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Research Report

Differential effects of practice on the executive processes used for truthful and deceptive responses: An event-related brain potential study

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Abstract

Behavior and event-related potentials (ERP) were recorded while participants made truthful and deceptive responses about previously memorized words under three instructional conditions: consistent truthful, consistent deceptive, and random deceptive. To determine if practice affected the deception-related activity we reported previously [R. Johnson, Jr., J. Barnhardt, J. Zhu, The deceptive response: effects of response conflict and strategic monitoring on the late positive component and episodic memory-related brain activity. Biol. Psychol., 64 (2003) 217–253; R. Johnson, Jr., J. Barnhardt, J. Zhu, The contribution of executive processes to deceptive responding. Neuropsychologia, 42 (2004) 878–901], participants performed two blocks of 145 trials of each condition. In the consistent truthful condition, practice benefited performance as indicated by decreased reaction time (RT) and RT variability. In addition, practice increased P300 amplitude and decreased the amplitude of a medial frontal negativity (MFN), which is believed to index the use of response-monitoring processes. However, a different pattern of results obtained in the two deception conditions. Although practice decreased RTs by almost as much as in the consistent truthful condition, the extent to which deceptive response in both conditions were slower than those in the consistent truthful condition actually increased slightly. Hence, the component of RT reflecting processing of conflicting response information did not decrease. In accord with the RT results, MFN amplitudes in the consistent deceptive and random deceptive conditions were unaffected by practice, suggesting that the amount of executive processes required to make and/or monitor deceptive responses was undiminished by practice. Although P300 amplitude increased slightly in the consistent deceptive condition, there was no change in the random deceptive condition. Thus, a major finding here is that, unlike truthful responses, the conceptually driven response conflicts underlying deceptive responses appear to be as resistant to practice-induced changes as described previously for perceptually driven response conflicts.

Theme: Neural basis of behavior
Topic: Cognition

Keywords: Deception; Executive process; Response conflict; ERP; MFN; P300

1. Introduction

Relatively little is known about the cognitive processes used when a person is deceptive. One reason for this is that, given that deceptions occur in many forms, which vary in their nature and complexity (for a review, see Ref. [66]), the particular cognitive processes used for any particular type of deception are likely to be quite variable. Further, the cognitive processes required will depend not only on the circumstances surrounding the deception, but also on such factors as the personality and personal habits of the deceiver (e.g., how often they lie). It also apparent that non-cognitive processes, such as those related to any emotional aspects of the deception, may play an integral part in deception.

Determining the cognitive basis of deception is hampered by the lack of a specific and widely accepted definition of deception (for reviews, see Refs. [49,66]). Complicating

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matters further, the various definitions that have been advanced are general in nature and do not address the question of which specific cognitive processes might be involved. We noted, however, that at least some definitions can be interpreted as implicitly dividing the cognitive operations used in deceptions into two broad categories: (1) those used to formulate such factors as the rationale, intent and strategies relevant to a deception and (2) those used to execute the deceptive motor response or act. Although this conceptualization is undoubtedly an oversimplification, due to the probable involvement of other types of processes (e.g., no emotional component is included for either category), this intent/action division of processes is consistent with at least some general definitions of deception (cf. [19]). Moreover, this conceptualization provided a starting point for specifying the cognitive processes involved in deception.

In our conception, executive control processes play a central role in the action stage of deception. Cognitive control is the term used to describe how, through a variety of executive processes, a person is able to coordinate and control the selection and execution of willed actions. These processes are therefore believed to provide the means by which one can interact successfully with the environment in all situations (e.g., Ref. [42]). One way in which cognitive control is thought to be implemented is through processes that help control actions by monitoring and resolving response conflicts when interference arises from competing information streams or when there is competition between alternative responses (e.g., Refs. [3,5,6,9,21,38]). Executive processes also play a role when there are unwanted responses and/or erroneous responses that need to be detected and inhibited [15–17,23,27]. Finally, executive processes are important to maintaining optimum performance in dual-task situations when it is necessary to coordinate and flexibly allocate cognitive resources between tasks (e.g., Ref. [62]). Thus, the ability to execute controlled and coordinated actions that achieve one's overall plans and goals depends entirely on these control processes.

These properties suggest that executive processes play an indispensable role in deception because, regardless of the nature or extent of the cognitive and emotional processes that precede and accompany a decision to deceive, all deceptions ultimately require both the inhibition of the truthful response and the execution of a response that is incompatible with the truth. Given that the success of every deception depends entirely on the ability of control processes to resolve accurately the response conflicts created by the tendency to make the pre-potent truthful response and the need to make a deceptive (i.e., conflicting) response, executive processes must play an even larger role for deceptive responses than for truthful responses. The essential nature of these control processes is evident from the fact that any failure to, for example, inhibit the execution of an unwanted truthful response would negate all preceding deception-related processing. It follows that the extra control processes required to make deceptive responses must be performed in addition to, and after, all the usual stimulus and response processing necessary to evaluate and select truthful responses. Thus, performing these extra executive processes, which also demand cognitive resources, can be thought of as a second task that the deceptive person must perform in addition to the primary task of determining the truthful response.

The brain mechanisms underlying executive control processes have been studied extensively in recent years. Typically, conflicting response information has been created by manipulating perceptual factors in such a way that one aspect of a stimulus suggests one response while another aspect of the same stimulus suggests a competing response. For example, in the Stroop task, participants see color words (e.g., "red") printed in different colored inks (e.g., blue) and must respond by naming the color of the ink in which a word is printed while ignoring the response indicated by the word itself. These perceptually based (i.e., stimulus driven) response conflicts produce decreased response accuracy and slowed reaction times (RT) (e.g., Refs. [9,11,56]). Hemodynamic studies (e.g., functional magnetic resonance imaging, fMRI) have shown that an area of the medial frontal lobes, the anterior cingulate cortex (ACC), is activated when stimuli create conflicting response tendencies or uncertainty about the identity of the proper response [4,5,9–11,38,43,52]. Other studies have found that this brain area is activated in word recognition paradigms, presumably as a result of uncertainty about the correct categorization of items as being known or not [25,55,67]. Different executive processes, however, appear to be used to inhibit pre-potent responses because different ACC areas are activated by error detection and correction processes [20]. Evidence of a rostral–caudal division of cognitive functions within the ACC has accumulated recently as fMRI studies have shown that error monitoring functions are located in rostral ACC areas while conflict detection and monitoring functions are located more caudally [20,39,63]. Based on these and other results, researchers have hypothesized that the ACC is a multi-functional brain area that aids in the control of behavior by monitoring a person's actions when there are conflicts between intended and actual responses [5,7,38,60,62,68].

The event-related brain potential (ERP) provides an index of brain activity with much greater temporal resolution than hemodynamic measures. One component of the ERP, elicited between 0 and 100 ms after a response, provides an index of medial frontal activity. Because this component was found initially to be elicited on error trials [15,16,23], it was labeled the error-related negativity (ERN) or error negativity (Ne) (for a review, see Ref. [17]). Subsequent studies have revealed a similar negativity, referred to as the medial frontal negativity (MFN), on correct trials [21,22,46,61,65], particularly in situations when there is ambiguity about how stimuli should be categorized [56]. Localization studies have placed the neural generators of the ERN and MFN in different locations within the medial frontal lobes, in or near the ACC [12,24,35,40,48]. In accord with the fMRI results