimuli (e.g., arrows)? What role does attention play in social interactions? How does attention differ among individuals and cultures? These are just a few of the many interesting questions that have been, up to this point, largely ignored.

With these issues in mind, our conclusion is that attention researchers must strike out in a new direction—one that involves studying how attention operates when people are embedded in real-world situations. To get a more complete understanding of the brain and cognitive processes involved in attention, one must move away from studying attention in impoverished settings (e.g., mere flashes of light on a computer screen). Instead, when studying attention, one must consider both (a) the natural characteristics of observers, such as their emotions, goals, and evolutionary histories, and (b) the characteristics of observers' natural everyday environment. Because observers are influenced by the environment, and also influence their experience of the environment, one cannot separate observers from their natural environments when studying attention.

Thus, an important step in this new direction is to reinstate the link between the observer and the natural environment. One way to achieve this is to bring the world back into the laboratory by creating conditions that better approximate situations that people encounter in the real world. Our studies of how

eye gaze influences attention provide an example of our first strides in this direction. Note, however, we are not simply suggesting that researchers use everyday stimuli in the same old paradigms. In fact, it is our position that the paradigms themselves do not adequately capture important aspects of natural settings. We believe that ultimately new methods and procedures will have to be developed in order to study attention as it is used in real life.

Another way to restore the link between the observer and the natural environment is to get out of the laboratory and study how individuals actually behave in the real world. This involves *observing* and *describing* how attention operates in the real world and using these observations and descriptions to guide new ways of conceptualizing attention. Observing and describing cognition and behavior in the real world has already proven to be fruitful in other areas of study. A wonderful recent example is provided by Güntürkün (2003). He observed kissing couples in public places and recorded that twice as many adults turn their heads to the right as the left when kissing. This lovely result suggests that a rightward head-turning bias, which is present shortly before and after birth, persists into adulthood. This study highlights what Neisser (1982) wrote more than 20 years ago when he argued that psychologists should ground their research in everyday behavior: "We are finding out what really happens in the world around us, and that will be worth knowing in any imaginable future" (p. 10).

Recommended Reading

Clark, A. (1997). *Being there: Putting brain, body, and world together again*. Cambridge, MA: MIT Press.

Neisser, U., & Hyman, I.E., Jr. (1982). *Memory observed*. New York: Worth.

Rosch, E. (1999). Reclaiming concepts. *Journal of Consciousness Studies*, 6, 61–77.

Wilson, M. (2002). Six views of embodied cognition. *Psychonomic Bulletin & Review*, 9, 625–636.

Note

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References

- Baron-Cohen, S. (1995). *Mindblindness: An essay on autism and theory of mind*. Cambridge, MA: MIT Press.
- Broadbent, D.E. (1971). *Decision and stress*. London: Academic Press.
- Eastwood, J.D., Smilek, D., & Merikle, P.M. (2001). Differential attentional guidance, by unattended faces expressing positive and negative emotion. *Perception & Psychophysics*, 63, 1004–1013.
- Friesen, C.K., & Kingstone, A. (1998). The eyes have it! Reflexive orienting is triggered by nonpredictive gaze. *Psychonomic Bulletin & Review*, 5, 490–495.
- Güntürkün, O. (2003). Adult persistence of head-turning asymmetry. *Nature*, 421, 711.
- Jonides, J. (1981). Voluntary versus automatic control over the mind's eye's movement. In J.B. Long & A.D. Baddeley (Eds.), *Attention and performance IX* (pp. 187–203). Hillsdale, NJ: Erlbaum.
- Kobayashi, H., & Kohshima, S. (1997). Unique morphology of the human eye. *Nature*, 387, 767–768.
- Neisser, U. (1982). Memory: What are the important questions? In U. Neisser & I.E. Hyman, Jr. (Eds.), *Memory observed* (pp. 3–18). New York: Worth.
- Posner, M.I. (1978). *Chronometric explorations of mind*. Hillsdale, NJ: Erlbaum.
- Ristic, J., Friesen, C.K., & Kingstone, A. (2002). Are eyes special? It depends on how you look at it. *Psychonomic Bulletin & Review*, 9, 507–513.
- Ristic, J., Olk, B., Ho, S., & Kingstone, A. (2003). Endogenous orienting: What have we been measuring? *Cognitive Neuroscience Society Abstracts*, 10, 55.
- Treisman, A., & Gelade, G. (1980). A feature integration theory of attention. *Cognitive Psychology*, 12, 97–136.

Inattentive Blindness: Looking Without Seeing

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Abstract

Surprising as it may seem, research shows that we rarely see what we are looking at unless our attention is directed to it. This phenomenon can have serious life-and-death consequences. Although the inextricable link between perceiving and attending was noted long ago by Aristotle, this phenomenon, now called inattentive blindness (IB), only recently has been named and carefully studied. Among the many questions that have been raised about IB are questions about the fate of the clearly visible, yet unseen stimuli, whether any stimuli reliably capture attention, and, if so, what they have in common. Finally, is IB an instance of rapid forgetting, or is it a failure to perceive?

Keywords

inattention; perception; awareness

Imagine an experienced pilot attempting to land an airplane on a busy runway. He pays close attention to his display console, carefully watching the airspeed indicator on his windshield to make sure he does not stall, yet he never sees that another airplane is blocking his runway!

Intuitively, one might think (and hope) that an attentive pilot would notice the airplane in time. However, in a study by Haines (1991), a few experienced pilots training in flight simulators proceeded with their landing when a clearly visible airplane was blocking the runway, unaware of the

second airplane until it was too late to avoid a collision.

As it turns out, such events are not uncommon and even may account for many car accidents resulting from distraction and inattention. This is why talking on cell telephones while driving is a distinctly bad idea. However, the pervasive assumption that the eye functions like a camera and our subjective impression of a coherent and richly detailed world lead most of us to assume that we see what there is to be seen by merely opening our eyes and looking. Perhaps this is why we are so astonished by events like the airplane scenario, although less potentially damaging instances occur every day, such as when we pass by a friend without seeing her.

These scenarios are examples of what psychologists call inattentive blindness (IB; Mack & Rock, 1998). IB denotes the failure to see highly visible objects we may be looking at directly when our attention is elsewhere. Although IB is a visual phenomenon, it has auditory and tactile counterparts as well; for example, we often do not hear something said to us if we are “not listening.”

INATTENTIONAL BLINDNESS

The idea that we miss a substantial amount of the visual world at any given time is startling even though evidence for such selective seeing was first reported in the 1970s by Neisser (1979). In one of several experiments, he asked participants to view a video of two superimposed ball-passing games in which one group of players wore white uniforms and another group wore black uniforms. Participants counted the number of passes between members of one of the groups. When the participants were subsequently asked to report what they had seen, only 21% reported the presence of a woman who had unexpectedly strolled through the basketball court carrying an open umbrella, even though she was clearly in view some of the time. Researchers recently replicated this finding with a study in which a man dressed in a gorilla costume stopped to thump his chest while walking through the court and remained visible for between 5 and 9 s (Simons & Chabris, 1999).

Although it is possible that some failures to see the gorilla or the umbrella-carrying woman might have resulted from not looking directly at them, another body of work supports the alternative explanation that the observers were so intent on counting ball passes that they missed the unexpected object that appeared in plain view. Research I have conducted with my colleagues (Mack & Rock, 1998) conclusively demonstrates that, with rare exceptions, observers generally do not see what they are looking directly at when they are attending to something else. In many of these experiments, observers fixated on specified locations while simultaneously attending to a demanding perceptual task, the object of which might be elsewhere. Under these conditions, observers often failed to

perceive a clearly visible stimulus that was located exactly where they were looking.

INATTENTIONAL BLINDNESS OR INATTENTIONAL AMNESIA?

Not surprisingly, there is a controversy over whether the types of failures documented in such experiments are really evidence that the observers did not see the stimulus, or whether they in fact saw the stimulus but then quickly forgot it. In other words, is IB more correctly described as *inattentive amnesia* (Wolfe, 1999)? Although this controversy may not lend itself to an empirical resolution, many researchers find it difficult to believe that a thumping gorilla appearing in the midst of a ball game is noticed and then immediately forgotten. What makes the argument for inattentive amnesia even more difficult to sustain is evidence that unseen stimuli are capable of priming, that is, of affecting some subsequent act. (For example, if a subject is shown some object too quickly to identify it and is then shown it again so that it is clearly visible, the subject is likely to identify it more quickly than if it had not been previously flashed. This is evidence of priming: The first exposure speeded the response to the second.) Priming can occur only if there is some memory of the stimulus, even if that memory is inaccessible.

UNCONSCIOUS PERCEPTION

A considerable amount of research has investigated unconscious, or *implicit*, perception and those perceptual processes that occur outside of awareness. This work has led many researchers to conclude that events in the envi-

ronment, even if not consciously perceived, may direct later behavior. If stimuli not seen because of IB are in fact processed but encoded outside of awareness, then it should be possible to demonstrate that they prime subsequent behavior.

The typical method for documenting implicit perception entails measuring reaction time over multiple trials. Such studies are based on the assumption that an implicitly perceived stimulus will either speed up or retard subsequent responses to relevant stimuli depending on whether the priming produces facilitation or inhibition.² However, because subjects in IB experiments cannot be made aware of the critical stimulus, unlike in many kinds of priming studies, only one trial with that stimulus is possible. This requirement rules out reaction time procedures, which demand hundreds of trials because reaction time differences tend to be small and therefore require stable response rates that can be achieved only with many trials. Fortunately, an alternate procedure, stem completion, can be used when the critical stimuli are words. In this method, some observers (experimental group) are exposed to a word in an IB procedure, and other observers (control group) are not. Then, the initial few letters of the unseen word are presented to all the observers, who are asked to complete the string of letters with one or two English words. If the members of the experimental group complete the string with the unseen word more frequently than do the members of the control group, this is taken as evidence that the experimental group implicitly perceived and encoded the word.

IB experiments using this method have demonstrated significant priming (Mack & Rock, 1998), as well as other kinds of evidence that visual information undergoes substantial processing prior to the engagement of attention. For exam-

ple, evidence that aspects of visual processing take place before attention is allocated has been provided by a series of ingenious IB experiments by Moore and her collaborators (e.g., Moore & Egeth, 1997). This work has shown that under conditions of inattention, basic perceptual processes, such as those responsible for the grouping of elements in the visual field into objects, are carried out and influence task responses even though observers are unable to report seeing the percepts that result from those processes. For example, in one study using a modification of the IB procedure, Moore and Egeth investigated the Müller-Lyer illusion, in which two lines of equal length look unequal because one has outgoing fins, which make it look longer, and the other has incoming fins, which make it look shorter. In this case, the fins were formed by the grouping of background dots: Dots forming the fins were closer together than the other dots in the background. Moore and Egeth demonstrated that subjects saw the illusion even when, because of inattention, the fins were not consciously perceived. Whatever processes priming entails, the fact that it occurs is evidence of implicit perception and the encoding of a stimulus in memory. Thus, the fact that the critical stimulus in the IB paradigm can prime subsequent responses is evidence that this stimulus is implicitly perceived and encoded.

When Do Stimuli Capture Attention and Why?

That unconsciously perceived stimuli in IB experiments undergo substantial processing in the brain is also supported by evidence that the select few stimuli able to capture attention when attention is elsewhere are complex and meaningful (e.g., the observer's name, an

iconic image of a happy face) rather than simple features like color or motion. This fact suggests that attention is captured only after the meaning of a stimulus has been analyzed. There are psychologists who believe that attention operates much earlier in the processing of sensory input, before meaning has been analyzed (e.g., Treisman, 1969). These accounts, however, do not easily explain why modest changes, such as inverting a happy face and changing one internal letter in the observer's name, which alter the apparent meaning of the stimuli but not their overall shape, cause a very large increase in IB (Mack & Rock, 1998).

Meaning and the Capture of Attention

If meaning is what captures attention, then it follows axiomatically that meaning must be analyzed before attention is captured, which is thought to occur at the end stage of the processing of sensory input. This therefore implies that even those stimuli that we are not intending to see and that do not capture our attention must be fully processed by the brain, for otherwise their meanings would be lost before they had a chance of capturing our attention and being perceived. If this is the case, then we are left with some yet-unanswered, very difficult questions. Are all the innumerable stimuli imaged on our retinas really processed for meaning and encoded into memory, and if not, which stimuli are and which are not?

Although we do not yet have answers to these questions, an unpublished doctoral dissertation by Silverman, at New School University, has demonstrated that there can be priming by more than one element in a multielement display, even when these elements cannot be reported by the subject. This finding is relevant to the question

of whether all elements in the visual field are processed and stored because up to now there has been scarcely any evidence of priming by more than one unreportable element in the field. The fact of multielement priming begins to suggest that unattended or unseen elements are processed and stored, although it says nothing about how many elements are processed and whether the meaning of all the elements is analyzed.

One answer to the question of how much of what is not seen is encoded into memory comes from an account of perceptual processing based on the assumption that perception is a limited-capacity process and that processing is mandatory up to the point that this capacity is exhausted (Lavie, 1995). According to this analysis, the extent to which unattended objects are processed is a function of the difficulty of the perceptual task (i.e., the perceptual load). When the perceptual load is high, only attended stimuli are encoded. When it is low, unattended stimuli are also processed. This account faces some difficulty because it is not clear how perceptual load should be estimated. Beyond this, however, it is difficult to reconcile this account with evidence suggesting that observers are likely to see their own names even when they occur among the stimuli that must be ignored in order to perform a demanding perceptual task (Mack, Pappas, Silverman, & Gay, 2002). It should be noted, however, that these latter results are at odds with a published report (Rees, Russell, Firth, & Driver, 1999) I describe in the next section.

EVIDENCE FROM NEURAL IMAGING

Researchers have used magnetic imaging techniques to try to

determine what happens in the brain when observers fail to detect a visual stimulus because their attention is elsewhere. Neural recording techniques may be able to show whether visual stimuli that are unconsciously perceived arouse the same areas of the brain to the same extent as visual stimuli that are seen. This is an important question because it bears directly on the nature of the processing that occurs outside of awareness prior to the engagement of attention and on the difference between the processing of attended and unattended stimuli.

In one study, Scholte, Spekreijse, and Lamme (2001) found similar neural activity related to the segregation of unattended target stimuli from their backgrounds (i.e., the grouping of the unattended stimuli so they stood out from the background on which they appeared), an operation that is thought to occur early in the processing of visual input. This activation was found regardless of whether the stimuli were attended and seen or unattended and not seen, although there was increased activation for targets that were attended and seen. This finding is consistent with the behavioral findings of Moore and Egeth (1997), cited earlier, showing that unattended, unseen stimuli undergo lower-level processing such as grouping, although the additional neural activity associated with awareness suggests that there may be important differences in processing of attended versus unattended stimuli.

In another study, Rees and his colleagues (Rees et al., 1999) used functional magnetic resonance imaging (fMRI) to picture brain activity while observers were engaged in a perceptual task. They found no evidence of any difference between the neural processing of meaningful and meaningless lexical stimuli when they were ignored, although when the same stimuli were at-

tended to and seen, the neural processing of meaningful and meaningless stimuli did differ. These results suggest that unattended stimuli are not processed for meaning. However, in another study that repeated the procedure used by Rees et al. (without fMRI recordings) but included the subject's own name among the ignored stimuli, many subjects saw their names, suggesting that meaning was in fact analyzed (Mack et al., 2002). Thus, one study shows that ignored stimuli are not semantically processed, and the other suggests that they are. This conflict remains unresolved. Are unattended, unseen words deeply processed outside of awareness, despite these fMRI results, which show no evidence of semantic neural activation by ignored words? How can one reconcile behavioral evidence of priming by lexical stimuli under conditions of inattention (Mack & Rock, 1998) with evidence that these stimuli are not semantically processed?

NEUROLOGICAL DISORDER RELATED TO INATTENTIONAL BLINDNESS

People who have experienced brain injuries that cause lesions in the parietal cortex (an area of the brain associated with attention) often exhibit what is called unilateral visual neglect, meaning that they fail to see objects located in the visual field opposite the site of the lesion. That is, for example, if the lesion is on the right, they fail to eat food on the left side of their plates or to shave the left half of their faces. Because these lesions do not cause any sensory deficits, the apparent blindness cannot be attributed to sensory causes and has been explained in terms of the role of the parietal cortex in attentional

processing (Rafal, 1998). Visual neglect therefore seems to share important similarities with IB. Both phenomena are attributed to inattention, and there is evidence that in both visual neglect (Rafal, 1998) and IB, unseen stimuli are capable of priming. In IB and visual neglect, the failure to see objects shares a common cause, namely inattention, even though in one case the inattention is produced by brain damage, and in the other the inattention is produced by the task. Thus, evidence of priming by neglected stimuli appears to be additional evidence of the processing and encoding of unattended stimuli.

ATTENTION AND PERCEPTION

IB highlights the intimate link between perception and attention, which is further underscored by recent evidence showing that unattended stimuli that share features with task-relevant stimuli are less likely to suffer IB than those that do not (Most et al., 2001). This new evidence illustrates the power of our intentions in determining what we see and what we do not.

CONCLUDING REMARKS

Although the phenomenon of IB is now well established, it remains surrounded by many unanswered questions. In addition to the almost completely unexplored question concerning whether all unattended, unseen stimuli in a complex scene are fully processed outside of awareness (and if not, which are and which are not), there is the question of whether the observer can locate where in the visual field the information extracted

from a single unseen stimulus came from, despite the fact that the observer has failed to perceive it. This possibility is suggested by the proposal that there are two separate visual systems, one dedicated to action, which does not entail consciousness, and the other dedicated to perception, which does entail consciousness (Milner & Goodale, 1995). That is, the action stream may process an unseen stimulus, including its location information, although the perception stream does not. An answer to this question would be informative about the fate of the unseen stimuli.

The pervasiveness of IB raises another unresolved question. Given that people see much less than they think they do, is the visual world a mere illusion? According to one provocative answer to this question, most recently defended by O'Regan and Noe (2001), the outcome of perceptual processing is not the construction of some internal representation; rather, seeing is a way of exploring the environment, and the outside world serves as its own external representation, eliminating the need for internal representations. Whether or not this account turns out to be viable, the phenomenon of IB has raised a host of questions, the answers to which promise to change scientists' understanding of the nature of perception. The phenomenon itself points to the serious dangers of inattention.

Recommended Reading

- Mack, A., & Rock, I. (1998). (See References)
- Rensink, R. (2002). Change blindness. *Annual Review of Psychology*, *53*, 245–277.
- Simons, D. (2000). Current approaches to change blindness. *Visual Cognition*, *7*, 1–15.
- Wilkens, P. (Ed.). (2000). Symposium on Mack and Rock's *Inattentional Blindness*. *Psyche*, *6* and *7*. Retrieved from <http://psyche.cs.monash.edu.au/psyche-index-v7.html#ib>

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Notes

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2. An example of a speeded-up response (facilitation, or positive priming) has already been given. Negative, or inhibition, priming occurs when a stimulus that has been actively ignored is subsequently presented. For example, if a series of superimposed red and green shapes is rapidly presented and subjects are asked to report a feature of the red shapes, later on it is likely to take them longer to identify the green shapes than a shape that has not previously appeared, suggesting that the mental representation of the green shapes has been associated with something like an "ignore me" tag.

References

- Haines, R.F. (1991). A breakdown in simultaneous information processing. In G. Obrecht & L.W. Stark (Eds.), *Presbyopia research* (pp. 171–175). New York: Plenum Press.
- Lavie, N. (1995). Perceptual load as a necessary condition for selective attention. *Journal of Experimental Psychology: Human Perception and Performance*, *21*, 451–468.
- Mack, A., Pappas, Z., Silverman, M., & Gay, R. (2002). What we see: Inattention and the capture of attention by meaning. *Consciousness and Cognition*, *11*, 488–506.
- Mack, A., & Rock, I. (1998). *Inattentional blindness*. Cambridge, MA: MIT Press.
- Milner, D., & Goodale, M.A. (1995). *The visual brain in action*. Oxford, England: Oxford University Press.
- Moore, C.M., & Egeth, H. (1997). Perception without attention: Evidence of grouping under conditions of inattention. *Journal of Experimental Psychology: Human Perception and Performance*, *23*, 339–352.
- Most, S.B., Simons, D.J., Scholl, B.J., Jimenez, R., Clifford, E., & Chabris, C.F. (2001). How not to be seen: The contribution of similarity and selective ignoring to sustained inattentional blindness. *Psychological Science*, *12*, 9–17.
- Neisser, U. (1979). The control of information pickup in selective looking. In A.D. Pick (Ed.), *Perception and its development: A tribute to Eleanor Gibson* (pp. 201–219). Hillsdale, NJ: Erlbaum.
- O'Regan, K., & Noe, A. (2001). A sensorimotor account of vision and visual consciousness. *Behavioral and Brain Sciences*, *25*, 5.
- Rafal, R. (1998). Neglect. In R. Parasuraman (Ed.), *The attentive brain* (pp. 489–526). Cambridge, MA: MIT Press.
- Rees, G., Russell, C., Firth, C., & Driver, J. (1999). Inattentional blindness versus inattentional amnesia. *Science*, *286*, 849–860.
- Scholte, H.S., Spekreijse, H., & Lamme, V.A. (2001). Neural correlates of global scene segmentation are present during inattentional blindness [Abstract]. *Journal of Vision*, *1*(3), Article 346. Retrieved from <http://journalofvision.org/1/3/346>
- Simons, D.J., & Chabris, C.F. (1999). Gorillas in our midst: Sustained inattention blindness for dynamic events. *Perception*, *28*, 1059–1074.
- Treisman, A. (1969). Strategies and models of selective attention. *Psychological Review*, *76*, 282–299.
- Wolfe, J. (1999). Inattentional amnesia. In V. Coltheart (Ed.), *Fleeting memories* (pp. 71–94). Cambridge, MA: MIT Press.

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”

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

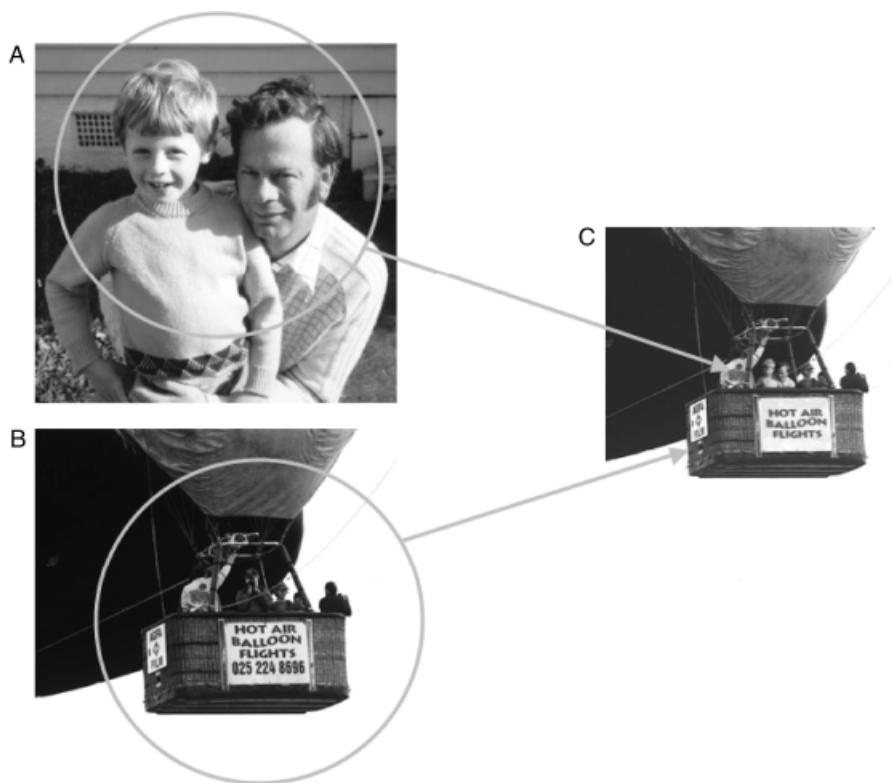


Fig. 1. Demonstration of the doctoring process as used in Wade et al. (2002). Subjects are “cut” from an original photo (A) and “pasted” into a dummy balloon photo (B). Subjects are shown the false photo (C) and asked how much they remember about the event over three interviews.

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 *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 a 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.

Recommended Reading

- Lindsay, D.S., Hagen, L., Read, J.D., Wade, K.A., & Garry, M. (2004). (See References)
- Loftus, E.F. (2003). Our changeable memories: Legal and practical implications. *Nature Reviews Neuroscience*, 4, 231–234.
- Wade, K.A., Garry, M., Read, J.D., & Lindsay, D.S. (2002). (See References)
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REFERENCES

- Bernstein, D.M., Whittlesea, B.W.A., & Loftus, E.F. (2002). Increasing confidence in remote autobiographical memory and general knowledge: Extensions of the revelation effect. *Memory & Cognition*, 30, 432–438.
- Clark, A., & Chalmers, D. (1998). The extended mind. *Analysis*, 58, 7–19.
- David, P. (1998). News concreteness and visual-verbal association: Do news pictures narrow the recall gap between concrete and abstract news? *Human Communication Research*, 25, 180–201.
- Dolan, Y.M. (1991). Resolving sexual abuse: Solution-focused therapy and Ericksonian hypnosis for adult survivors. New York: Norton.
- Garry, M., Strange, D., Bernstein, D., & Kinzett, T. (2005). *Photographs can distort memory for the news*. Manuscript submitted for publication.
- Garry, M., & Wade, K.A. (2005). Actually, a picture is worth less than 45 words: Narratives produce more false memories than photographs. *Psychonomic Bulletin & Review*, 12, 359–366.
- Johnson, M.K., Hashtroudi, S., & Lindsay, D.S. (1993). Source monitoring. *Psychological Bulletin*, 114, 3–28.
- Kehle, T.J., Bray, M.A., Margiano, S.G., Theodore, L.A., & Zhou, Z. (2002). Self-modeling as an effective intervention for students with serious emotional disturbance: Are we modifying children's memories? *Psychology in the schools*, 39, 203–207.
- Kelly, J.D., & Nace, D. (1994). Knowing about digital imaging and believing news photographs. *Visual Communication Quarterly*, 18(1), 4–5.
- Lindsay, D.S., Hagen, L., Read, J.D., Wade, K.A., & Garry, M. (2004). True photographs and false memories. *Psychological Science*, 15, 149–154.

- Loftus, E.F., & Pickrell, J.E. (1995). The formation of false memories. *Psychiatric Annals*, 25, 720–725.
- Neimeyer, G.J., & Metzler, A.E. (1994). Personal identity and autobiographical recall. In U. Neisser & R. Fivush (Eds.), *The remembering self: Construction and accuracy in the self-narrative* (pp. 105–135). NY: Cambridge University Press.
- Rosenberg, S. (1995, December). You can't believe your eyes. *Wired*, 3(12), 170–171.
- Sorry . . . we were hoaxed. (2004, May 15). *Daily Mirror*, p. 1.
- Wade, K.A., Garry, M., Read, J.D., & Lindsay, D.S. (2002). A picture is worth a thousand lies: Using false photographs to create false childhood memories. *Psychonomic Bulletin & Review*, 9, 597–603.
- Weiser, J. (2002). PhotoTherapy techniques: Exploring the secrets of personal snapshots and family albums. *Child & Family*, 5, 16–25.
- Wigoder, M. (2001). History begins at home. *History and memory: Studies in representations of the past*, 13, 19–59.

Recovering Memories of Trauma: A View From the Laboratory

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Abstract

The controversy over the validity of repressed and recovered memories of childhood sexual abuse (CSA) has been extraordinarily bitter. Yet data on cognitive functioning in people reporting repressed and recovered memories of trauma have been strikingly scarce. Recent laboratory studies have been designed to test hypotheses about cognitive mechanisms that ought to be operative if people can repress and recover memories of trauma or if they can form false memories of trauma. Contrary to clinical lore, these studies have shown that people reporting CSA histories are not characterized by a superior ability to forget trauma-related material. Other studies have shown that individuals reporting recovered memories of either CSA or abduction by space aliens are characterized by heightened proneness to form false memories in certain laboratory tasks. Although cognitive psychology methods cannot distinguish true memories from false ones, these methods can illuminate mechanisms for remembering and forgetting among people reporting histories of trauma.

Keywords

recovered memories; trauma; repression; sexual abuse; dissociation

How victims remember trauma is among the most explosive issues

facing psychology today. Most experts agree that combat, rape, and other horrific experiences are unforgettably engraved on the mind (Pope, Oliva, & Hudson, 1999). But some also believe that the mind can defend itself by banishing traumatic memories from awareness, making it difficult for victims to remember them until many years later (Brown, Schefflin, & Hammond, 1998).

This controversy has spilled out of the clinics and cognitive psychology laboratories, fracturing families, triggering legislative change, and determining outcomes in civil suits and criminal trials. Most contentious has been the claim that victims of childhood sexual abuse (CSA) often repress and then recover memories of their trauma in adulthood.² Some psychologists believe that at least some of these memories may be false—inadvertently created by risky therapeutic methods (e.g., hypnosis, guided imagery; Ceci & Loftus, 1994).

One striking aspect of this controversy has been the paucity of data on cognitive functioning in people reporting repressed and recovered memories of CSA. Accordingly, my colleagues and I have been conducting studies designed to test hypotheses about mechanisms that might enable people either to repress and recover memories of trauma or to develop false memories of trauma.

For several of our studies, we recruited four groups of women from the community. Subjects in the *repressed-memory group* suspected they had been sexually abused as children, but they had

no explicit memories of abuse. Rather, they inferred their hidden abuse history from diverse indicators, such as depressed mood, interpersonal problems with men, dreams, and brief, recurrent visual images (e.g., of a penis), which they interpreted as “flashbacks” of early trauma. Subjects in the *recovered-memory group* reported having remembered their abuse after long periods of not having thought about it.³ Unable to corroborate their reports, we cannot say whether the memories were true or false. Lack of corroboration, of course, does not mean that a memory is false. Subjects in the *continuous-memory group* said that they had never forgotten their abuse, and subjects in the *control group* reported never having been sexually abused.

PERSONALITY TRAITS AND PSYCHIATRIC SYMPTOMS

To characterize our subjects in terms of personality traits and psychiatric symptoms, we asked them to complete a battery of questionnaires measuring normal personality variation (e.g., differences in absorption, which includes the tendency to fantasize and to become emotionally engaged in movies and literature), depressive symptoms, posttraumatic stress disorder (PTSD) symptoms, and dissociative symptoms (alterations in consciousness, such as memory lapses, feeling disconnected with one’s body, or episodes of “spacing out”; McNally, Clancy, Schacter, & Pitman, 2000b).

There were striking similarities and differences among the groups in terms of personality profiles and psychiatric symptoms. Subjects who had always remembered their abuse were indistinguishable from those who said they had never been abused on all personality measures. Moreover, the continuous-memory and control groups

did not differ in their symptoms of depression, posttraumatic stress, or dissociation. However, on the measure of negative affectivity—prone to experience sadness, anxiety, anger, and guilt—the repressed-memory group scored higher than did either the continuous-memory or the control group, whereas the recovered-memory group scored midway between the repressed-memory group on the one hand and the continuous-memory and control groups on the other.

The repressed-memory subjects reported more depressive, dissociative, and PTSD symptoms than did continuous-memory and control subjects. Repressed-memory subjects also reported more depressive and PTSD symptoms than did recovered-memory subjects, who, in turn, reported more dissociative and PTSD symptoms than did control subjects. Finally, the repressed- and recovered-memory groups scored higher than the control group on the measure of fantasy proneness, and the repressed-memory group scored higher than the continuous-memory group on this measure.

This psychometric study shows that people who believe they harbor repressed memories of sexual abuse are more psychologically distressed than those who say they have never forgotten their abuse.

FORGETTING TRAUMA-RELATED MATERIAL

Some clinical theorists believe that sexually molested children learn to disengage their attention during episodes of abuse and allocate it elsewhere (e.g., Terr, 1991). If CSA survivors possess a heightened ability to disengage attention from threatening cues, impairing their subsequent memory for them, then this ability ought to be evident in the laboratory. In our first exper-

iment, we used directed-forgetting methods to test this hypothesis (McNally, Metzger, Lasko, Clancy, & Pitman, 1998). Our subjects were three groups of adult females: CSA survivors with PTSD, psychiatrically healthy CSA survivors, and nonabused control subjects. Each subject was shown, on a computer screen, a series of words that were either trauma related (e.g., *molested*), positive (e.g., *charming*), or neutral (e.g., *mailbox*). Immediately after each word was presented, the subject received instructions telling her either to remember the word or to forget it. After this encoding phase, she was asked to write down all the words she could remember, irrespective of the original instructions that followed each word.

If CSA survivors, especially those with PTSD, are characterized by heightened ability to disengage attention from threat cues, thereby attenuating memory for them, then the CSA survivors with PTSD in this experiment should have recalled few trauma words, especially those they had been told to forget. Contrary to this hypothesis, this group exhibited memory deficits for positive and neutral words they had been told to remember, while demonstrating excellent memory for trauma words, including those they had been told to forget. Healthy CSA survivors and control subjects recalled remember-words more often than forget-words regardless of the type of word. Rather than possessing a superior ability to forget trauma-related material, the most distressed survivors exhibited difficulty banishing this material from awareness.

In our next experiment, we used this directed-forgetting approach to test whether repressed- and recovered-memory subjects, relative to nonabused control subjects, would exhibit the hypothesized superior ability to forget material related to trauma (McNally, Clancy, & Schacter, 2001). If anyone pos-

esses this ability, it ought to be such individuals. However, the memory performance of the repressed- and recovered-memory groups was entirely normal: They recalled remember-words better than forget-words, regardless of whether the words were positive, neutral, or trauma related.

INTRUSION OF TRAUMATIC MATERIAL

The hallmark of PTSD is involuntary, intrusive recollection of traumatic experiences. Clinicians have typically relied on introspective self-reports as confirming the presence of this symptom. The emotional Stroop color-naming task provides a quantitative, non-introspective measure of intrusive cognition. In this paradigm, subjects are shown words varying in emotional significance, and are asked to name the colors the words are printed in while ignoring the meanings of the words. When the meaning of a word intrusively captures the subject's attention despite the subject's efforts to attend to its color, Stroop interference—delay in color naming—occurs. Trauma survivors with PTSD take longer to name the colors of words related to trauma than do survivors without the disorder, and also take longer to name the colors of trauma words than to name the colors of positive and neutral words or negative words unrelated to their trauma (for a review, see McNally, 1998).

Using the emotional Stroop task, we tested whether subjects reporting either continuous, repressed, or recovered memories of CSA would exhibit interference for trauma words, relative to nonabused control subjects (McNally, Clancy, Schacter, & Pitman, 2000a). If severity of trauma motivates repression of traumatic memories, then subjects who cannot recall their

presumably repressed memories may nevertheless exhibit interference for trauma words. We presented a series of trauma-related, positive, and neutral words on a computer screen, and subjects named the colors of the words as quickly as possible. Unlike patients with PTSD, including children with documented abuse histories (Dubner & Motta, 1999), none of the groups exhibited delayed color naming of trauma words relative to neutral or positive ones.

MEMORY DISTORTION AND FALSE MEMORIES IN THE LABORATORY

Some psychotherapists who believe their patients suffer from repressed memories of abuse will ask them to visualize hypothetical abuse scenarios, hoping that this guided-imagery technique will unblock the presumably repressed memories. Unfortunately, this procedure may foster false memories.

Using Garry, Manning, Loftus, and Sherman's (1996) methods, we tested whether subjects who have recovered memories of abuse are more susceptible than control subjects to this kind of memory distortion (Clancy, McNally, & Schacter, 1999). During an early visit to the laboratory, subjects rated their confidence regarding whether they had experienced a series of unusual, but nontraumatic, childhood events (e.g., getting stuck in a tree). During a later visit, they performed a guided-imagery task requiring them to visualize certain of these events, but not others. They later rerated their confidence that they had experienced each of the childhood events. Nonsignificant trends revealed an inflation in confidence for imagined versus nonimagined events. But the magnitude of this memory distortion was

more than twice as large in the control group as in the recovered-memory group, contrary to the hypothesis that people who have recovered memories of CSA would be especially vulnerable to the memory-distorting effects of guided imagery.

To use a less-transparent paradigm for assessing proneness to develop false memories, we adapted the procedure of Roediger and McDermott (1995). During the encoding phase in this paradigm, subjects hear word lists, each consisting of semantically related items (e.g., *sour, bitter, candy, sugar*) that converge on a nonpresented word—the *false target*—that captures the gist of the list (e.g., *sweet*). On a subsequent recognition test, subjects are given a list of words and asked to indicate which ones they heard during the previous phase. The false memory effect occurs when subjects “remember” having heard the false target. We found that recovered-memory subjects exhibited greater proneness to this false memory effect than did subjects reporting either repressed memories of CSA, continuous memories of CSA, or no abuse (Clancy, Schacter, McNally, & Pitman, 2000). None of the lists was trauma related, and so we cannot say whether the effect would have been more or less pronounced for words directly related to sexual abuse.

In our next experiment, we tested people whose memories were probably false: individuals reporting having been abducted by space aliens (Clancy, McNally, Schacter, Lenzenweger, & Pitman, 2002). In addition to testing these individuals (and control subjects who denied having been abducted by aliens), we tested individuals who believed they had been abducted, but who had no memories of encountering aliens. Like the repressed-memory subjects in our previous studies, they inferred

their histories of trauma from various “indicators” (e.g., a passion for reading science fiction, unexplained marks on their bodies). Like subjects with recovered memories of CSA, those reporting recovered memories of alien abduction exhibited pronounced false memory effects in the laboratory. Subjects who only believed they had been abducted likewise exhibited robust false memory effects.

CONCLUSIONS

The aforementioned experiments illustrate one way of approaching the recovered-memory controversy. Cognitive psychology methods cannot ascertain whether the memories reported by our subjects were true or false, but these methods can enable testing of hypotheses about mechanisms that ought to be operative if people can repress and recover memories of trauma or if they can develop false memories of trauma.

Pressing issues remain unresolved. For example, experimentalists assume that directed forgetting and other laboratory methods engage the same cognitive mechanisms that generate the signs and symptoms of emotional disorder in the real world. Some therapists question the validity of this assumption. Surely, they claim, remembering or forgetting the word *incest* in a laboratory task fails to capture the sensory and narrative complexity of autobiographical memories of abuse. On the one hand, the differences between remembering the word *incest* in a directed-forgetting experiment, for example, and recollecting an episode of molestation do, indeed, seem to outweigh the similarities. On the other hand, laboratory studies may underestimate clinical relevance. For example, if someone

cannot expel the word *incest* from awareness during a directed-forgetting experiment, then it seems unlikely that this person would be able to banish autobiographical memories of trauma from consciousness. This intuition notwithstanding, an important empirical issue concerns whether these tasks do, indeed, engage the same mechanisms that figure in the cognitive processing of traumatic memories outside the laboratory.

A second issue concerns attempts to distinguish subjects with genuine memories of abuse from those with false memories of abuse. Our group is currently exploring whether this might be done by classifying trauma narratives in terms of how subjects describe their memory-recovery experience. For example, some of the subjects in our current research describe their recovered memories of abuse by saying, "I had forgotten about that. I hadn't thought about the abuse in years until I was reminded of it recently." The narratives of other recovered-memory subjects differ in their experiential quality. These subjects, as they describe it, suddenly realize that they are abuse survivors, sometimes attributing current life difficulties to these long-repressed memories. That is, they do not say that they have remembered forgotten events they once knew, but rather indicate that they have learned (e.g., through hypnosis) the abuse occurred. It will be important to determine whether these two groups of recovered-memory subjects differ cognitively. For example, are subjects exemplifying the second type of recovered-memory experience more prone to develop false memories in the laboratory than are subjects exemplifying the first type of experience?

Recommended Reading

- Lindsay, D.S., & Read, J.D. (1994). Psychotherapy and memories of childhood sexual abuse: A cognitive perspective. *Applied Cognitive Psychology, 8*, 281–338.
- McNally, R.J. (2001). The cognitive psychology of repressed and recovered memories of childhood sexual abuse: Clinical implications. *Psychiatric Annals, 31*, 509–514.
- McNally, R.J. (2003). Progress and controversy in the study of post-traumatic stress disorder. *Annual Review of Psychology, 54*, 229–252.
- McNally, R.J. (2003). *Remembering trauma*. Cambridge, MA: Belknap Press/Harvard University Press.
- Piper, A., Jr., Pope, H.G., Jr., & Borowiecki, J.J., III. (2000). Custer's last stand: Brown, Schefflin, and Whitfield's latest attempt to salvage "dissociative amnesia." *Journal of Psychiatry and Law, 28*, 149–213.

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Notes

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2. Some authors prefer the term *dissociation* (or *dissociative amnesia*) to *repression*. Although these terms signify different proposed mechanisms, for practical purposes these variations make little difference in the recovered-memory debate. Each term implies a defensive process that blocks access to disturbing memories.

3. However, not thinking about a disturbing experience for a long period of time must not be equated with an inability to remember it. Amnesia denotes an inability to recall information that has been encoded.

References

- Brown, D., Schefflin, A.W., & Hammond, D.C. (1998). *Memory, trauma treatment, and the law*. New York: Norton.
- Ceci, S.J., & Loftus, E.F. (1994). 'Memory work': A royal road to false memories? *Applied Cognitive Psychology, 8*, 351–364.
- Clancy, S.A., McNally, R.J., & Schacter, D.L. (1999). Effects of guided imagery on memory distortion in women reporting recovered memories of childhood sexual abuse. *Journal of Traumatic Stress, 12*, 559–569.
- Clancy, S.A., McNally, R.J., Schacter, D.L., Lenzenweger, M.F., & Pitman, R.K. (2002). Memory distortion in people reporting abduction by aliens. *Journal of Abnormal Psychology, 111*, 455–461.
- Clancy, S.A., Schacter, D.L., McNally, R.J., & Pitman, R.K. (2000). False recognition in women reporting recovered memories of sexual abuse. *Psychological Science, 11*, 26–31.
- Dubner, A.E., & Motta, R.W. (1999). Sexually and physically abused foster care children and posttraumatic stress disorder. *Journal of Consulting and Clinical Psychology, 67*, 367–373.
- Garry, M., Manning, C.G., Loftus, E.F., & Sherman, S.J. (1996). Imagination inflation: Imagining a childhood event inflates confidence that it occurred. *Psychonomic Bulletin & Review, 3*, 208–214.
- McNally, R.J. (1998). Experimental approaches to cognitive abnormality in posttraumatic stress disorder. *Clinical Psychology Review, 18*, 971–982.
- McNally, R.J., Clancy, S.A., & Schacter, D.L. (2001). Directed forgetting of trauma cues in adults reporting repressed or recovered memories of childhood sexual abuse. *Journal of Abnormal Psychology, 110*, 151–156.
- McNally, R.J., Clancy, S.A., Schacter, D.L., & Pitman, R.K. (2000a). Cognitive processing of trauma cues in adults reporting repressed, recovered, or continuous memories of childhood sexual abuse. *Journal of Abnormal Psychology, 109*, 355–359.
- McNally, R.J., Clancy, S.A., Schacter, D.L., & Pitman, R.K. (2000b). Personality profiles, dissociation, and absorption in women reporting repressed, recovered, or continuous memories of childhood sexual abuse. *Journal of Consulting and Clinical Psychology, 68*, 1033–1037.
- McNally, R.J., Metzger, L.J., Lasko, N.B., Clancy, S.A., & Pitman, R.K. (1998). Directed forgetting of trauma cues in adult survivors of childhood sexual abuse with and without posttraumatic stress disorder. *Journal of Abnormal Psychology, 107*, 596–601.
- Pope, H.G., Jr., Oliva, P.S., & Hudson, J.I. (1999). Repressed memories: The scientific status. In D.L. Faigman, D.H. Kaye, M.J. Saks, & J. Sanders (Eds.), *Modern scientific evidence: The law and science of expert testimony* (Vol. 1, pocket part, pp. 115–155). St. Paul, MN: West Publishing.
- Roediger, H.L., III, & McDermott, K.B. (1995). Creating false memories: Remembering words not presented in lists. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21*, 803–814.
- Terr, L.C. (1991). Childhood traumas: An outline and overview. *American Journal of Psychiatry, 148*, 10–20.

Neurobehavioral Changes in Adolescence

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Abstract

Adolescents across a variety of species exhibit age-specific behavioral characteristics that may have evolved to help them attain the necessary skills for independence. These adolescent-related characteristics, such as an increase in risk taking, may be promoted less by the hormonal changes of puberty than by developmental events occurring in brain. Among the prominent brain transformations of adolescence are alterations in the prefrontal cortex, limbic brain areas, and their dopamine input, systems that are sensitive to stressors and form part of the neural circuitry modulating the motivational value of drugs and other reinforcing stimuli. Such developmental transformations of the adolescent brain may predispose adolescents to behave in particular ways and make them particularly likely to initiate use of alcohol and other drugs.

Keywords

adolescent; adolescence; brain development; risk taking; drug use

To successfully negotiate the developmental transition from youth to maturity, adolescents of many species must survive the risks and stressors of this disequilibrating passage while acquiring the skills necessary for independence and success in adult life. Although cer-

tain attributes of human adolescents are unique and not evident in other species, other characteristic features are expressed by adolescents of diverse species and may be evolutionarily adaptive in helping the adolescent conquer this critical transition. For instance, like their counterparts among human adolescents, rats undergoing the developmental transition of adolescence likewise show a marked developmental increase in the amount of time spent in social investigation and interaction with peers, along with elevations in risk-taking behavior, illustrated by their seeking out novel stimuli and exploring unknown areas more avidly than at younger ages or in adulthood. Although some adolescent-associated increase in risk taking and sensation seeking appears normative across a variety of species, there may be individual differences in the expression of these propensities within species. High levels of risk taking may be maladaptive, leading to excessive use of drugs and alcohol by some human adolescents or their involvement in reckless activities that may be life-threatening for themselves or others.

One of the prominent physiological events occurring at some point within the broad age range of adolescence is a pubertal increase in sex hormones (e.g., estrogen in females and testosterone in males) and the associated emergence of secondary sexual characteristics. Yet, there is surprisingly little evidence that these hormonal alterations are associated in any simple

fashion with behavioral change during adolescence (Susman et al., 1987). Instead, striking changes that occur in the adolescent brain may contribute to the behavioral changes characteristic of this age. Brain areas undergoing remodeling during adolescence in a variety of species include stressor-sensitive forebrain regions implicated in novelty seeking and in modulating the motivational value of drugs and other reinforcing stimuli. Given the clear differences between adolescents and adults in functioning of these brain regions, it would be surprising indeed if adolescents did not differ from adults in various aspects of their behavior toward these stimuli.

ADOLESCENT-TYPICAL BEHAVIORS AND RESPONSES TO STRESSORS

Social Interactions and Peer Affiliations

Social interactions, particularly with peers, take on increasing importance during adolescence in many species. Human adolescents spend substantially more time interacting socially with peers than with adults; peer-directed social interactions may help the adolescent develop social skills away from the home environment and hence ease the transition toward independence (Larson & Richards, 1994). In many species, social interactions also help guide choice behavior, such as selection of appropriate food items, and provide the opportunity to practice and model adult-typical behavior patterns (Galef, 1981).

Sensation Seeking and Risk Taking

Adolescents across a variety of species exhibit age-related in-

creases in novelty seeking, sensation seeking, and risk taking (Arnett, 1992; Spear, in press). This may have evolutionary significance in providing the impetus to explore novel and broader areas away from the home, helping to avoid inbreeding via dispersal of male (and sometimes female) offspring to new territories away from the initial social unit before they reproduce. Such increases in risk taking may also provide the opportunity to explore new behaviors and potential rewards, perhaps facilitating the relinquishing of childhood patterns of behavior as well as the acquisition of behaviors essential for successful adult functioning.

The kinds of risks that human adolescents take include not only reckless behavior, school misconduct, and so-called antisocial behaviors (including fighting, stealing, trespassing, and property damage), but also use of alcohol, cigarettes, and illicit drugs. Shedler and Block (1990) have argued that modest amounts of risk taking may represent "developmentally appropriate experimentation," noting that, for instance, adolescents engaging in moderate extents of risk taking have been found to be more socially competent in both childhood and adolescence than abstainers as well as frequent risk takers. Thus, although there may be constructive functions of risk taking—at least in an evolutionary sense and arguably also for the individual human adolescent—excess may be disadvantageous, if not life-threatening, for the adolescent or others.

Adolescent Drug Use

As with other types of risk-taking behavior, some amount of exploratory drug use is normative in human adolescents. According to the 1996 survey results from the

Monitoring the Future Study, sponsored by the National Institute of Drug Abuse, by the time that adolescents reach their senior year in high school, approximately 50% have used marijuana or hashish, 65% have smoked cigarettes, and 82% have drunk alcohol (Johnston, O'Malley, & Bachman, 1998). This drug use begins relatively early in adolescence, with 26% of 8th graders reporting use of alcohol and 15% reporting use of illicit drugs in the prior month. Some of this use is excessive. For instance, 10% of 8th graders, 21% of 10th graders, and 31% of 12th graders reported getting drunk one or more times during the past month. Clearly, many adolescents engage in at least some exploratory drug use, with evidence of excessive use emerging in some individuals.

Consequences of such use may be long-lasting. Early onset of drug and alcohol use is one of the strongest predictors of later abuse of alcohol and other drugs (Grant & Dawson, 1997). It remains to be determined whether early drug use serves merely as a marker of later abuse or whether such drug exposure is causal, influencing ongoing brain development to induce long-term alterations in neural function that increase later propensity for drug abuse.

Stress and Adolescence

Studies examining adolescents of a variety of species have shown that adolescents may be more disrupted by stressors than adults are. Although most human adolescents traverse this developmental period without significant psychological problems, the incidence of depressed mood is greater during adolescence than at younger or older ages (Petersen et al., 1993). Adolescents may generally respond with greater negative affect to circumstances in their environ-

ment than do children and adults; even when referring to the same activities, adolescents often find them less pleasurable than their parents (Larson & Richards, 1994).

Physiologically as well, adolescents may show an increased responsiveness to stressors. Human adolescents exhibit greater increases in blood pressure and in blood flow through the heart in response to various laboratory test procedures than do children (Allen & Matthews, 1997). Similarly, in other species, adolescents often exhibit elevated stress-induced increases in the stress-related hormone corticosterone relative to younger organisms and prolonged increases in corticosterone relative to adults (Spear, in press). Such elevated stress responsiveness of adolescents may contribute to their propensity to initiate drug and alcohol use, given that stressors have been shown to enhance alcohol consumption and to facilitate the onset of drug use.

THE ADOLESCENT BRAIN

More dramatic than the often-striking changes occurring in the physical appearance of adolescents are the transformations that are occurring in their brains. This remodeling of the brain is seen in adolescents of a variety of species and entails not only brain growth, including the formation of additional connections between nerve cells, but also a prominent loss (or pruning) of such connections in particular neural regions. Among the brain areas prominently remodeled during adolescence is the prefrontal cortex, a brain region thought to be involved in various goal-directed behaviors (including rule learning, working memory, and spatial learning) and in emotional processing, particularly of aversive stimuli. Along with a decline in the

relative size of the prefrontal cortex during adolescence, there is substantial remodeling of connections between neurons—with some connections lost and others added.

As can be seen in Figure 1, the amount of input received from two key chemicals (neurotransmitters) involved in brain-cell communication—the excitatory neurotransmitter glutamate and the inhibitory neurotransmitter gamma-aminobutyric acid (GABA)—is reduced in prefrontal cortex during adolescence, while input from another neurotransmitter, dopamine, peaks in prefrontal cortex during adolescence (Lewis, 1997). Developmental adjustments in dopamine activity are evident not only in prefrontal cortex, but also in limbic brain regions (Andersen, Dumont, &

Teicher, 1997). A variety of other adolescent-associated neural alterations are seen across species in various limbic brain regions. For example, Yurgelun-Todd, at the McLean Hospital in Belmont, Massachusetts, has found an age-related shift in activation of the human amygdala, a limbic structure that, among other things, is thought to be involved in emotional reactivity and in coordinating responses to stressful stimuli.

The adolescent-associated changes in dopamine input to prefrontal cortex and limbic brain regions may be of considerable consequence for adolescent behavior and psychological functioning. This stress-sensitive dopamine system appears to play a role in novelty seeking (Dellu, Piazza, Mayo,

Le Moal, & Simon, 1996) and to be part of the neural circuitry involved in assessing the motivational value of stimuli, including potentially reinforcing drugs, and translating this assessment into action (Kalivas, Churchill, & Klitenick, 1993). To the extent that adolescence is associated with developmental alterations in prefrontal cortex, limbic brain areas, and the dopamine input to these regions, concomitant developmental alterations in various motivated behaviors might also be expected. Alterations in the incentive value attributed to stimuli could underlie many of the behavioral alterations seen in adolescents, increasing the importance of social reinforcement derived from peers and provoking the pursuit of new potentially rewarding stimuli, a quest that may lead to increases in drug use and other risk-taking behaviors. Given the differences between adolescents and adults in functioning in these brain regions, it would be astonishing indeed if adolescents did *not* differ from adults in various aspects of their motivated behavior.

FINAL THOUGHTS

Over the past several decades, research in developmental psychology has placed surprisingly little emphasis on the adolescent brain in the quest for determinants of adolescents' typical behavioral propensities. But the focus of research is gradually changing, with the recognition that the brain of the adolescent differs markedly from the younger or adult brain, and that some of these differences are found in neural regions implicated in the typical behavioral characteristics of the adolescent. Yet, much remains to be done.

Additional research is needed to examine normal brain function in adolescence. The rather piecemeal

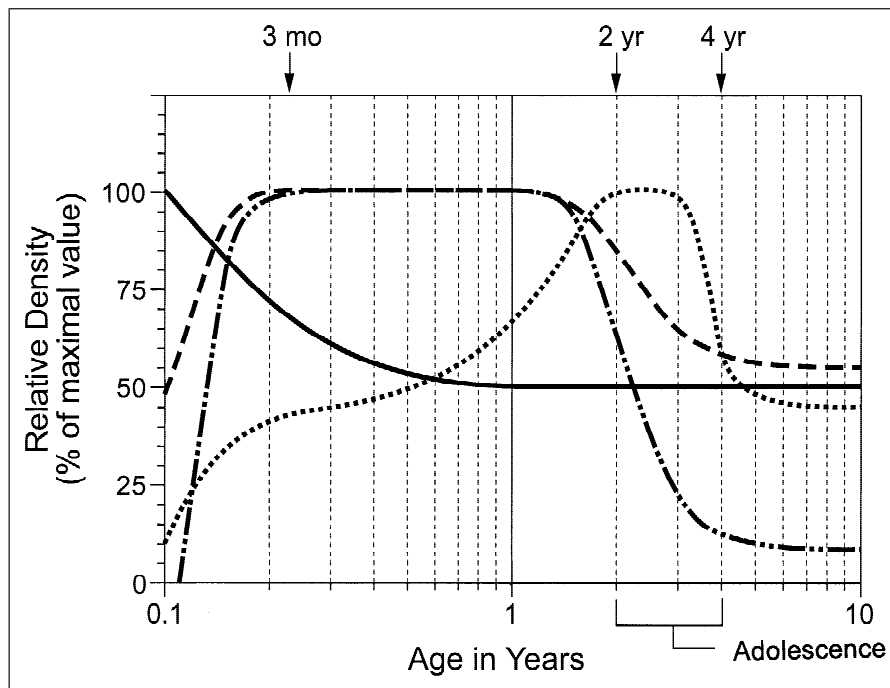


Fig. 1. Age-related changes in four types of input to a major type of output neuron (layer III pyramidal cells) of the primate prefrontal cortex. The x-axis refers to the age of the animals, and the y-axis represents the percentage of the maximal value reached at any point in the life span for each measure. The broken line illustrates excitatory glutaminergic input into this cortical region, the broken line with dots shows gamma-aminobutyric acid (GABA) inhibitory input, and the dotted line illustrates dopamine input; the solid line demonstrates levels of another neurotransmitter (cholecystikinin) in this brain region. Reprinted by permission of Elsevier Science from "Development of the Prefrontal Cortex During Adolescence: Insights Into Vulnerable Neural Circuits in Schizophrenia," by D.A. Lewis, 1997, *Neuropsychopharmacology*, 16, p. 392. Copyright 1997 by American College of Neuropsychopharmacology.

observations of the adolescent brain to date need to be integrated within a broader characterization of adolescent brain function. Then, the relationship of these neural alterations to adolescent-typical behavior patterns needs to be substantiated using experimental approaches.

Neural mechanisms underlying initiation of drug use during adolescence are a particularly important area for study. Given the clear differences between adolescents and adults in brain regions implicated in drug seeking and other motivated behaviors, the factors that serve to precipitate and maintain adolescent drug and alcohol use may well vary from the factors that underlie such use in adulthood. Yet, study of psychobiological determinants of drug initiation has been almost exclusively conducted in adult organisms, so the findings are of questionable relevance to the typical initiation of alcohol and drug use during adolescence.

The question also remains as to whether early exposure to drugs or alcohol actually increases the propensity for later abuse, or whether early use is just a marker for a later abuse disorder. This issue is clearly germane to current prevention efforts directed toward postponing first use ("just say later").

Multiple research approaches and study populations will be needed in this work. Although some aspects of adolescence can be properly and productively modeled in laboratory animals, others clearly cannot and will require studies in human adolescents.

Advances in brain-imaging techniques (Thatcher, Lyon, Rumsey, & Krasnegor, 1996) have made the brain of the human adolescent more accessible for study, yet many questions about the adolescent brain and its relationship to age-related behavioral characteristics will require experimental manipulations involving laboratory animals. Multidisciplinary studies conducted in species ranging from human and nonhuman primates to rodents and using levels of analysis ranging from gene expression to behavior will help illuminate the dramatic transformations of the adolescent brain and their association with behavioral function during this unique maturational phase.

Recommended Reading

- Lewis, D.A. (1997). (See References)
 Spear, L.P. (in press). (See References)
 Susman, E.J., Inoff-Germain, G., Nottelmann, E.D., Loriaux, D.L., Cutler, G.B., Jr., & Chrousos, G.P. (1987). (See References)
 Witt, E.D. (1994). Mechanisms of alcohol abuse and alcoholism in adolescents: A case for developing animal models. *Behavioral and Neural Biology*, 62, 168–177.

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References

- Allen, M.T., & Matthews, K.A. (1997). Demodynamic responses to laboratory stressors in chil-

dren and adolescents: The influences of age, race, and gender. *Psychophysiology*, 34, 329–339.

- Andersen, S.L., Dumont, N.L., & Teicher, M.H. (1997). Developmental differences in dopamine synthesis inhibition by (±)-7-OH-DPAT. *Naunyn-Schmiedeberg's Archives of Pharmacology*, 356, 173–181.
- Arnett, J. (1992). Reckless behavior in adolescence: A developmental perspective. *Developmental Review*, 12, 339–373.
- Dellu, F., Piazza, P.V., Mayo, W., Le Moal, M., & Simon, H. (1996). Novelty-seeking in rats—Biobehavioral characteristics and possible relationship with the sensation-seeking trait in man. *Neuropsychobiology*, 34, 136–145.
- Galef, B.G., Jr. (1981). The ecology of weaning: Parasitism and the achievement of independence by altricial mammals. In D.J. Gubernick & P.H. Klopfer (Eds.), *Parental care in mammals* (pp. 211–241). New York: Plenum Press.
- Grant, B.F., & Dawson, D.A. (1997). Age at onset of alcohol use and its association with DSM-IV alcohol abuse and dependence: Results from the National Longitudinal Alcohol Epidemiologic Survey. *Journal of Substance Abuse*, 9, 103–110.
- Johnston, L.D., O'Malley, P.M., & Bachman, J.G. (1998). *National survey results on drug use from the Monitoring the Future study, 1975–1997: Vol. 1. Secondary school students* (NIH Publication No. 98-4345). Rockville, MD: National Institute on Drug Abuse.
- Kalivas, P.W., Churchill, L., & Klitenick, M.A. (1993). The circuitry mediating the translation of motivational stimuli into adaptive motor responses. In P.W. Kalivas & C.D. Barnes (Eds.), *Limbic motor circuits and neuropsychiatry* (pp. 237–287). Boca Raton, FL: CRC Press.
- Larson, R., & Richards, M.H. (1994). *Divergent realities: The emotional lives of mothers, fathers, and adolescents*. New York: Basic Books.
- Lewis, D.A. (1997). Development of the prefrontal cortex during adolescence: Insights into vulnerable neural circuits in schizophrenia. *Neuropsychopharmacology*, 16, 385–398.
- Petersen, A.C., Compas, B.E., Brooks-Gunn, J., Stemmler, M., Ey, S., & Grant, K.E. (1993). Depression in adolescence. *American Psychologist*, 48, 155–168.
- Shedler, J., & Block, J. (1990). Adolescent drug use and psychological health: A longitudinal inquiry. *American Psychologist*, 45, 612–630.
- Spear, L.P. (in press). The adolescent brain and age-related behavioral manifestations. *Neuroscience and Biobehavioral Reviews*.
- Susman, E.J., Inoff-Germain, G., Nottelmann, E.D., Loriaux, D.L., Cutler, G.B., Jr., & Chrousos, G.P. (1987). Hormones, emotional disposition, and aggressive attributes in young adolescents. *Child Development*, 58, 1114–1134.
- Thatcher, R.W., Lyon, G.R., Rumsey, J., & Krasnegor, N. (Eds.). (1996). *Developmental neuroimaging: Mapping the development of brain and behavior*. San Diego: Academic Press.

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 (Ber-

thier, DeBlois, Poirier, Novak, & Clifton, 2000; Hood, Carey, & Prasad, 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 top-most 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.

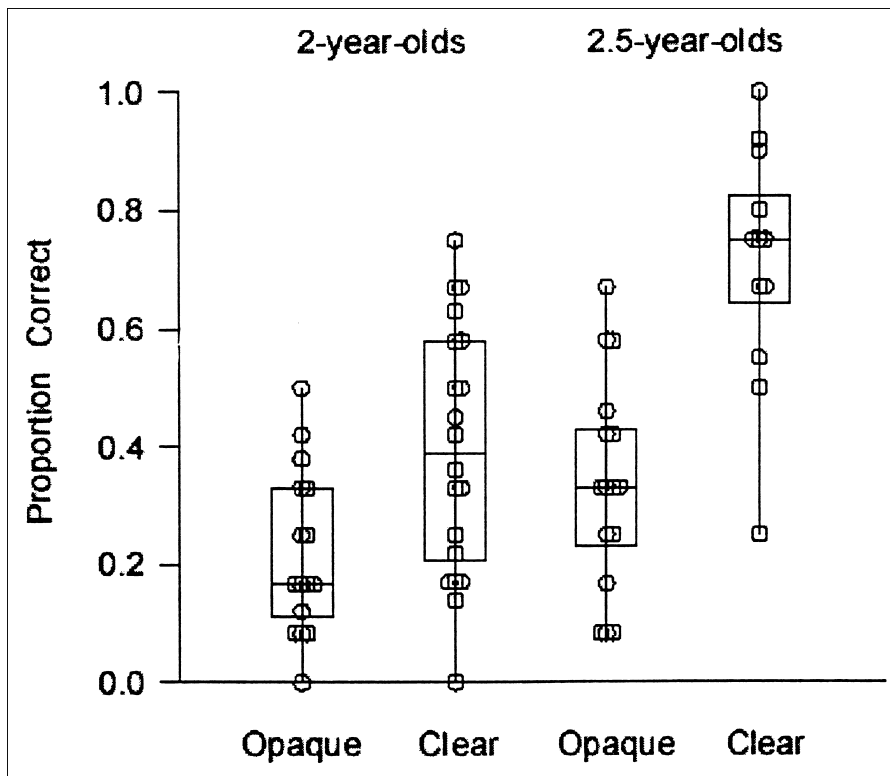


Fig. 2. Proportion of trials correct on the first reach for 2- and 2.5-year olds. Results are shown separately for trials with an opaque screen and a transparent screen. Each circle represents one child's performance. The boxes enclose the second and third quartiles of the distributions, and the horizontal 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.

Recommended Reading

- Bertenthal, B.I. (1996). Origins and early development of perception, action, and representation. *Annual Review of Psychology*, 47, 431–459.
- Bremner, J.G. (1997). From perception to cognition. In G. Bremner, A. Slater, & G. Butterworth (Eds.), *Infant development: Recent advances* (pp. 55–74). Hove, England: Psychology Press.
- Spelke, E.S. (1991). Physical knowledge in infancy: Reflections on Piaget's theory. In S. Carey & R. Gelman (Eds.), *The epigenesis of mind: Essays on biology and cognition* (pp. 133–169). Hillsdale, NJ: Erlbaum.
- Willatts, P. (1997). Beyond the "Couch Potato" infant: How infants use

their knowledge to regulate action, solve problems, and achieve goals. In G. Bremner, A. Slater, & G. Butterworth (Eds.), *Infant development: Recent advances* (pp. 109–135). Hove, England: Psychology Press.

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Note

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References

- Baillargeon, R. (1993). The object concept revisited: New directions in the investigation of infants' physical knowledge. In C.E. Granrud (Ed.), *Visual perception and cognition in infancy* (pp. 265–315). Hillsdale, NJ: Erlbaum.
- Baillargeon, R., Graber, M., DeVos, J., & Black, J. (1990). Why do young infants fail to search for hidden objects? *Cognition*, *36*, 225–284.
- Baillargeon, R., Spelke, E., & Wasserman, S. (1985). Object permanence in five-month-old infants. *Cognition*, *20*, 191–208.
- Berthier, N.E., DeBlois, S., Poirier, C.R., Novak, J.A., & Clifton, R.K. (2000). Where's the ball? Two- and three-year-olds reason about unseen events. *Developmental Psychology*, *36*, 394–401.
- Butler, S.C., Berthier, N.E., & Clifton, R.K. (2002). Two-year-olds' search strategies and visual tracking in a hidden displacement task. *Developmental Psychology*, *38*, 581–590.
- Clifton, R., Rochat, P., Litovsky, R., & Perris, E. (1991). Object representation guides infants' reaching in the dark. *Journal of Experimental Psychology: Human Perception and Performance*, *17*, 323–329.
- Hood, B., Carey, S., & Prasada, S. (2000). Predicting the outcomes of physical events: Two-year-olds fail to reveal knowledge of solidity and support. *Child Development*, *71*, 1540–1554.
- Hood, B., Cole-Davies, V., & Dias, M. (2003). Looking and search measures of object knowledge in pre-school children. *Developmental Psychology*, *39*, 61–70.
- Mash, C., Clifton, R.K., & Berthier, N.E. (2002, April). Two-year-olds' event reasoning and object search. In L. Santos (Chair), *Interpreting dissociations between infant looking and reaching: A comparative approach*. Symposium conducted at the meeting of the International Society on Infant Studies, Toronto, Ontario, Canada.
- Mash, C., Keen, R., & Berthier, N.E. (in press). Visual access and attention in two-year-olds' event reasoning and object search. *Infancy*.
- Spelke, E.S., Breinlinger, K., Macomber, J., & Jacobson, K. (1992). Origins of knowledge. *Psychological Review*, *99*, 605–632.

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

Children of Lesbian and Gay Parents

Charlotte J. Patterson

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ABSTRACT—*Does parental sexual orientation affect child development, and if so, how? Studies using convenience samples, studies using samples drawn from known populations, and studies based on samples that are representative of larger populations all converge on similar conclusions. More than two decades of research has failed to reveal important differences in the adjustment or development of children or adolescents reared by same-sex couples compared to those reared by other-sex couples. Results of the research suggest that qualities of family relationships are more tightly linked with child outcomes than is parental sexual orientation.*

KEYWORDS—*sexual orientation; parenting; lesbian; gay; child; socialization*

Does parental sexual orientation affect child development, and if so, how? This question has often been raised in the context of legal and policy proceedings relevant to children, such as those involving adoption, child custody, or visitation. Divergent views have been offered by professionals from the fields of psychology, sociology, medicine, and law (Patterson, Fulcher, & Wainright, 2002). While this question has most often been raised in legal and policy contexts, it is also relevant to theoretical issues. For example, does healthy human development require that a child grow up with parents of each gender? And if not, what would that mean for our theoretical understanding of parent-child relations (Patterson & Hastings, in press)? In this article, I describe some research designed to address these questions.

EARLY RESEARCH

Research on children with lesbian and gay parents began with studies focused on cases in which children had been born in the context of a heterosexual marriage. After parental separation and divorce, many children in these families lived with divorced

lesbian mothers. A number of researchers compared development among children of divorced lesbian mothers with that among children of divorced heterosexual mothers and found few significant differences (Patterson, 1997; Stacey & Biblarz, 2001).

These studies were valuable in addressing concerns of judges who were required to decide divorce and child custody cases, but they left many questions unanswered. In particular, because the children who participated in this research had been born into homes with married mothers and fathers, it was not obvious how to understand the reasons for their healthy development. The possibility that children's early exposure to apparently heterosexual male and female role models had contributed to healthy development could not be ruled out.

When lesbian or gay parents rear infants and children from birth, do their offspring grow up in typical ways and show healthy development? To address this question, it was important to study children who had never lived with heterosexual parents. In the 1990s, a number of investigators began research of this kind.

An early example was the Bay Area Families Study, in which I studied a group of 4- to 9-year-old children who had been born to or adopted early in life by lesbian mothers (Patterson, 1996, 1997). Data were collected during home visits. Results from in-home interviews and also from questionnaires showed that children had regular contact with a wide range of adults of both genders, both within and outside of their families. The children's self-concepts and preferences for same-gender playmates and activities were much like those of other children their ages. Moreover, standardized measures of social competence and of behavior problems, such as those from the Child Behavior Checklist (CBCL), showed that they scored within the range of normal variation for a representative sample of same-aged American children. It was clear from this study and others like it that it was quite possible for lesbian mothers to rear healthy children.

STUDIES BASED ON SAMPLES DRAWN FROM KNOWN POPULATIONS

Interpretation of the results from the Bay Area Families Study was, however, affected by its sampling procedures. The study

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had been based on a convenience sample that had been assembled by word of mouth. It was therefore impossible to rule out the possibility that families who participated in the research were especially well adjusted. Would a more representative sample yield different results?

To find out, Ray Chan, Barbara Raboy, and I conducted research in collaboration with the Sperm Bank of California (Chan, Raboy, & Patterson, 1998; Fulcher, Sutfin, Chan, Scheib, & Patterson, 2005). Over the more than 15 years of its existence, the Sperm Bank of California's clientele had included many lesbian as well as heterosexual women. For research purposes, this clientele was a finite population from which our sample could be drawn. The Sperm Bank of California also allowed a sample in which, both for lesbian and for heterosexual groups, one parent was biologically related to the child and one was not.

We invited all clients who had conceived children using the resources of the Sperm Bank of California and who had children 5 years old or older to participate in our research. The resulting sample was composed of 80 families, 55 headed by lesbian and 25 headed by heterosexual parents. Materials were mailed to participating families, with instructions to complete them privately and return them in self-addressed stamped envelopes we provided.

Results replicated and expanded upon those from earlier research. Children of lesbian and heterosexual parents showed similar, relatively high levels of social competence, as well as similar, relatively low levels of behavior problems on the parent form of the CBCL. We also asked the children's teachers to provide evaluations of children's adjustment on the Teacher Report Form of the CBCL, and their reports agreed with those of parents. Parental sexual orientation was not related to children's adaptation. Quite apart from parental sexual orientation, however, and consistent with findings from years of research on children of heterosexual parents, when parent-child relationships were marked by warmth and affection, children were more likely to be developing well. Thus, in this sample drawn from a known population, measures of children's adjustment were unrelated to parental sexual orientation (Chan et al., 1998; Fulcher et al., 2005).

Even as they provided information about children born to lesbian mothers, however, these new results also raised additional questions. Women who conceive children at sperm banks are generally both well educated and financially comfortable. It was possible that these relatively privileged women were able to protect children from many forms of discrimination. What if a more diverse group of families were to be studied? In addition, the children in this sample averaged 7 years of age, and some concerns focus on older children and adolescents. What if an older group of youngsters were to be studied? Would problems masked by youth and privilege in earlier studies emerge in an older, more diverse sample?

STUDIES BASED ON REPRESENTATIVE SAMPLES

An opportunity to address these questions was presented by the availability of data from the National Longitudinal Study of Adolescent Health (Add Health). The Add Health study involved a large, ethnically diverse, and essentially representative sample of American adolescents and their parents. Data for our research were drawn from surveys and interviews completed by more than 12,000 adolescents and their parents at home and from surveys completed by adolescents at school.

Parents were not queried directly about their sexual orientation but were asked if they were involved in a "marriage, or marriage-like relationship." If parents acknowledged such a relationship, they were also asked the gender of their partner. Thus, we identified a group of 44 12- to 18-year-olds who lived with parents involved in marriage or marriage-like relationships with same-sex partners. We compared them with a matched group of adolescents living with other-sex couples. Data from the archives of the Add Health study allowed us to address many questions about adolescent development.

Consistent with earlier findings, results of this work revealed few differences in adjustment between adolescents living with same-sex parents and those living with opposite-sex parents (Wainright, Russell, & Patterson, 2004; Wainright & Patterson, 2006). There were no significant differences between teenagers living with same-sex parents and those living with other-sex parents on self-reported assessments of psychological well-being, such as self-esteem and anxiety; measures of school outcomes, such as grade point averages and trouble in school; or measures of family relationships, such as parental warmth and care from adults and peers. Adolescents in the two groups were equally likely to say that they had been involved in a romantic relationship in the last 18 months, and they were equally likely to report having engaged in sexual intercourse. The only statistically reliable difference between the two groups—that those with same-sex parents felt a greater sense of connection to people at school—favored the youngsters living with same-sex couples. There were no significant differences in self-reported substance use, delinquency, or peer victimization between those reared by same- or other-sex couples (Wainright & Patterson, 2006).

Although the gender of parents' partners was not an important predictor of adolescent well-being, other aspects of family relationships were significantly associated with teenagers' adjustment. Consistent with other findings about adolescent development, the qualities of family relationships rather than the gender of parents' partners were consistently related to adolescent outcomes. Parents who reported having close relationships with their offspring had adolescents who reported more favorable adjustment. Not only is it possible for children and adolescents who are parented by same-sex couples to develop in healthy directions, but—even when studied in an extremely diverse, representative sample of American adolescents—they generally do.

These findings have been supported by results from many other studies, both in the United States and abroad. Susan Golombok and her colleagues have reported similar results with a near-representative sample of children in the United Kingdom (Golombok et al., 2003). Others, both in Europe and in the United States, have described similar findings (e.g., Brewaeys, Ponjaert, Van Hall, & Golombok, 1997).

The fact that children of lesbian mothers generally develop in healthy ways should not be taken to suggest that they encounter no challenges. Many investigators have remarked upon the fact that children of lesbian and gay parents may encounter anti-gay sentiments in their daily lives. For example, in a study of 10-year-old children born to lesbian mothers, Gartrell, Deck, Rodas, Peyser, and Banks (2005) reported that a substantial minority had encountered anti-gay sentiments among their peers. Those who had had such encounters were likely to report having felt angry, upset, or sad about these experiences. Children of lesbian and gay parents may be exposed to prejudice against their parents in some settings, and this may be painful for them, but evidence for the idea that such encounters affect children's overall adjustment is lacking.

CONCLUSIONS

Does parental sexual orientation have an important impact on child or adolescent development? Results of recent research provide no evidence that it does. In fact, the findings suggest that parental sexual orientation is less important than the qualities of family relationships. More important to youth than the gender of their parent's partner is the quality of daily interaction and the strength of relationships with the parents they have.

One possible approach to findings like the ones described above might be to shrug them off by reiterating the familiar adage that "one cannot prove the null hypothesis." To respond in this way, however, is to miss the central point of these studies. Whether or not any measurable impact of parental sexual orientation on children's development is ever demonstrated, the main conclusions from research to date remain clear: Whatever correlations between child outcomes and parental sexual orientation may exist, they are less important than those between child outcomes and the qualities of family relationships.

Although research to date has made important contributions, many issues relevant to children of lesbian and gay parents remain in need of study. Relatively few studies have examined the development of children adopted by lesbian or gay parents or of children born to gay fathers; further research in both areas would be welcome (Patterson, 2004). Some notable longitudinal studies have been reported, and they have found children of same-sex couples to be in good mental health. Greater understanding of family relationships and transitions over time would, however, be helpful, and longitudinal studies would be valuable. Future research could also benefit from the use of a variety of methodologies.

Meanwhile, the clarity of findings in this area has been acknowledged by a number of major professional organizations. For instance, the governing body of the American Psychological Association (APA) voted unanimously in favor of a statement that said, "Research has shown that the adjustment, development, and psychological well-being of children is unrelated to parental sexual orientation and that children of lesbian and gay parents are as likely as those of heterosexual parents to flourish" (APA, 2004). The American Bar Association, the American Medical Association, the American Academy of Pediatrics, the American Psychiatric Association, and other mainstream professional groups have issued similar statements.

The findings from research on children of lesbian and gay parents have been used to inform legal and public policy debates across the country (Patterson et al., 2002). The research literature on this subject has been cited in amicus briefs filed by the APA in cases dealing with adoption, child custody, and also in cases related to the legality of marriages between same-sex partners. Psychologists serving as expert witnesses have presented findings on these issues in many different courts (Patterson et al., 2002). Through these and other avenues, results of research on lesbian and gay parents and their children are finding their way into public discourse.

The findings are also beginning to address theoretical questions about critical issues in parenting. The importance of gender in parenting is one such issue. When children fare well in two-parent lesbian-mother or gay-father families, this suggests that the gender of one's parents cannot be a critical factor in child development. Results of research on children of lesbian and gay parents cast doubt upon the traditional assumption that gender is important in parenting. Our data suggest that it is the quality of parenting rather than the gender of parents that is significant for youngsters' development.

Research on children of lesbian and gay parents is thus located at the intersection of a number of classic and contemporary concerns. Studies of lesbian- and gay-parented families allow researchers to address theoretical questions that had previously remained difficult or impossible to answer. They also address oft-debated legal questions of fact about development of children with lesbian and gay parents. Thus, research on children of lesbian and gay parents contributes to public debate and legal decision making, as well as to theoretical understanding of human development.

Recommended Reading

- Golombok, S., Perry, B., Burston, A., Murray, C., Mooney-Somers, J., Stevens, M., & Golding, J. (2003). (See References)
 Patterson, C.J., Fulcher, M., & Wainright, J. (2002). (See References)
 Stacey, J., & Biblarz, T.J. (2001). (See References)
 Wainright, J.L., & Patterson, C.J. (2006). (See References)
 Wainright, J.L., Russell, S.T., & Patterson, C.J. (2004). (See References)
-

REFERENCES

- American Psychological Association (2004). Resolution on sexual orientation, parents, and children. Retrieved September 25, 2006, from <http://www.apa.org/pi/lgbc/policy/parentschildren.pdf>
- Brewaeys, A., Ponjaert, I., Van Hall, E.V., & Golombok, S. (1997). Donor insemination: Child development and family functioning in lesbian mother families. *Human Reproduction, 12*, 1349–1359.
- Chan, R.W., Raboy, B., & Patterson, C.J. (1998). Psychosocial adjustment among children conceived via donor insemination by lesbian and heterosexual mothers. *Child Development, 69*, 443–457.
- Fulcher, M., Sutfin, E.L., Chan, R.W., Scheib, J.E., & Patterson, C.J. (2005). Lesbian mothers and their children: Findings from the Contemporary Families Study. In A. Omoto & H. Kurtzman (Eds.), *Recent research on sexual orientation, mental health, and substance abuse* (pp. 281–299). Washington, DC: American Psychological Association.
- Gartrell, N., Deck, A., Rodas, C., Peyser, H., & Banks, A. (2005). The National Lesbian Family Study: 4. Interviews with the 10-year-old children. *American Journal of Orthopsychiatry, 75*, 518–524.
- Golombok, S., Perry, B., Burston, A., Murray, C., Mooney-Somers, J., Stevens, M., & Golding, J. (2003). Children with lesbian parents: A community study. *Developmental Psychology, 39*, 20–33.
- Patterson, C.J. (1996). Lesbian mothers and their children: Findings from the Bay Area Families Study. In J. Laird & R.J. Green (Eds.), *Lesbians and gays in couples and families: A handbook for therapists* (pp. 420–437). San Francisco: Jossey-Bass.
- Patterson, C.J. (1997). Children of lesbian and gay parents. In T. O'Leary & R. Prinz (Eds.), *Advances in clinical child psychology* (Vol. 19, pp. 235–282). New York: Plenum Press.
- Patterson, C.J. (2004). Gay fathers. In M.E. Lamb (Ed.), *The role of the father in child development* (4th ed., pp. 397–416). New York: Wiley.
- Patterson, C.J., Fulcher, M., & Wainright, J. (2002). Children of lesbian and gay parents: Research, law, and policy. In B.L. Bottoms, M.B. Kovera, & B.D. McAuliff (Eds.), *Children, social science and the law* (pp. 176–199). New York: Cambridge University Press.
- Patterson, C.J., & Hastings, P. (in press). Socialization in context of family diversity. In J. Grusec & P. Hastings (Eds.), *Handbook of socialization*. New York: Guilford Press.
- Stacey, J., & Biblarz, T.J. (2001). (How) Does sexual orientation of parents matter? *American Sociological Review, 65*, 159–183.
- Wainright, J.L., & Patterson, C.J. (2006). Delinquency, victimization, and substance use among adolescents with female same-sex parents. *Journal of Family Psychology, 20*, 526–530.
- Wainright, J.L., Russell, S.T., & Patterson, C.J. (2004). Psychosocial adjustment and school outcomes of adolescents with same-sex parents. *Child Development, 75*, 1886–1898.

ences, and how to enhance cognitive skills?

- We need to identify the brain processes that influence cognition. Jensen has found correlations between *g* and elementary cognitive tasks (mental processing speed), the brain's electrical response to stimuli, and how quickly an injection of glucose is absorbed by the brain. Hope for further advance in this area lies in new techniques of viewing what brain centers are active when different cognitive tasks are being done.
- We should learn more about social multipliers. Boozer and Cacciola (2001) showed that when reduced class size raises academic performance, peer interaction multiplies that rise and accounts for virtually all of the long-term gains.
- The relative potency of Whites' and Blacks' social multipliers should be compared.
- Although teaching children "how to think" is desirable, we should recognize that this will not necessarily enhance numeracy and literacy. The focus must be on

teaching reading and arithmetic skills. And note that if we really want to enhance those skills, there will have to be an attitude shift, so that Americans welcome core subjects that make greater cognitive demands. If all parents and children were like Chinese Americans, the "nation's report card" would improve dramatically.

- Above all, we must go beyond *g* to develop a theory of intelligence with a sociological dimension. In this theory, *g* will still play an important role. Within every generation, people compete to win, and, therefore, *g* will always help explain why some people excel across so many cognitive skills.

Recommended Reading

- Deary, I.J. (2001). *Intelligence: A very short introduction*. Oxford, England: Oxford University Press.
- Dickens, W.T., & Flynn, J.R. (2001, April 21). Great leap forward. *New Scientist*, 170, 44–47.
- Jensen, A.R. (1998). *The g factor: The science of mental ability*. Westport, CT: Praeger.

Note

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References

- Boozer, M., & Cacciola, S.E. (2001). *Inside the black box of Project STAR: Estimation of peer effects using experimental data* (Center Discussion Paper No. 832). New Haven, CT: Yale University Economic Growth Center.
- Greenfield, P. (1998). The cultural evolution of IQ. In U. Neisser (Ed.), *The rising curve: Long-term gains in IQ and related measures* (pp. 81–123). Washington, DC: American Psychological Association.
- Howard, R.W. (1999). Preliminary real-world evidence that average intelligence really is rising. *Intelligence*, 27, 235–250.
- Jensen, A.R. (1973). *Educability and group differences*. New York: Harper and Row.
- Jensen, A.R. (2002). Galton's legacy to research on intelligence. *Journal of Biosocial Science*, 34, 145–172.
- McWorter, J. (2000). *Losing the race: Self-sabotage in Black America*. New York: Free Press.
- Nunn, J. (1999). *John Nunn's chess puzzle book*. London: Gambit Publications.
- Rosenau, J.N., & Fagan, W.M. (1997). A new dynamism in world politics: Increasingly skilled individuals? *International Studies Quarterly*, 41, 655–686.
- Schooler, C. (1998). Environmental complexity and the Flynn effect. In U. Neisser (Ed.), *The rising curve: Long-term gains in IQ and related measures* (pp. 67–79). Washington, DC: American Psychological Association.

Spanking Children: Evidence and Issues

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Abstract

Whether or not to spank children as a discipline practice is controversial among lay and professional audiences alike. This article highlights different views of spanking, key conclusions about its effects, and methodological limitations of the research and the resulting

ambiguities that fuel the current debate and plague interpretation. We propose an expanded research agenda to address questions about the goals of parental discipline; the role, if any, that punishment plays in achieving these goals; the effects and side effects of alternative discipline practices; and the impact of

punishment on underlying developmental processes.

Keywords

spanking children; punishment; parent discipline

Spanking as a way of disciplining children is a topic of broad interest to people involved in the care and education of children (e.g., parents, teachers), as well as to the many professions involved with children, parents, and families (e.g., pediatrics, psychiatry, psychology, and social work). Hitting children is intertwined with religious beliefs, cultural views, government, law, and social policy and

has enormous implications for mental and physical health throughout the world (Krug, Dahlberg, Mercy, Zwi, & Lozano, 2002). Corporal punishment as a means of child discipline at home and at school has been banned by many countries, including Austria, Croatia, Cyprus, Denmark, Finland, Germany, Israel, Italy, Latvia, Norway, and Sweden (Gershoff, 2002). The United Nations (Article 19 of the UN Convention on the Rights of Children) argues against all forms of physical violence in relation to children.

Within the United States, several organizations (e.g., Project No Spank—<http://www.nospank.net/toc.htm>) lobby for an end to hitting children and for according children the same legal protections accorded adults (i.e., laws against being hit by others). Despite the lobbying, spanking is still a “hit” with parents—it is quite prevalent. For example, in the United States, 74% of parents of children 17 years of age or younger use spanking as a discipline technique (Gallup, 1995); 94% of parents of 3- and 4-year-olds use corporal punishment (Straus & Stewart, 1999).

After decades of research, debate continues. In this article, we review key findings about the effects of spanking, issues that limit progress in understanding the effects of spanking, and avenues to move research forward. By discussing the topic, we are not in any way endorsing or advocating the use of spanking. Indeed, integral to the research agenda we propose are questions regarding why so many parents believe hitting is an appropriate and effective form of parental discipline and whether hitting is actually needed to accomplish the goals underlying its use in child rearing.

SPANKING DEFINED

Perhaps the most critical issue that underlies this debate is the def-

inition of spanking. The definition determines who participates in a research study, what studies are included in literature reviews, and, hence, what conclusions are reached. A commonly adopted definition specifies spanking as hitting a child with an open hand on the buttocks or extremities with the intent to discipline without leaving a bruise or causing physical harm. This definition helps separate occasional spanking from more severe corporal punishment (Baumrind, Larzelere, & Cowan, 2002; Consensus Statements, 1996).

Physical abuse usually is defined to encompass corporal punishment that is harsh and excessive, involves the use of objects (e.g., belts, paddles), is directed to parts of the body other than the extremities, and causes or has the potential to cause physical harm. Because many parents report using objects during punishment, behaviors that many professionals might consider as clearly abusive are fairly common and included in some definitions of spanking (Gershoff, 2002). Research on hitting (spanking, corporal punishment) varies widely on whether the definition includes practices that frankly are or blend into abuse.

THREE VIEWS OF SPANKING

Three positions about spanking as a form of discipline capture public and professional views rather well. The *pro-corporal punishment* view is infrequently advocated in research and academic writings, but is alive and well in everyday life. This view is represented by the familiar, cryptic, incomplete, and probably misconstrued biblical quotation, “spare the rod and spoil the child” (Proverbs 13:24). The view underscores the beliefs that desirable consequences (e.g., respect for authority, good behavior,

socialization) follow from the use of spanking, untoward consequences result from not spanking, and responsible parenting includes such punishment.

The *anti-corporal punishment* view is that corporal punishment is likely to have short- and long-term deleterious consequences. “Violence begets violence” captures much of this view, which focuses on modeling and social learning as the means by which violence is transmitted from one generation to the next (Straus, 1994). The morality of inflicting pain is also key to this view, so the untoward consequences of hitting are not the only basis for the objection to spanking.

The *conditional corporal punishment* view notes that the effects of spanking are not necessarily negative or positive but may be either depending on other conditions. Spanking can vary along multiple dimensions (e.g., frequency and intensity) and be delivered in many different contexts that may moderate its impact. This view does not advocate spanking, but rather notes that a “blanket injunction” against spanking cannot be supported scientifically (Baumrind, 1996).

OVERVIEW OF RESEARCH FINDINGS

The empirical literature on spanking has been reviewed extensively. The most recent and comprehensive review, completed by Gershoff (2002), consists of a meta-analysis² of 88 studies. Gershoff examined the relationship between corporal punishment and compliance of the child, moral internalization, aggression, criminal and antisocial behavior, quality of the parent-child relationship, mental health, and abuse. Spanking tended to be associated with imme-

mediate compliance of the child (i.e., desisting the behavior targeted by the punishment), which Gershoff considered to be the only positive outcome evident in her review. On the negative side, spanking was associated with decreased internalization of morals, diminished quality of parent-child relations, poorer child and adult mental health, increased delinquency and antisocial behavior for children, and increased criminal and antisocial behavior for adults; spanking also was associated with an increased risk of being a victim of abuse or of abusing one's own child or spouse.

Reanalyses of studies have underscored the importance of how spanking is defined. Several studies in Gershoff's review included rather harsh punishment that would qualify as physical abuse (e.g., slapping in the face, hitting with an object). Reanalyses indicated the outcomes were more negative in those studies than in studies of less severe punishment (Baumrind et al., 2002). Similarly, other reviews have suggested that very mild spanking used as a backup for mild disciplinary effects may not be detrimental and indeed can reduce noncompliance and fighting (Larzelere, 2000).

It would be difficult to identify a consensus among researchers beyond a few key points. First, the deleterious effects of corporal punishment are likely to be a function of severity and frequency. Harsh punishment is associated with many untoward consequences, including increased morbidity and mortality for major adult forms of illness (e.g., heart disease, cancer, lung disease; Krug et al., 2002). Second, the effects of mild spanking (an oxymoron to some people) that is occasional, is a backup to other disciplinary procedures such as time out from reinforcement or reasoning, is physically noninjurious, involves an open hand to hit the extremities or buttocks, and inflicts temporary pain are not so

clear (Baumrind et al., 2002). Again, there is no advocacy of corporal punishment in this latter view, but merely an acknowledgment that the research does not speak to the consequence of occasional spanking.

KEY ISSUES FOR RESEARCH

Fundamental conceptual and methodological issues plague the literature on spanking. First, the varied definitions of spanking can dictate the conclusions investigators and reviewers reach, as we have noted. Second, assessments of spanking and children's characteristics (e.g., aggression, deviance) often are retrospective and completed by the same rater (the parent). These influences alone can affect the magnitude of correlations of punishment, child characteristics, and outcomes. Third, the time line is rarely established to show that in fact spanking antedated an untoward outcome and that the "outcome" (e.g., child deviance, poor parent-child relations) was not present in advance of or at the same time as spanking. Fourth, spanking could well be a proxy for a host of other variables that in fact relate to untoward child outcomes. For example, compared with parents who spank less, those who spank more read to, play with, and hug their children less; experience higher levels of stress, more major life events, and more difficult, discordant, and abusive marital relations; and have higher rates of mental illness or substance abuse. These other variables, alone or in combination, might explain the effects attributed to spanking. However, redressing these pivotal methodological issues alone would still leave unanswered many critical questions that could inform the use of spanking (see Benjet & Kazdin, 2003).

Goals of Parent Discipline

Presumably, the goals of disciplining children are to decrease some behaviors (e.g., tantrums, talking back), to develop others (e.g., problem solving, playing cooperatively, completing homework), and to promote socialization more generally. It is not at all clear from animal laboratory studies and human applied studies that punishment is among the better strategies for accomplishing these behavior-change goals. For example, decreasing and eliminating inappropriate child behavior in the home can be achieved through positive reinforcement techniques (e.g., from many arrangements that focus on rewarding alternative behaviors) without the use of any punishment (Kazdin, 2001). In addition, noncorporal punishment techniques that are less aversive than spanking (e.g., brief periods of time out from reinforcement, small fines on a point chart) can be effective. The use of spanking raises questions regarding the goals of discipline, whether any punishment is needed to attain them, and, if in fact punishment is needed, whether hitting has any benefit over noncorporal punishment. Comparisons of punishment with nonaversive procedures, even in laboratory analogues, would add pertinent information that could inform debates about spanking. Additionally, the underlying processes motivating parents to spank or to continue to use spanking could be investigated to determine whether they are concordant with the stated goals of spanking.

Concomitant Effects of Punishment

Concomitant effects include any effects outside the direct focus of spanking and encompass the development of prosocial behaviors,

misbehavior other than the one to which spanking was directed, and emotional reactions (e.g., crying, anger). Gershoff (2002) found that children who were spanked were more angry, aggressive, and stressed than children who were not disciplined in this way. This finding is in keeping with other applied as well as animal laboratory research showing that punishment can have untoward side effects, including emotional reactions, aggression, and escape from and avoidance of people, settings, and situations associated with punishment (Hutchinson, 1977; Kazdin, 2001). These effects are particularly likely with corporal punishment, but they can occur with low levels of noncorporal punishment as well. Few studies have examined side effects of spanking and how these compare with the side effects that may result from equally effective (or more effective) strategies that do not rely on punishment.

Impact of Corporal Punishment on Development

Child abuse, a more extreme form of corporal punishment than is the focus of this article, can exert biochemical, functional, and structural changes in the brain (e.g., changes in cerebral volume and increased or decreased reactivity to various neurotransmitters; Glaser, 2000). Some of these changes have psychological concomitants (e.g., changes in reactivity to stress and in working memory). We do not wish to imply that spanking necessarily has any similar consequences or effects, but at the same time, it is not clear whether, how, or at what threshold the brain makes the distinction between child abuse and spanking. As a result, the circumstances under which spanking might also have such deleterious effects is uncertain.

Other psychological areas critical to development (e.g., attachment,

emotional regulation, stress of the child, parent-child relations) reflect critical brain-behavior-environment interactions that warrant attention. Although we do not challenge reviews claiming that very mild corporal punishment has not been shown to have either beneficial or deleterious effects, we argue that there is a need to look at how spanking might influence psychological processes critical to development. Research has already demonstrated that many developmental processes can be adversely influenced by harsh punishment.

Main Effects and Moderators

It is likely that any effects of parenting discipline practice are moderated by scores of variables related to the child, parent, family, and broader context (e.g., culture). The range of candidate variables to investigate is daunting, but there are exciting possibilities. Advances in molecular genetics will no doubt lead to breakthroughs that move researchers closer to understanding mechanisms and to identifying subgroups of youths who might be especially vulnerable to various discipline practices. For example, boys who are maltreated are likely to develop antisocial behavior if they have a particular gene characteristic related to one of the brain's neurotransmitter systems (Caspi et al., 2002). There are not many models that have been proposed and tested to explain influences that moderate the effects of spanking. This is a difficult topic in part because a study might implicitly endorse spanking as a good, or at least neutral, practice for some children and families and as a detrimental practice for others, or even unwittingly "blame" the child for extreme reactions to corporal punishment. The study of moderators of the effects of spanking is a charged topic because it could be

unwittingly construed as advocating hitting some children but not others. We have already raised the question of whether spanking is needed at all in child rearing.

CLOSING COMMENTS

Objections to spanking are made on moral, humane, and legal grounds (e.g., the immorality of inflicting pain, unequal treatment of children and adults under the law). These objections are critical insofar as they apply to all hitting of children and are independent of the evidence on the effects of spanking. The evidence suggests that spanking that is frequent and harsh is often associated with undesirable mental and physical health outcomes.

The effects of very mild, occasional spanking are not well studied or sufficiently clear from available studies. In one sense, it may be correct to say that current evidence does not establish the deleterious or beneficial effects of very mild spanking. Even so, it may be prudent to caution against the use of spanking because there are nonaversive alternatives for accomplishing the same disciplinary goals, and because it has not been empirically established where the demarcation is between mild spanking that may be safe to use and severe corporal punishment that is known to be dangerous. Moreover, mild spanking can escalate and apparently does mix in with more severe hitting (Gershoff, 2002). Thus, the many health, psychological, and neurological consequences of harsh punishment cannot be dismissed as irrelevant to mild spanking. One of the reasons that there is a debate about the effects of spanking is that investigators who study spanking and the parents and teachers who interact with children cannot ad-

here consistently to a delimited and crisp definition of spanking or hitting that is "mild and occasional."

From a parenting and policy perspective, the basic question is, why use corporal punishment at all? Mild noncorporal punishments such as brief time out from reinforcement or short-term loss of privileges in the context of praise and rewards can accomplish the goals for which spanking is usually employed. After years of research, critical questions about mild forms of corporal punishment remain. We have suggested some lines of work to inform discussions about the practice of spanking and its effects. More longitudinal studies are needed to help establish time lines between spanking and desirable and undesirable outcomes, competing constructs that may explain the effects attributed to spanking need to be ruled out more persuasively, and animal laboratory studies could be brought to bear more forcefully on the topic. Human and animal laboratory studies evaluating transient and enduring biological and behavioral reactions to punishment will be critical for illuminating the developmental processes that are influenced by corporal punishment and whether distinctions in the severity and frequency

of punishment are relevant to these processes.

Recommended Reading

- Benjet, C., & Kazdin, A.E. (2003). (See References)
- Gershoff, E.T. (2002). (See References) (Multiple commentaries follow this article)
- Larzelere, R.E. (2000). (See References)
- Straus, M.A., & Stewart, J.H. (1999). (See References)

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Notes

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2. Meta-analysis combines the effects of several studies using a common unit of analysis. For each study, groups are compared (e.g., children who have been spanked vs. those who have not), and their difference is placed into a common metric that permits studies to be compared and combined.

References

- Baumrind, D. (1996). A blanket injunction against disciplinary use of spanking is not warranted by the data. *Pediatrics*, *98*, 828–831.
- Baumrind, D., Larzelere, R.E., & Cowan, P.A. (2002). Ordinary physical punishment: Is it harmful? Comment on Gershoff (2002). *Psychological Bulletin*, *128*, 580–589.
- Benjet, C., & Kazdin, A.E. (2003). Spanking children: The controversies, findings, and new directions. *Clinical Psychology Review*, *23*, 197–224.
- Caspi, A., McClay, J., Moffitt, T.E., Mill, J., Martin, J., Craig, I.W., Taylor, A., & Poulton, R. (2002). Role of genotype in the cycle of violence in maltreated children. *Science*, *297*, 851–854.
- Consensus Statements. (1996). *Pediatrics*, *98*, 853.
- Gallup Organization. (1995). *Disciplining children in America: A Gallup poll report*. Princeton, NJ: Author.
- Gershoff, E.T. (2002). Parental corporal punishment and associated child behaviors and experiences: A meta-analytic and theoretical review. *Psychological Bulletin*, *128*, 539–579.
- Glaser, D. (2000). Child abuse and neglect and the brain: A review. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, *41*, 97–116.
- Hutchinson, R.R. (1977). By-products of aversive control. In W.K. Honig & J.E.R. Staddon (Eds.), *Handbook of operant behavior* (pp. 415–431). Englewood Cliffs, NJ: Prentice-Hall.
- Kazdin, A.E. (2001). *Behavior modification in applied settings* (6th ed.). Belmont, CA: Wadsworth.
- Krug, E.G., Dahlberg, L.L., Mercy, J.A., Zwi, A.B., & Lozano, R. (2002). *World report on violence and health*. Geneva, Switzerland: World Health Organization.
- Larzelere, R.E. (2000). Child outcomes of nonabusive and customary physical punishment by parents: An updated literature review. *Clinical Child and Family Psychology Review*, *3*, 199–221.
- Straus, M.A. (1994). Should the use of corporal punishment by parents be considered child abuse? Yes. In M.A. Mason & E. Gambrill (Eds.), *Debating children's lives* (pp. 195–203, 219–222). Thousand Oaks, CA: Sage.
- Straus, M.A., & Stewart, J.H. (1999). Corporal punishment by American parents: National data on prevalence, chronicity, severity, and duration, in relation to child and family characteristics. *Clinical Child and Family Psychology Review*, *2*, 55–70.

Rough-and-Tumble Play and the Development of the Social Brain

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ABSTRACT—*Social play—that is, play directed toward others—is a readily recognizable feature of childhood. In nonhuman animals, social play, especially seemingly competitive rough-and-tumble play or play fighting, has been the most studied of all forms of play. After several decades of study, researchers of play fighting in laboratory rats have pieced together the rudiments of the neural mechanisms that regulate the expression of this behavior in the mammalian brain. Furthermore, the understanding of the organization, development, and neural control of play in rats has provided a model with which to examine how the experiences accrued during play fighting can lead to organizational changes in the brain, especially those areas involved in social behavior.*

KEYWORDS—*play fighting; social competence; juveniles*

In the schoolyard, Johnny sneaks up behind Freddy, grabs him by the shoulders, and flings him to the ground. Johnny prances around smiling and laughing while Freddy regains his composure. Freddy then smiles at Johnny, and the two run off together. Such rough-and-tumble play may seem frivolous or even dangerous, and as a consequence, many schools have worked toward eliminating it (Bjorklund & Pellegrini, 2002). However, rough-and-tumble play is a recurring feature of childhood, and several studies show that engagement in such play is correlated with measures of social competence (Pellegrini, 1995). Of course, it is not possible to do the critical experiments with human subjects to determine whether there is a causal link between play and social competence. Experimental work from many laboratories using nonhuman animals, especially rats, suggests such a causal link, and researchers are beginning to characterize the possible mechanisms involved.

In nonhuman animals, rough-and-tumble play, also known as play fighting, is one of the forms of play most often reported by

researchers (Pellis & Pellis, 1998), and, certainly within the laboratory context, it is the most intensively studied (Panksepp, 1998). As is true for play in general, there is no accepted definition of play fighting, but there is growing agreement about some of its key elements (Burghardt, 2005), such as being engaged in voluntarily and being associated with positive affect. Nonetheless, because play fighting varies in degree of roughness, there is still debate about when it becomes serious fighting. Fortunately, in rats there is a clear behavioral difference between play fighting and serious fighting.

During play fighting, rats compete for access to the nape of their partner's neck, which if contacted is nuzzled. In serious fighting, they compete for access to the rump and the lower flanks of their partner's body, which if contacted are bitten (Pellis & Pellis, 1987). Thus, even though the rats appear to be competing and often vary in the degree of roughness, the targeting of the nape makes play fights readily discernible from serious fights. Play fighting involves playful attack by one partner coupled with playful defense by the other, with the role of attacker and defender alternating (Fig. 1). The ease with which such roles alternate depends on attack and defense tactics; there is considerable independence between the frequency of attack and the types of defense tactics used. Such independence has provided a fertile resource for linking different features of play fighting to different neural mechanisms (Pellis & Pellis, 1998). These neural mechanisms suggest a means by which play fighting may influence the development of social competency.

THE BENEFITS OF PLAY

Adult rats that have been prevented from playing with peers as juveniles have many emotional and cognitive deficits. Among the most striking of these are social problems such as hyper-defensiveness to the approach of another rat and difficulty in coordinating movements with those of a social partner—either in a cooperative encounter such as sex or in a competitive encounter such as defending a piece of food (for a review, see Pellis & Pellis, 2006). Studies by a Dutch group (see, e.g., van Frijtag, Schot, van den Bos, & Spruijt, 2002) capitalized on the

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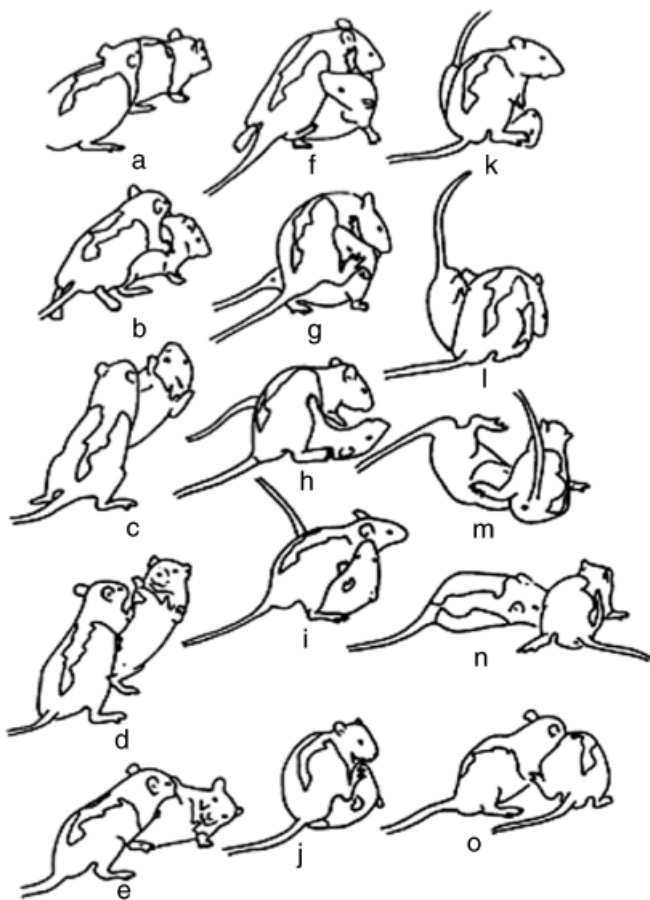


Fig. 1. A sequence of play fighting for a pair of juvenile rats, in which there is repeated attack and defense of the nape area. The sequence begins with the rat on the left approaching (a) and pouncing toward its partner's nape from the rear (b); but before the nape is reached, the defender rotates on its longitudinal axis (c) to face the attacker (d). As the attacker moves forward, the defender is pushed onto its side (e) but then rolls over onto its back as the attacker continues to reach for its nape (f–h). From the supine position, the defender launches an attack to its partner's nape (i), but is blocked by its partner's hind foot (j, k). After another attempt to gain access to its partner's nape, the rat on top (l) is pushed off by the supine animal's hind feet (m). The original defender regains its footing (n) and then lunges to attack its partner's nape (o). As can be seen, the rats use a variety of offensive and defensive maneuvers as they compete for access to the nape. A common feature of play fighting, especially in the juvenile phase, is that the partners frequently switch attacker and defender roles. From "Play-Fighting Differs From Serious Fighting in Both Target of Attack and Tactics of Fighting in the Laboratory Rat *Rattus norvegicus*," by S.M. Pellis & V.C. Pellis, 1987, *Aggressive Behavior*, 13, p. 235. Copyright 1987 by Wiley. Reprinted with permission.

social organization of rats, which involves multimale and multi-female colonies within which one adult male assumes the dominant role. Under natural conditions, younger males may intrude into the territory of a colony, seeking to establish residency. The dominant male of a colony typically resists such intrusions by attacking the unfamiliar males.

After establishing such colonies in a laboratory, groups of young adult males were introduced into the colonies. Some of these males had been reared together and so had plenty of op-

portunity to play fight, and some had been reared in isolation, with no play-fighting opportunities. When introduced into a colony, the rats that had been reared with peers quickly learned that if they remained crouched and motionless, attacks from the dominant male diminished. Similarly, when placed in a colony that contained a platform on which the rats could perch and so avoid contact with the dominant, the rats that were reared socially quickly learned to move onto and remain on the platform. In contrast, the play-deprived rats did not learn that remaining motionless would reduce attention from the dominant; they continued to move about the cage and so attracted further serious attacks. Furthermore, the play-deprived rats failed to take advantage of the platform as refuge. The play-deprived rats also produced higher levels of stress hormones and maintained these levels for longer periods of time than the rats raised with peers (e.g., von Frijtag et al., 2002), thus exposing them to the detrimental effects of chronic stress. The picture that emerges is one in which play-deprived rats are overly stressed by novel social encounters and are poor at adopting strategies that can alleviate that stress. Thus, it appears that in rats, the opportunity to engage in play fighting as juveniles is critical for the development not only of cognitive and emotional competency but also social competency. However, there is an important caveat to consider.

When rats are deprived of play fighting, they are usually deprived of other forms of social contact as well, and so the contributions from nonplayful social contact cannot be discounted. Nonetheless, a large body of evidence strongly suggests that although a role for nonplayful social contact cannot be discounted, the experience of peer–peer play fighting is crucial (for a review, see Pellis & Pellis, 2006). In a particularly illuminating series of studies, Dorothy Einon and her colleagues (e.g., Einon & Morgan, 1977) showed that rats that were reared as pairs but with mesh partitions between them so that they could see, smell, and lean against each other, still had cognitive and social deficiencies as adults. Further, rats that were reared in the same cage with an adult, a situation that provides the opportunity for direct social contact but little opportunity to engage in play fighting, also showed such deficiencies as adults. Rats reared in isolation but given access to an age-matched partner for 1 hour per day throughout the juvenile period performed as well as controls did in a number of cognitive tests as adults. For most of that hour, the young rats engaged in play fighting. Not coincidentally, rats reared with a litter of siblings play for about an hour a day. The experience of play fighting during the juvenile period seems to be a crucial ingredient for normal development.

Our own research on rats has shown that play fighting has specific properties in the juvenile phase and that these properties may provide a clue to how the behavior contributes to normal development. In rats, play fighting first occurs just before weaning, around the 3rd week after birth; it peaks between 30 and 40 days of age, and declines around puberty, the 8th to 9th week. When we examined the content of the play, we found that when play fighting is at its peak, it has a juvenile-typical

quality—that is, offensive and defensive tactics are organized to decrease the control that the rats have on their own and their partners' movements. This organization results in more frequent role reversals and provides the juvenile rats with an increased opportunity to experience not only novel bodily movements but also continually changing bodily configurations with their partners. The play fighting that occurs before this peak period more closely resembles that of postpubescent animals, which is far more stereotyped in the organization of the movements involved; thus the pattern of play in the juvenile phase is unique (for a review, see Pellis, Pellis, & Foroud, 2005).

But what is it about the unique pattern of play fighting in the juvenile period that provides the experiences that promote normal development? Rats reared in isolation can perform all socially relevant behavior patterns, but because their ability to coordinate their movements appropriately with those of their opponents is impaired, they may fail to orient their bodies correctly relative to the position of their opponents (e.g., Pellis, Field, & Whishaw, 1999). This apparent lack of ability to calibrate movements with those of a partner is a significant deficit in juvenile rats deprived of play fighting. Furthermore, such insensitivity to the outside world may also lay the foundation for the failure to develop emotional and cognitive skills in general. Indeed, there is growing evidence for a connection between the development of movement and the development of cognition (e.g., Diamond, 2000).

A MODEL FOR THE DEVELOPMENT OF THE SOCIAL BRAIN

Like all complex behaviors, play fighting involves many areas of the brain. The behavior patterns are likely organized in the lower brainstem; the motivation to engage in such behavior is organized in the mid-brain and the lower forebrain, which encompasses the reward systems of the brain; and finally, the cortex fine-tunes play fighting so that it is modified appropriately with context and past experience (Panksepp, 1998). Because play fighting is a highly social activity, when rats play fight, those areas of the brain that work together to deal with social phenomena—the social brain—are activated. Recent work suggests that juvenile play fighting induces the release of chemical growth factors in these areas of the brain, which may promote growth and development of these areas (Gordon, Burke, Akil, Watson, & Panksepp, 2003). Among those areas whose growth is promoted is the orbitofrontal cortex (OFC), a brain area known to be involved in social discrimination and decision making. Not unlike rats reared under conditions of play deprivation, rats with damage to the OFC fail to modify their behavior appropriately with different social partners, whether in playful or nonplayful contexts. That is, although rats with OFC damage can execute appropriate actions, these actions are not modified to take into account the idiosyncratic features of the partner's social status or its movements (Pellis et al., 2006).

Findings from several laboratories indicate that the juvenile-typical pattern of play fighting produces experiences that provide feedback for some of the brain areas responsible for generating such play and so promotes development of those areas. That such feedback may actually lead to functional enhancement in the output of these brain areas as the rats mature is suggested by deficits seen in rats with OFC damage and those with intact brains that have been deprived of play-fighting experience as juveniles. Furthermore, these brain areas are many of the same areas that regulate social behavior and cognition in general, and so improvements derived from play fighting may improve the capacity for more subtle social interactions.

CONCLUSION

The broad outlines of the story for laboratory rats suggest that there is a mechanism by which experiences accrued during play fighting can improve social competence. There is good evidence that there is continuity between human and nonhuman animals for at least some forms of play (Power, 2000), especially play fighting (Panksepp, 1998). There seems to be a considerable similarity between the behavioral effects of play deprivation in the early development of monkeys and that described here for rats (for a review, see Pellis & Pellis, 2006). If a similar pattern exists for rats and nonhuman primates, it is plausible that, for humans also, experience in play fighting in childhood is causally related to social competence later in life. Thus, the correlation between experience in play fighting and social competence in humans (Pellegrini, 1995) may not be spurious. That is, it may not be the case that the more socially competent children engage in more play fighting, but rather that the play fighting may promote the development of social competency.

Given the value of the rat model for studying the role of play fighting in the development of the social brain and social competence, it can be further used to elaborate the causal mechanisms involved. For example, researchers can characterize not only the broad areas of the brain that are altered by play experience but also the actual neural mechanisms by which the brain's structure and function are modified by such experience. Similarly, the facets of the play-fighting experience most important in promoting the development of the social brain can be characterized.

Finally, it has been well established for humans and nonhuman animals that play fighting is more frequent and rougher in males (Power, 2000). The rat model can help researchers determine whether the juvenile experiences needed to develop the social brain differ between the sexes and, if so, how. Again, rats provide a means with which to conduct the critical experiments that are either not practical or not ethical with humans. The knowledge thus gained can provide the clues to the correlated consequences of those processes that can be studied in humans.

Recommended Reading

- Bekoff, M., & Byers, J.A. (1998). *Play behavior: Comparative, evolutionary, and ecological perspectives*. Cambridge, England: Cambridge University Press.
- Geary, D.C., Byrd-Craven, J., Hoard, M.K., Vigil, J., & Numtee, C. (2003). Evolution and development of boys' social behavior. *Developmental Review*, 23, 444–470.
- Pellegrini, A.D., & Smith, P.K. (2005). *The nature of play: Great apes and humans*. New York: Guilford.
- Pellis, S.M., & Iwaniuk, A.N. (2004). Evolving a playful brain: A levels of control approach. *International Journal of Comparative Psychology*, 17, 92–118.
-

REFERENCES

- Bjorklund, D.F., & Pellegrini, A.D. (2002). *The origins of human nature: Evolutionary developmental psychology*. Washington, DC: American Psychological Association.
- Burghardt, G.M. (2005). *The genesis of animal play*. Cambridge, MA: The MIT Press.
- Diamond, A. (2000). Close interrelation of motor development and cognitive development and of the cerebellum and prefrontal cortex. *Child Development*, 71, 44–56.
- Einon, D.F., & Morgan, M.J. (1977). A critical period for social isolation in the rat. *Developmental Psychobiology*, 11, 213–225.
- Gordon, N.S., Burke, S., Akil, H., Watson, S.J., & Panksepp, J. (2003). Socially-induced brain “fertilization”: Play promotes brain derived neurotrophic factor transcription in the amygdala and dorsolateral frontal cortex in juvenile rats. *Neuroscience Letters*, 341, 17–20.
- Panksepp, J. (1998). *Affective neuroscience*. New York: Oxford University Press.
- Pellegrini, A.D. (1995). Boys' rough-and-tumble play and social competence: Contemporaneous and longitudinal relations. In A.D. Pellegrini (Ed.), *The future of play theory: A multidisciplinary inquiry into the contributions of Brian Sutton-Smith* (pp. 107–126). Albany: State University of New York Press.
- Pellis, S.M., Field, E.F., & Whishaw, I.Q. (1999). The development of a sex-differentiated defensive motor pattern in rats: A possible role for juvenile experience. *Developmental Psychobiology*, 35, 156–164.
- Pellis, S.M., Hastings, E., Shimizu, T., Kamitakahara, H., Komorowska, J., Forgie, M.L., & Kolb, B. (2006). The effects of orbital frontal cortex damage on the modulation of defensive responses by rats in playful and nonplayful social contexts. *Behavioral Neuroscience*, 120, 72–84.
- Pellis, S.M., & Pellis, V.C. (1987). Play-fighting differs from serious fighting in both target of attack and tactics of fighting in the laboratory rat *Rattus norvegicus*. *Aggressive Behavior*, 13, 227–242.
- Pellis, S.M., & Pellis, V.C. (1998). Play fighting in comparative perspective: A schema for neurobehavioral analysis. *Neuroscience & Biobehavioral Reviews*, 23, 87–101.
- Pellis, S.M., & Pellis, V.C. (2006). Play and the development of social engagement: A comparative perspective. In P.J. Marshall & N.A. Fox (Eds.), *The development of social engagement: Neurobiological perspectives* (pp. 247–274). Oxford, England: Oxford University Press.
- Pellis, S.M., Pellis, V.C., & Foroud, A. (2005). Play fighting: Aggression, affiliation and the development of nuanced social skills. In R. Tremblay, W.W. Hartup, & J. Archer (Eds.), *Developmental origins of aggression* (pp. 47–62). New York: Guilford.
- Power, T.G. (2000). *Play and exploration in children and animals*. Mahwah, NJ: Erlbaum.
- Von Frijtag, J.C., Schot, M., van den Bos, R., & Spruijt, B.M. (2002). Individual housing during the play period results in changed responses to and consequences of a psychosocial stress situation in rats. *Developmental Psychobiology*, 41, 58–69.

Cell-Phone–Induced Driver Distraction

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ABSTRACT—*Our research examined the effects of hands-free cell-phone conversations on simulated driving. We found that even when participants looked directly at objects in the driving environment, they were less likely to create a durable memory of those objects if they were conversing on a cell phone. This pattern was obtained for objects of both high and low relevance, suggesting that very little semantic analysis of the objects occurs outside the restricted focus of attention. Moreover, in-vehicle conversations do not interfere with driving as much as cell-phone conversations do, because drivers are better able to synchronize the processing demands of driving with in-vehicle conversations than with cell-phone conversations. Together, these data support an inattention-blindness interpretation wherein the disruptive effects of cell-phone conversations on driving are due in large part to the diversion of attention from driving to the phone conversation.*

KEYWORDS—*driver distraction; inattention blindness; attention; cell phones*

This article focuses on a dual-task activity that over 100 million drivers in the United States currently engage in: the concurrent use of a cell phone while operating a motor vehicle. It is now well established that cell-phone use significantly impairs driving performance (e.g., McEvoy et al., 2005; Redelmeier & Tibshirani, 1997; Strayer, Drews, & Johnston, 2003; Strayer & Johnston, 2001). For example, our earlier research found that cell-phone conversations made drivers more likely to miss traffic signals and react more slowly to the signals that they did detect (Strayer & Johnston, 2001). Moreover, equivalent deficits in driving performance were obtained for users of both hand-held and hands-free cell phones (see also Strayer, Drews, & Crouch, 2006). By contrast, listening to radio broadcasts or books on tape did not impair driving. These findings are important because

they demonstrate that listening to verbal material, by itself, is not sufficient to produce the dual-task interference associated with using a cell phone while driving. The data indicate that when a driver becomes involved in a cell-phone conversation, attention is withdrawn from the processing of the information in the driving environment necessary for safe operation of the motor vehicle.

EVIDENCE OF INATTENTION BLINDNESS

The objective of this article is to muster evidence in support of the hypothesis that cell-phone conversations impair driving by inducing a form of inattention blindness in which drivers fail to see objects in their driving environment when they are talking on a cell phone. Our first study examined how cell-phone conversations affect drivers' attention to objects they encounter while driving. We contrasted performance when participants were driving but not conversing (i.e., single-task conditions) with that when participants were driving and conversing on a hands-free cell phone (i.e., dual-task conditions). We used an incidental-recognition-memory paradigm to assess what information in the driving scene participants attended to while driving. The procedure required participants to perform a simulated driving task without the foreknowledge that their memory for objects in the driving scene would be subsequently tested. Later, participants were given a surprise recognition-memory test in which they were shown objects that had been presented while they were driving and were asked to discriminate these objects from foils that had not been in the driving scene. Differences in incidental recognition memory between single- and dual-task conditions provide an estimate of the degree to which attention to visual information in the driving environment is distracted by cell-phone conversations.

Each of the four studies we report here used a computerized driving simulator (made by I-SIM; shown in Fig. 1) with high-resolution displays providing a 180-degree field of view. (The dashboard instrumentation, steering wheel, gas, and brake pedal are from a Ford Crown Victoria sedan with an automatic transmission.) The simulator incorporates vehicle-dynamics,

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Fig. 1. A participant talking on a hands-free cell phone while driving in the simulator.

traffic-scenario, and road-surface software to provide realistic scenes and traffic conditions. We monitored the eye fixations of participants using a video-based eye-tracker (Applied Science Laboratories Model 501) that allows a free range of head and eye movements, thereby affording naturalistic viewing conditions for participants as they negotiated the driving environment.

The dual-task conditions in our studies involved naturalistic conversations with a confederate on a cell phone. To avoid any possible interference from manual components of cell-phone use, participants used a hands-free cell phone that was positioned and adjusted before driving began (see Fig. 1). Additionally, the call was begun before participants began the dual-task scenarios. Thus, any dual-task interference that we observed had to be due to the cell-phone conversation itself, as there was no manual manipulation of the cell phone during the dual-task portions of the study.

Our first study focused on the conditional probability of participants recognizing objects that they had fixated on while driving. This analysis specifically tested for memory of objects presented where a given driver's eyes had been directed. The conditional probability analysis revealed that participants were more than twice as likely to recognize roadway signs encountered in the single-task condition than in the dual-task condition. That is, when we focused our analysis on objects in the driving scene on which participants had fixated, we found significant differences in recognition memory between single- and dual-task conditions. Moreover, our analysis found that even when participants' eyes were directed at objects in the driving environment for the same duration, they were less likely to remember them if they were conversing on a cellular phone. The data are consistent with the inattention-blindness hypothesis: The cell-phone conversation disrupts performance by diverting attention from the external environment associated with the driving task to an engaging context associated with the cell-phone conversation.

Our second study examined the extent to which drivers who engage in cell-phone conversations strategically reallocate attention from the processing of less-relevant information in the driving scene to the cell-phone conversation while continuing to give highest priority to the processing of task-relevant information in the driving scene. If such a reallocation policy were observed, it would suggest that drivers might be able to learn how to safely use cell phones while driving. The procedure was similar to that of the first study except that we used a two-alternative forced-choice recognition-memory paradigm to determine what information in the driving scene participants attended to while driving. We placed 30 objects varying in relevance to safe driving (e.g., pedestrians, cars, trucks, signs, billboards, etc.) along the roadway in the driving scene; another 30 objects were not presented in the driving scene and served as foils in the recognition-memory task. There were different driving scenarios for different participants and target objects for some participants were foil objects for others. Objects in the driving scene were positioned so that they were clearly in view as participants drove past them, and the target and foils were counterbalanced across participants. Here again, participants were not informed about the memory test until after they had completed the driving portions of the study.

As in the first study, we computed the conditional probability of recognizing an object given that participants fixated on it while driving. Like the first study, this analysis specifically tested for memory of objects that were located where the driver's eyes had been directed. We found that participants were more likely to recognize objects encountered in the single-task condition than in the dual-task condition and that this difference was not affected by how long they had fixated on the objects. Thus, when we ensured that participants looked at an object for the same amount of time, we found significant differences in recognition memory between single- and dual-task conditions.

After each forced-choice judgment, participants were also asked to rate the objects in terms of their relevance to safe driving, using a 10-point scale (participants were initially given an example in which a child playing near the road might receive a rating of 9 or 10, whereas a sign documenting that a volunteer group cleans a particular section of the highway might receive a rating of 1). Participants' safety-relevance ratings ranged from 1.5 to 8, with an average of 4.1. A series of regression analyses revealed that there was no association between recognition memory and traffic relevance. In fact, traffic relevance had absolutely no effect on the difference in recognition memory between single- and dual-task conditions, suggesting that the contribution of an object's perceived relevance to recognition-memory performance is negligible. This analysis is important because it indicates that drivers do not strategically reallocate attention from the processing of less-relevant information in the driving scene to the cell-phone conversation while continuing to give highest priority to the processing of task-relevant information in the driving scene.

The studies discussed thus far have relied on explicit-memory measures taken after the driving session to test the hypothesis that cell-phone conversations interfere with the initial encoding of information in the driving scene. However, an alternative possibility is that there are no differences in the initial encoding but rather differences in the retrieval of the information during subsequent memory tests. This distinction is more than academic, because the former has direct implications for traffic safety whereas the latter does not (i.e., failing to recognize an item at a later point in time does not necessarily imply an impairment in encoding and reaction to an object in the driving environment).

Our third study tested the inattention-blindness hypothesis by recording on-line measures of brain activity elicited by events in the driving environment. Prior research has found that the amplitude of the P300 component of the event-related brain potential (ERP) is sensitive to the attention allocated to a task (e.g., Sirevaag, Kramer, Coles, & Donchin, 1989; Wickens, Kramer, Vanasse, & Donchin, 1983) and, further, that memory performance is superior for objects eliciting larger-amplitude P300s during encoding (e.g., Fabiani, Karis, & Donchin, 1986; Otton & Donchin, 2000). Moreover, ERPs recorded in flight simulation revealed that the P300 component discriminates between different levels of task difficulty, decreasing as the task demands increased (e.g., Kramer, Sirevaag, & Braun, 1987; Sirevaag et al., 1993).

In this study, we used a car-following paradigm in which participants drove on a simulated multilane freeway. Participants followed a pace car that would brake at random intervals and ERPs were time-locked to the onset of the pace-car brake lights in both single- and dual-task conditions. If the impairments in memory performance are due to differences in the initial encoding of objects in the driving scene, then P300 amplitude should be smaller in dual-task conditions than in single-task conditions. By contrast, if the memory differences are due to impaired retrieval of information at the time of the recognition-memory test but not at the time of encoding, then we would not expect to find differences in P300 amplitude between single- and dual-task conditions.

The average ERPs are presented in Figure 2. Visual inspection reveals a large positive potential between 250 and 750 milliseconds (the P300 component of the ERP). Our analysis indicated that the amplitude of the P300 component of the ERPs was reduced by 50% when the drivers were talking on the cell phone. Thus, drivers using a cell phone fail to see information in the driving scene because they do not encode it as well as they do when they are not distracted by the cell-phone conversation. These data suggest that drivers using a cell phone will be less able to react with alacrity in situations that demand it because of the diversion of attention from driving to the phone conversation (see also Strayer, Drews, & Johnston, 2003).

Our fourth study contrasted two modes of conversation commonly engaged in while driving: Conversation with a friend via a

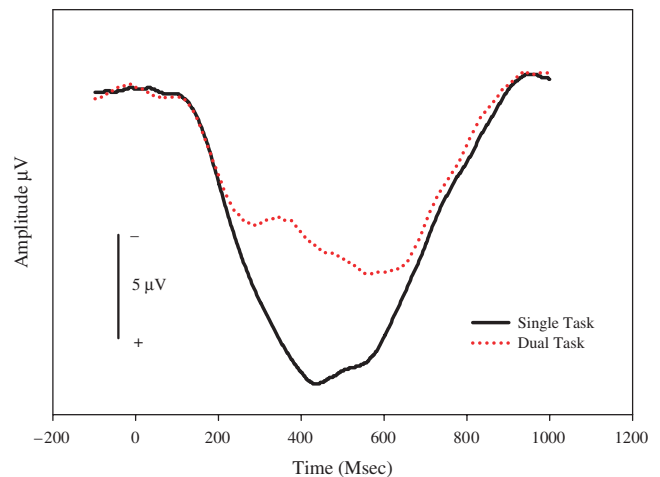


Fig. 2. Event-related potentials (ERPs) elicited by the onset of a pace car's brake light when talking on a cell phone (dual-task condition) and when not talking on a cell phone (single-task condition). The amplitude of the P300 component of the ERP (which is a manifestation of higher cognitive processing such as memory encoding) was reduced by 50% when participants were conversing on a hands-free cell phone.

hands-free cell phone versus conversation with a friend seated in the passenger seat located next to the driver in the vehicle. We hypothesized that these two conversations would differ because passengers tend to adjust their conversation based on driving difficulty; often helping the driver to navigate and identify hazards on the roadway and pausing the conversations during difficult sections of the drive. By contrast, this real-time adjustment based upon traffic demands is not possible with cell-phone conversations.

Participants were instructed to drive on a multilane freeway and exit at a rest stop approximately 8 miles down the road. We found that the majority of drivers (88%) who were conversing with a passenger successfully completed the task of navigating to the rest area, whereas 50% of the drivers talking on a cell phone failed to navigate to the rest area. Analysis of the video recordings indicated that a primary difference between these two modes of communication was that the passenger helped the driver in the navigation task by reminding them to exit at the rest stop. Moreover, our analysis of the content of the conversation indicated that references to traffic conditions were more likely with passenger conversations than they were with cell-phone conversations.

THEORETICAL CONSIDERATIONS AND FUTURE DIRECTIONS

What are the implications of these findings for the architecture of cognition? Multiple-resource models of dual-task performance (e.g., Wickens, 1984) have been interpreted as suggesting that an auditory/verbal/vocal cell-phone conversation may be performed concurrently with little or no cost to a visual/spatial/manual driving task. That is, given the apparent lack of overlap

in processing resources, the cell phone and driving dual-task combination should be performed with little degradation in performance. However, given the clear and consistent interference between cell-phone and driving tasks, it would appear that multiple-resource models do not apply well to this dual-task combination.

One alternative possibility that we are currently exploring is that the dual-task interference stems from a central-processing bottleneck, wherein attending to the cell-phone conversation temporarily blocks or impedes the processing of information in the driving environment (cf. Levy, Pashler, & Boer, 2006). We hypothesize that the central-processing bottleneck forces serial processing of these two sources of information (i.e., the information necessary for the safe operation of a motor vehicle and the cell-phone conversation) and that the cell-phone conversation may not lend itself to parsing in ways that are compatible with driving (cf. Strayer & Johnston, 2001). That is, a conversation on the phone cannot be successfully broken into arbitrary units, but instead is composed of “turns” that engage the central-processing bottleneck for prolonged periods of time (e.g., pausing in mid-sentence/thought impedes the flow of the conversation); moreover, this turn-taking is often asynchronous with the processing demands of driving. Supporting this idea is the observation that in-vehicle conversations do not interfere with driving as much as cell-phone conversations do because there is a greater ability to synchronize an in-vehicle conversation with the processing demands of driving than there is with a cell-phone conversation.

The findings reported here highlight the need for sharpening our theoretical understanding of multitasking in complex naturalistic environments. The usefulness of such theory increases with the ever-increasing prevalence of new technologies allowing people to engage in concurrent activities. Theory development will improve our ability to determine why some tasks are successfully performed in combination whereas others are incompatible.

In sum, the data indicate that cell-phone conversations place demands upon the driver that differ qualitatively from those of other auditory/verbal/vocal tasks commonly performed while operating a motor vehicle. Even when cell-phone drivers direct their gaze at objects in the driving environment, they often fail to “see” them because attention has been diverted to the cell-phone conversation.

Recommended Reading

- Redelmeier, D.A., & Tibshirani, R.J. (1997). (See References)
 Strayer, D.L., & Johnston, W.A. (2001). (See References)
-

REFERENCES

- Fabiani, M., Karis, D., & Donchin, E. (1986). P300 and recall in an incidental memory paradigm. *Psychophysiology*, *23*, 298–308.
- Kramer, A.F., Sirevaag, E.J., & Braun, R. (1987). A psychophysiological assessment of operator workload during simulated flight missions. *Human Factors*, *29*, 145–160.
- Levy, J., Pashler, H., & Boer, E. (2006). Central interference in driving: Is there any stopping the psychological refractory period? *Psychological Sciences*, *17*, 228–235.
- McEvoy, S.P., Stevenson, M.R., McCartt, A.T., Woodward, M., Haworth, C., Palamara, P., & Cercarelli, R. (2005). Role of mobile phones in motor vehicle crashes resulting in hospital attendance: A case-crossover study. *British Medical Journal*, *331*, 428–433.
- Ottom, L.J., & Donchin, E. (2000). Relationship between P300 amplitude and subsequent recall for distinctive events: Dependence on type of distinctiveness attribute. *Psychophysiology*, *37*, 644–661.
- Redelmeier, D.A., & Tibshirani, R.J. (1997). Association between cellular-telephone calls and motor vehicle collisions. *The New England Journal of Medicine*, *336*, 453–458.
- Sirevaag, E.J., Kramer, A.F., Coles, M.G.H., & Donchin, E. (1989). Recourse reciprocity: An event-related brain potential analysis. *Acta Psychologica*, *70*, 77–97.
- Sirevaag, E.J., Kramer, A.F., Wickens, C.D., Reisweber, M., Strayer, D.L., & Grenell, J.H. (1993). Assessment of pilot performance and mental workload in rotary wing aircraft. *Ergonomics*, *9*, 1121–1140.
- Strayer, D.L., Drews, F.A., & Crouch, D.J. (2006). Comparing the cell-phone driver and the drunk driver. *Human Factors*, *48*, 381–391.
- Strayer, D.L., Drews, F.A., & Johnston, W.A. (2003). Cell phone induced failures of visual attention during simulated driving. *Journal of Experimental Psychology: Applied*, *9*, 23–52.
- Strayer, D.L., & Johnston, W.A. (2001). Driven to distraction: Dual-task studies of simulated driving and conversing on a cellular phone. *Psychological Science*, *12*, 462–466.
- Wickens, C.D. (1984). Processing resources in attention. In R. Parasuraman & R. Davies (Eds.), *Varieties of Attention*. (pp. 63–101). New York: Academic Press.
- Wickens, C.D., Kramer, A.F., Vanasse, L., & Donchin, E. (1983). Performance of concurrent tasks: A psycho-physiological assessment of the reciprocity of information-processing resources. *Science*, *221*, 1080–1082.

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. Al-

cohol-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 per-

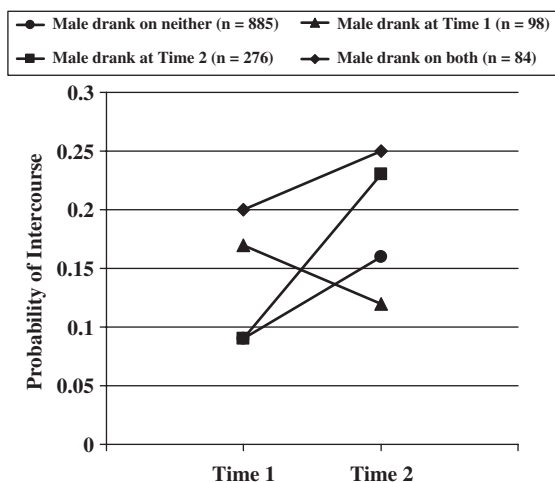


Fig. 1. Male couple-member alcohol use and probability of intercourse on two first-date occasions. From Cooper & Orcutt (1997).

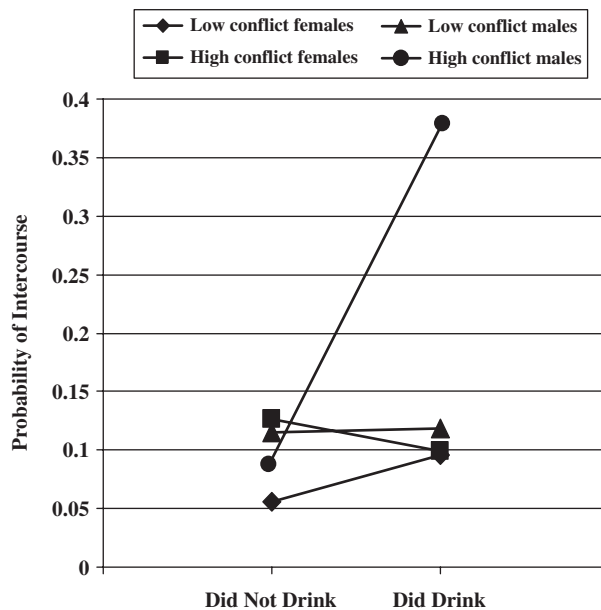


Fig. 2. Alcohol use, gender, and perceived conflict predicting probability of intercourse on the most recent first date. From Cooper & Orcutt (1997).

ception 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).

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.

Recommended Reading

- Cooper, M.L. (2002). (See References)
- George, W.H., & Stoner, S.A. (2000). Understanding acute alcohol effects on sexual behavior. *Annual Review of Sex Research, 11*, 92–122.

Leigh, B.C., & Stall, R. (1993). (See References)

Weinhardt, L.S., & Carey, M.P. (2000). Does alcohol lead to sexual risk behavior? Findings from event-level research. *Annual Review of Sex Research, 11*, 125–157.

REFERENCES

- Cooper, M.L. (2002). Alcohol use and risky sexual behavior among college students and youth. *Journal of Studies on Alcohol, 14*(Suppl.), 101–117.
- Cooper, M.L., & Orcutt, H.K. (1997). Drinking and sexual experiences on first dates among adolescents. *Journal of Abnormal Psychology, 106*, 191–202.
- Cooper, M.L., Wood, P.K., Orcutt, H.K., & Albino, A.W. (2003). Personality and predisposition to engage in risky or problem behaviors during adolescence. *Journal of Personality and Social Psychology, 84*, 390–410.
- Dermen, K.H., & Cooper, M.L. (1994). Sex-related alcohol expectancies among adolescents. *Psychology of Addictive Behaviors, 8*, 161–168.
- Dermen, K.H., & Cooper, M.L. (2000). Inhibition conflict and alcohol expectancy as moderators of alcohol's relationship to condom use. *Experimental and Clinical Psychopharmacology, 8*, 198–206.
- George, W.H., Stoner, S.A., Norris, J., Lopez, P.A., & Lehman, G.L. (2000). Alcohol expectancies and sexuality: A self-fulfilling prophecy analysis of dyadic perceptions and behavior. *Journal of Studies on Alcohol, 61*, 168–176.
- Hull, J.G., & Bond, C.F. (1986). Social and behavioral consequences of alcohol consumption and expectancy: A meta-analysis. *Psychological Bulletin, 99*, 347–360.
- Leigh, B.C. (2002). Alcohol and condom use: A meta-analysis of event-level studies. *Sexually Transmitted Disease, 29*, 476–482.
- Leigh, B.C., & Stall, R. (1993). Substance use and risky sexual behavior for exposure to HIV: Issues in methodology. *American Psychologist, 48*, 1035–1045.
- MacDonald, T.K., Fong, G.T., Zanna, M.P., & Martineau, A.M. (2000). Alcohol myopia and condom use: Can alcohol intoxication be associated with more prudent behavior? *Journal of Personality and Social Psychology, 78*, 605–619.
- Steele, C.M., & Josephs, R.A. (1990). Alcohol myopia: Its prized and dangerous effects. *American Psychologist, 45*, 921–932.

Mood and Emotion in Major Depression

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ABSTRACT—*Nothing is more familiar to people than their moods and emotions. Oddly, however, it is not clear how these two kinds of affective processes are related. Intuitively, it makes sense that emotional reactions are stronger when they are congruent with a preexisting mood, an idea reinforced by contemporary emotion theory. Yet empirically, it is uncertain whether moods actually facilitate emotional reactivity to mood-congruent stimuli. One approach to the question of how moods affect emotions is to study mood-disturbed individuals. This review describes recent experimental studies of emotional reactivity conducted with individuals suffering from major depression. Counter to intuitions, major depression is associated with reduced emotional reactivity to sad contexts. A novel account of emotions in depression is advanced to assimilate these findings. Implications for the study of depression and normal mood variation are considered.*

KEYWORDS—*depression; emotion; mood; affect; reactivity*

Isn't it a common experience that moods make people more emotionally volatile? For example, don't irritable moods make it easier for even a minor slight to trigger outbursts of rage? Don't anxious moods make people so jumpy that a few strange noises in the night will provoke full panic and terror? This article considers the interplay of moods and emotions, by focusing on studies that examine one mood (depressed mood) and one emotion (sadness) in one population (clinically depressed persons). I first consider the intuitive hypothesis that major depression facilitates sad emotional reactions. Second, I describe a series of experiments that yielded results largely inconsistent with this idea. Third, I assimilate these novel findings into an alternative framework for understanding emotions in major depression. Finally, I highlight three directions for future research on the interaction between mood and emotion.

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DOES DEPRESSED MOOD FACILITATE SAD EMOTIONAL REACTIONS?

One approach to studying mood–emotion interaction is to examine mood-disturbed individuals. People who suffer from major depressive disorder, commonly known as major depression, have a markedly severe type of mood disturbance. Major depression is the leading cause of psychiatric hospitalization; it is estimated to affect nearly one out of seven people and is associated with several adverse consequences, including increased risk of suicide. Major depression is defined as a 2-week period of persistent sad mood and/or a loss of interest or pleasure in daily activities, as well as four or more additional symptoms, such as marked changes in weight or appetite, sleep disturbance, pervasive guilt, fatigue, and difficulty concentrating. Although major depression is a complex package of symptoms, a profound change in mood is its most characteristic feature. Major depression thus provides a rich context for exploring the ways that mood alters emotional reactivity.

In considering mood–emotion interaction in depression, the first problem arises from the very slipperiness of the core terms, *mood* and *emotion*. Indeed, some researchers, clinicians, and laypeople have used these terms in confusing and incommensurate ways. For clarity and to follow current practices in affective science (Watson, 2000; Rottenberg & Gross, 2003), I here use moods to mean diffuse, slow-moving feeling states that are weakly tied to specific objects or situations. By contrast, emotions are quick-moving reactions that occur when organisms encounter meaningful stimuli that call for adaptive responses. Emotional reactions typically involve coordinated changes in feeling state, behavior, and physiology, and last seconds or minutes. Moods, by contrast, exert their clearest effects on feeling states and cognitions (as opposed to behavior and physiology) and last hours or days. When mood and emotion are distinguished in this way, it becomes apparent that depression, by definition, involves changes in moods but does not necessarily involve changes in emotional reactions.

Emotion theorists have posited that moods facilitate emotional reactions when the mood and the emotion are similar in nature

(e.g., Rosenberg, 1998). Does depressed mood facilitate sad emotional reactions? Circumstantial evidence suggests it does. From early psychoanalytic formulations of depression to contemporary cognitive conceptualizations, depression scholars have noted an increased expression of negative thoughts and feelings in this disorder. Depressed persons' increased report and display of negative feelings is apparent in several settings. For example, depressed persons typically report (in interviews and on questionnaires) strong sadness behaviors such as crying spells. These self-reports of increased tearfulness are corroborated by the observations of mental health professionals, who note that depressed persons are prone to cry in therapeutic settings.

Although these clinical observations are consistent with the mood-facilitation hypothesis, they do not in themselves establish that depressed persons react more strongly than other people to sad stimuli. For example, observations of notable crying in clinical contexts could reflect changes in depressed persons' social behavior, such as a tendency to seek comfort from potentially sympathetic others (Coyne, 1976). Likewise, increased crying could reflect that depressed persons are exposed to more sad stimuli in their everyday environments than are healthy individuals. Indeed, depressed persons are almost certainly faced with a different world of emotion-generative stimuli than healthy individuals are. For these reasons, a better way to test the mood-facilitation hypothesis is to assess depressed and healthy individuals' emotional reactivity to controlled sadness-eliciting stimuli in the laboratory.

Testing the Mood-Facilitation Hypothesis

To test the mood-facilitation hypothesis, my colleagues and I created short films, using material taken from commercially available movies; our films were designed to elicit specific emotional states, and we pretested them in healthy populations. Of particular interest were responses to films that were edited either to elicit sadness or a neutral state (i.e., few reports or displays of emotion in healthy participants; Rottenberg, Kasch, Gross, & Gotlib, 2002). The sad film dramatized a death scene and revolved around themes of loss and grief; the neutral film depicted relatively innocuous landscape scenery. We recorded depressed and nondepressed participants' self-reported emotional experience and their observed expressive behavioral reactions and physiological reactions to the films. Surprisingly, the results from this study did not support the mood-facilitation hypothesis. First, depressed individuals' experiential, behavioral, and physiological reactions to the sad film were of similar magnitude to those of healthy people. Second, depressed participants reported greater sadness than healthy participants in response to the neutral film. Third, and most strikingly, when responses to the neutral film were used as a reference point, a typical practice in studies of emotional reactivity, depressed subjects actually reported smaller increases in sad feelings in response to the sad film than healthy controls did. Finally, this group difference did not appear to be a ceiling effect—that is, a consequence of depressed

persons' sadness already being at an upper limit of measure while watching the neutral film. The difference remained significant even after depressed participants who had reported very high levels of sadness to the neutral film were removed from the analysis.

Further Violations of the Mood-Facilitation Hypothesis in Depression

Although a single violation of the mood-facilitation hypothesis is not decisive in itself, the lack of any support for the hypothesis in our first analysis gave us pause. Were our results an anomaly? To find out, we sought to test the mood-facilitation hypothesis under conditions that we expected to favor its confirmation.

Crying Responses

One alternative explanation for why depressed individuals originally reported relatively little change in their feeling state in response to our sad film is that the film simply failed to engage the depressed participants. It is easy to imagine, for example, that the concentration difficulties experienced by depressed persons, or their lack of motivation to watch films, could curtail the impact of a sad film. To address the possibility that our results were a consequence of low engagement, we reanalyzed our data, focusing only on those depressed and healthy participants who responded to the sad film with verifiable crying behavior (visible tears in the eyes); we assumed that participants who visibly cried during the film were fully engaged with it. Indeed, given the popular belief that depressed persons cry readily and intensely, it seemed reasonable to expect that these analyses of criers would favor the facilitation hypothesis.

Despite this expectation, when criers in the two diagnostic groups were compared directly, depressed criers did not exhibit a greater response to the sad film in their emotional experience, expressive behavior (e.g., tearful eyes, furrowed brow, downturned mouth), or physiological responses such as heart rate and skin conductance (a measure of sweat gland activity). In fact, as displayed in Figure 1, when reactivity was computed from a neutral reference, depressed criers actually showed smaller changes in their emotional experience and physiology than healthy criers did (Rottenberg, Gross, Wilhelm, Najmi, & Gotlib, 2002). Therefore, restriction of the analysis to criers did not yield support for the mood-facilitation hypothesis. In fact, our results suggested that depression might actually blunt the distress and arousal that is typically associated with crying (Gross, Fredrickson, & Levenson, 1994).

Personally Tailored Sad Stimuli

Analysis of criers suggested that depressed persons' reduced response to sad material was unlikely to be an artifact of low engagement. Still, the possibility remained that our sad film was not an ideal stimulus for eliciting sadness in a depressed individual, in part because it was not relevant to the concerns of someone suffering from a serious disorder such as major de-

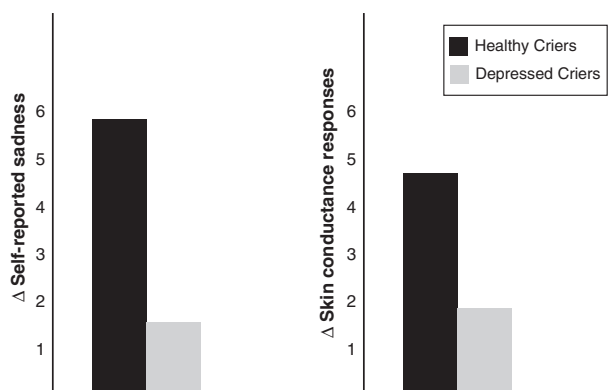


Fig. 1. Differences in self-reported sadness (left) and skin-conductance response rate (right) between healthy and depressed individuals who cried in response to a sad film. Adapted from “Crying threshold and intensity in major depressive disorder,” by J. Rottenberg, J.J. Gross, F.H. Wilhelm, S. Najmi, and I.H. Gotlib, 2002, *Journal of Abnormal Psychology*, 111, p. 307. Copyright 2002 by the American Psychological Association. Adapted with permission.

pression. After all, the sad film had been drawn from a commercial entertainment, and it dramatized the misfortunes of other people using a fairly generic theme of loss. Would the mood-facilitation hypothesis hold if a more personally relevant sad stimulus were employed?

To answer this question, we repeated our experiment with a new sample of participants (again, depressed people and a healthy control group). This time, we included personally tailored emotional films alongside the standardized emotional films previously used. The personally tailored films, drawn from videotaped interviews, were videotapes of the participants themselves talking about the saddest and happiest events from their own lives. (Segments of videotape of participants answering demographic questions about themselves were used as a neutral reference.) Remarkably, results indicated that even when they were responding to emotional films depicting themselves relating sad events that had happened to them personally, depressed persons still did not show greater sensitivity to sad stimuli than healthy controls did. The results instead confirmed our earlier result: Depressed individuals reported considerable sadness to neutral emotional material and reported little differential response to acutely sad material (Rottenberg, Gross, & Gotlib, 2004).

IMPLICATIONS OF THESE FINDINGS

In summary, none of our work conducted with individuals with major depression has adduced evidence for the mood-facilitation hypothesis. In fact, our data indicate that major depression actually impedes reactivity to sad stimuli. Thus, contrary to both common intuition and emotion theory (Rosenberg, 1998), strong moods may not always facilitate strong emotional reactions to a mood-relevant stimulus. These findings have implications for how we understand major depression and the broader relationship between mood and emotion.

Rethinking Emotional Functioning in Depression

It has long been known that depressed individuals exhibit relatively little reactivity to positive emotional contexts (e.g., less smiling at jokes). The data presented here are novel in suggesting that this lack of reactivity extends to negative emotional contexts. To be clear, in these studies, depressed persons do respond to sad stimuli with reports of sadness and behavioral signs of sadness. But, remarkably, they appear to show essentially the same pattern of response to sad stimuli as they do to emotionally innocuous stimuli. In other words, depression flattens the emotional landscape, greatly constricting the range of emotional reactions to differing emotional contexts. My colleagues and I label this emotionally constricted pattern *emotion context insensitivity* (ECI; Rottenberg et al., 2004).

Converging Evidence for ECI in Major Depression

ECI—though a novel label—accords with several previous observations of depression. First, ECI accords with naturalistic observations of depressed persons’ behavior. Depressed patients often exhibit few changes in expressive behavior to environmental events and display monotonous sad expressions. Second, ECI accords with depressed patients’ personal descriptions of their disorder, which often feature emotional constriction: Patients describe their world as being flat, dull, and empty, and they remark that “everything is the same” (Healy, 1993). Third, ECI accords with the findings of recent investigations of emotion in major depression. For example, a recent naturalistic study found that, relative to healthy persons, depressed persons reported less emotional sensitivity to negative events (Peeters, Nicolson, Berkhof, Delespaul, & deVries, 2003).

The Clinical Significance of ECI

What are the clinical implications of ECI? Although ECI is a generally observable feature in depressed patients, patients also vary in the extent to which they show ECI. Early data suggests that depressed patients with the most pronounced ECI may face a relatively worse prognosis. For example, we found that those depressed persons who reported the most similar reactions to sad and neutral contexts (the constricted pattern expected by ECI) evidenced the most impaired functioning—specifically, the most severe depression, the longest episodes of depression, and the poorest overall psychosocial functioning (Rottenberg, Kasch, et al., 2002). Also underscoring the potential clinical importance of ECI, we recently found that depressed individuals who disclosed the least sad emotion when discussing memories of sad life events showed the least improvement of their symptoms 1 year later (Rottenberg, Joormann, Brozovich, & Gotlib, in press).

Does Depressed Mood Have a Purpose?

Depressed mood is painful, is associated with terrible human costs, and is remarkably prevalent. Scholars and sufferers alike have wondered whether depressed mood has any purpose. That

severe depressed-mood states impede emotional reactions may speak to the possible functions of depressed mood. Nesse (2000) postulated that depressed mood evolved originally as an internal signal designed to bias an organism against action, particularly in adverse situations in which continued activity might prove to be futile or dangerous (e.g., famine). Depressed mood may drive several features associated with depression—such as pessimism, self-absorption, and loss of interest in the environment—that hold a person in place and prevent ill-considered actions. In this way, severe depressed-mood states may constitute a broad defensive response that “shuts down” motivated activity.

When Might Mood Facilitation Hold?

Strong moods may not always facilitate emotional reactions to mood-relevant stimuli, but how general is the exception? Should the intuition that irritable moods predispose people to angry outbursts and tense moods to anxiety attacks be abandoned? Although more compelling empirical demonstration of mood facilitation is needed, considerable indirect evidence for mood facilitation does exist, particularly for anxiety. In fact, most characterizations of anxiety disorders refer to prevailing anxious mood and to strong emotional reactions to mood-relevant stimuli (e.g., panic attacks, phobic reactions; see Barlow, 2002). Clinical anxiety and depression often co-occur; if it can be shown that anxious and depressed moods affect emotion differently, this fact may help better distinguish the two conditions (Watson, 2000).

FUTURE DIRECTIONS

This review suggests that studying emotional disorders such as major depression can yield surprising insights about the interactions of mood and emotion. As we learn more about mood–emotion interaction, surely other surprising findings will follow. I close by highlighting three important questions for future research.

Do mild depressed moods affect emotion differently than clinical depression does? Careful assessment of emotional reactivity across the range of depressed mood may reveal that mild depression facilitates emotional reactions, whereas clinical depression impedes them. Such nonlinearity would further enrich the debate about whether depression is best conceived as a continuum or a discrete category (Beach & Amir, 2003). Such nonlinearity would also raise intriguing questions about research on neuroticism (a personality trait, involving unstable affect, that is a risk factor for depression), which has demonstrated that neurotic individuals react more strongly than non-neurotic individuals to negative stimuli (Larsen & Ketelaar, 1991).

How do the consequences of depressed moods differ from that of other moods? Parallel investigations using other mood states (e.g., irritable, anxious, and positive) will be critical for examining the boundary conditions for mood facilitation. Likewise, to determine whether depressed persons’ diminished response to

stimuli designed to elicit sadness is generalizable, other negative emotions (e.g., anger) should be examined with equal care.

How does mood influence other aspects of emotion besides the magnitude of emotional responses? Affective science is increasingly highlighting the payoffs of studying the timing and orchestration of emotion, for instance the speed at which emotional responses rise and fall (e.g., Rottenberg & Gross, 2003). Thus, future work on mood–emotion interaction should study not only mood’s effects on emotion magnitude but on these other aspects of the unfolding emotion waveform.

Recommended Reading

- Nesse, R.M. (2000). (See References)
 Rottenberg, J., Gross, J.J., Wilhelm, F.H., Najmi, S., & Gotlib, I.H. (2002). (See References)
 Rottenberg, J., Kasch, K.L., Gross, J.J., & Gotlib, I.H. (2002). (See References)
-

REFERENCES

- Barlow, D. (2002). *Anxiety and its disorders*. New York: Guilford Press.
 Beach, S.R.H., & Amir, N. (2003). Is depression taxonic, dimensional, or both? *Journal of Abnormal Psychology, 112*, 228–236.
 Coyne, J.C. (1976). Toward an interactional description of depression. *Psychiatry, 39*, 28–40.
 Gross, J.J., Frederickson, B.L., & Levenson, R.W. (1994). The psychophysiology of crying. *Psychophysiology, 31*, 460–468.
 Healy, D. (1993). Dysphoria. In C.G. Costello (ed.) *Symptoms of Depression* (pp. 23–42). New York: John Wiley.
 Larsen, R.J., & Ketelaar, T. (1991). Personality and susceptibility to positive and negative emotional states. *Journal of Personality and Social Psychology, 61*, 132–140.
 Nesse, R.M. (2000). Is depression an adaptation? *Archives of General Psychiatry, 57*, 14–20.
 Peeters, F., Nicolson, N.A., Berkhof, J., Delespaul, P., & deVries, M. (2003). Effects of daily events on mood states in Major Depressive Disorder. *Journal of Abnormal Psychology, 112*, 203–211.
 Rosenberg, E.L. (1998). Levels of analysis and the organization of affect. *Review of General Psychology, 2*, 247–270.
 Rottenberg, J., Gross, J.J., & Gotlib, I.H. (2004). *Emotion context insensitivity in major depression*. Manuscript submitted for publication.
 Rottenberg, J., Gross, J.J., Wilhelm, F.H., Najmi, S., & Gotlib, I.H. (2002). Crying threshold and intensity in major depressive disorder. *Journal of Abnormal Psychology, 111*, 302–312.
 Rottenberg, J., Joormann, J., Brozovich, F., & Gotlib, I.H. (in press). Emotional intensity of idiographic sad memories in depression predicts symptom levels one year later. *Emotion*.
 Rottenberg, J., Kasch, K.L., Gross, J.J., & Gotlib, I.H. (2002). Sadness and amusement reactivity differentially predict concurrent and prospective functioning in major depressive disorder. *Emotion, 2*, 135–146.
 Rottenberg, J., & Gross, J.J. (2003). When emotion goes wrong: Realizing the promise of affective science. *Clinical Psychology: Science and Practice, 10*, 227–232.
 Watson, D. (2000). *Mood and temperament*. New York: Guilford Press.

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.

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

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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-

realistic, 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 pre-trauma 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.

Recommended Reading

- Brewin, C.R., Andrews, B., & Valentine, J.D. (2000). (See References)
- McNally, R.J. (2003). Progress and controversy in the study of posttraumatic stress disorder. *Annual Review of Psychology, 54*, 229–252.
- Ozer, E.J., Best, S.R., Lipsey, T.L., & Weiss, D.S. (2003). (See References)
- Wilson, J.P., Friedman, M.J., & Lindy, J.D. (Eds.). (2001). *Treating psychological trauma and PTSD*. New York: Guilford Press.
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REFERENCES

- Brewin, C.R., Andrews, B., & Valentine, J.D. (2000). Meta-analysis of risk factors for posttraumatic stress disorder in trauma-exposed adults. *Journal of Consulting and Clinical Psychology, 68*, 748–766.
- Foa, E.B., & Rothbaum, B.O. (1989). Behavioral-cognitive conceptualizations of posttraumatic stress disorder. *Behavior Therapy, 20*, 155–176.
- Herman, J. (1992). Complex PTSD. *Journal of Traumatic Stress, 5*, 377–391.
- Keane, T.M., Kolb, L.C., Kaloupek, D.G., Orr, S.P., Blanchard, E.B., Thomas, R.G., Hsieh, F.Y., & Lavori, P.W. (1998). Utility of psychophysiological measurement in the diagnosis of posttraumatic stress disorder: Results from a Department of Veterans Affairs cooperative study. *Journal of Consulting and Clinical Psychology, 66*, 914–923.
- Kessler, R.C., Sonnega, A., Bromet, E., Hughes, M., & Nelson, C.B. (1995). Posttraumatic stress disorder in the National Comorbidity Survey. *Archives of General Psychiatry, 52*, 1048–1060.
- Kulka, R.A., Schlenger, W.E., Fairbank, J.A., Hough, R.L., Jordan, B.K., Marmar, C.R., & Weiss, D.S. (1990). *Trauma and the Vietnam war generation: Report of the findings from the National Vietnam Veterans Readjustment Study*. New York: Brunner/Mazel.
- LeDoux, J.E. (2000). Emotion circuits in the brain. *Annual Review of Neuroscience, 23*, 155–184.
- Martin-Baro, I. (1994). *Writings for a liberation psychology* (A. Aron & S. Corne, Eds.). Cambridge, MA: Harvard University Press.
- McCann, I.L., & Pearlman, L.A. (1990). *Psychological trauma and the adult survivor*. New York: Brunner/Mazel.
- Ozer, E.J., Best, S.R., Lipsey, T.L., & Weiss, D.S. (2003). Predictors of posttraumatic stress disorder and symptoms in adults: A meta-analysis. *Psychological Bulletin, 129*, 52–73.
- Rauch, S.L., van der Kolk, B., Fisler, R.E., Alpert, N.M., Orr, S.P., Savage, C.R., Fischman, A.J., Jenike, M.A., & Pitman, R.K. (1996). A symptom provocation study of posttraumatic stress disorder using positron emission tomography and script-driven imagery. *Archives of General Psychiatry, 53*, 380–387.
- Schuff, N., Marmar, C.R., Weiss, D.S., Neylan, T.C., Schoenfeld, F.B., Fein, G., & Weiner, M.W. (1997). Reduced hippocampal volume and n-acetyl aspartate in posttraumatic stress disorder. *Annals of the New York Academy of Sciences, 821*, 516–520.
- Silver, R.C., Holman, E.A., McIntosh, D.N., Poulin, M., & Gil-Rivas, V. (2002). National Longitudinal Study of Psychological Responses to September 11. *Journal of the American Medical Association, 288*, 1235–1244.
- Weiss, D.S., Marmar, C.R., Schlenger, W.E., Fairbank, J.A., Jordan, B.K., Hough, R.L., & Kulka, R.A. (1992). The prevalence of lifetime and partial post-traumatic stress disorder in Vietnam Theatre veterans. *Journal of Traumatic Stress, 5*, 365–376.
- Yehuda, R. (1998). Psychoneuroendocrinology of post-traumatic stress disorder. *Psychiatric Clinics of North America, 21*, 359–379.