Poor Stop-Signal Task Performance:

Mechanisms Revealed through Event-related Brain Potentials

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Abstract

The stop-signal task has been used extensively in order to test abilities of inhibition as well as cognitive functioning. In previous experiments, a relatively large number of participants had to be excluded from analysis because of poor performance on the task. In this experiment, we examined the differences between adequate and poor performers on a stop-signal task embedded in an emotional lexical decision task. The personality and behavioral data of the poor stop-signal task performers did not differ from the adequate performers, but the P3 and error-related negativity (ERN) ERPs provided evidence that the poor stop-signal performers attended to the lexical decision portion of the task rather than the stop-signal. However, poor stop-signal task performers did not fail to process the stop signal. These results suggest that the selection of the task in which the stop signal is embedded is crucial.

Keywords: stop-signal task, event-related potentials, error-related negativity

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The stop-signal task has been used extensively to test internal processes related to inhibition and executive function. The task is a powerful one because it focuses solely on the participant's ability to control his/her own responses. Whereas many other experiments rely on the participant's reaction to different stimuli or use the environment to gauge a participant's responses, the stop-signal task places the focus squarely on the individual and the ability to access the required mechanisms and processes to inhibit an action (Logan, 1994).

The Stop-Signal Task

In a stop-signal task, the participant responds to a given stimulus, which comprises the "Go" condition. The "No Go" condition, however, requires the participant to withhold their previously prepared response and occurs on a minority of trials. The stop-signal task is thought to be an effective way of testing the top-down processes that activate inhibition and act as a brake on the go response when the participant realizes that the stop signal has occurred (Dimoska, Johnstone, & Barry, 2006).

In order to better understand how the inhibition process works, Logan and Cowan (1984) proposed a "horse-race" model that has been well established and consistently validated. According to the horse-race model, the processes involved in responding to the go stimulus race against the processes responding to the no go (stop-signal) stimulus. If the participant can initiate these stop processes and complete them before the go processes cause an action to be made, the result will be a successful inhibition. If the stop-signal occurs too late for the participant to initiate the stop processes, however, an incorrect response will be made (Logan, Cowan, & Davis, 1984). The stop and go processes are in a race against each other, and the first to completion will determine the response of the participant. Stop-signal tasks have been used for a number of purposes, including examining the differences between younger and older adults (Bedard et al., 2002; Hasher, Stoltzfus, Zacks, & Rypma, 1991; Stoltzfus, Hasher, Zacks, Ulivi, & Goldstein, 1993) and impulsivity (Dimoska, Johnstone, Barry, & Clarke, 2003; Logan, Schachar, & Tannock, 1997).

Many methods can be used to establish stop-signal reaction times, the five most prominent of which are described in Logan (1994). One method that can tightly calibrate a stop-signal task to individual differences in stop-signal reaction time is to use a dynamic stimulus onset asynchrony for each stop-signal trial (Logan et al., 1997). In this dynamic stop-signal delay version of the task, the stop-signal delay is altered depending on the participant's ability to inhibit his or her response on the previous trial. If a participant successfully inhibits his or her response, the stop-signal delay increases on the next stop-signal trial, making it less likely that the participant will inhibit his or her response. Conversely, if a participant fails to inhibit his or her response, the stop-signal delay decreases on the next stop-signal trial, making it more likely that the participant will inhibit his or her response on the following stop-signal trial. In this way, the probability of withholding a response in the stop-signal task should be approximately 50% across an experiment.

A common theme running throughout many stop-signal studies, however, is the problem of poor performers (e.g., Kray, Kipp, & Karbach, 2009; Morein-Zamir & Meiran, 2003; Rieger & Gauggel, 1999). In many experiments, participants have to be excluded from analysis because they are judged to have inadequately understood the task based on their performance. In the dynamic stop-signal delay task, participants who consistently fail to inhibit their responses will generate stop-signal accuracies approaching 0%. Thus, their data may be unusable because they have failed to perform the stop signal task at all. However, if they are not performing the stop-signal task, what are they doing in the experiment?

The Lexical Decision Task

One reason that individuals may perform poorly in stop-signal tasks is that the stop signal itself must be embedded in another task, which participants may perform to the exclusion of considering the stop signal. Many such tasks have been used to generate prepotent "go" responses in which the stop signal can be embedded, including a simple reaction time task (Chao, Luo, Chang, & Li, 2009) and a simple choice-reaction time task (Kray et al., 2009; Padmala & Pessoa, 2010). In a simple reaction time task, the participant responds whenever a stimulus is presented unless the stop-signal is also presented. The Go condition is relatively constant and the participant always sees the same Go stimuli. In a choice-reaction time task, however, the participant has a choice of two options to which the stimulus can belong. For example, Padmala and Pessoa (2010) required the participant to identify either a square or a circle stimulus on each trial in order to keep the participant actively engaged in the task.

One choice-reaction time task that is particularly attractive is an emotional lexical decision task. The lexical decision task is a simple, but effective task in which participants view a string of text and determine whether the text is a word or a non-word. The valence of the words within the task can also be varied to provide a covert manipulation of emotional state within the task. This valence effect is incidental to the overt task of classifying a string as a word or a non-word, and it is likely to be evident only in participants whose attention is directed substantially to the lexical decision task. Previous studies have shown that reaction times to nonwords are slower than to words (Czigler & Csibra, 1991) and that responses to the emotional words are faster and more accurate than responses to neutral words (Graves, Landis, & Goodgrass, 1981; Strauss, 1983). Nevertheless, the processing of common words is a relatively automatic process (Hasher & Zacks, 1979), so this task should not distract from performing the stop-signal task.

ERP Measures of Cognitive Processing

Behavioral differences in the stop-signal task separate poor stop-signal task performers from adequate stop-signal task performers. However, it is difficult to tease apart stimulus and response-related processes when examining only accuracy. Thus, to examine the processing of stimuli and responses, event-related brain potentials (ERP) have been indicated as an excellent measure of the information processing that occurs between the onset of the stimulus and the participant's response (van der Molen, Bashore, Halliday, & Callaway, 1991) to evaluate the differences between groups. The two ERP measures crucial to the current task are the P3 and the error-related negativity (ERN).

The P3 is a late, positive ERP component that is thought to reflect the cognitive processes allocated to perceiving a target stimulus and determining the appropriate response to be made (Kramer & Spinks, 1991; McCarthy & Donchin, 1980). More specifically, the latency of the P3 provides a measure of the processes underlying stimulus discrimination, while its amplitude reflects the amount of arousal involved

(Hansenne, 2000). Examining the P3 is useful in a number of ways in this study, including drawing conclusions about the engagement of participants in either the lexical decision task or the stop-signal task as well as gauging the difficulty of the task for participants. With the stop-signal task, the P3 has also been shown to relate to successful inhibition, as it shows enhanced amplitude for successful stop-signal trials as opposed to failed ones (De Jong, Coles, Logan, & Gratton, 1990; Dimoska, Johnstone, Barry, & Clarke, 2003).

Whereas the P3 reflects processing of stimuli, the ERN measures processes underlying a participant's response. The ERN is a negative deflection, occurring approximately 100 ms after an error is made during a task and it is maximal at frontal and central recording sites and can have an amplitude as large as 10 μV (Bernstein, Scheffers, & Coles, 1995; Carter et al., 1998; Falkenstein, Hohnsbein, Hoormann, & Blanke, 1990; Gehring, Coles, Meyer, & Donchin, 1990; Gehring, Goss, Coles, Meyer, & Donchin, 1993). As a measure of neural activity, the ERN should provide a much more direct means of assessing a participant's engagement with the task and processing of the error (Bernstein et al., 1995).

The ERN is elicited during errors in the stop-signal task (Falkenstein, Hohnsbein, & Hoormann, 1995; Kato, Endo, & Kizuka, 2009), but it is also only seen when the participant knows that an error has been committed (Carter et al., 1998). If the participant does not realize that he/she has committed an error, the amplitude of the ERN will be much smaller. In theory, the ERN could be generated by either a comparison between an anticipated and the actual stimuli, or by a comparison between the correct and the actual response (Bernstein et al., 1995).

It may also be the case that poor performers in the stop-signal task fail to process the stop signal to the same degree as those who perform adequately. The N1 ERP is associated with processing auditory information, and its amplitude is sensitive to attention (Naatanen & Picton, 1987). Thus, if poor stop-signal performers do not attend to the acoustic stop signal, N1 amplitude to the stop signal should be reduced in this group compared to those who are adequate stop-signal task performers. Alternatively, if the two groups do not differ in N1 amplitude to the stop signal, it would indicate that both groups processed the stop signal.

Current Study

In this study, we aim to examine the poor performers in a stop-signal task and elucidate the difference between poor stop-signal task performers and adequate stop-signal task performers. We embedded the stop-signal task in a lexical decision task with emotional words. We defined participants who performed poorly on the stop-signal task as those who failed to inhibit at a conservative α level of .005 on the task (that is, people who inhibited their response on less than 38.3% of the stop-signal trials) and compared the behavioral and personality characteristics of the poor and adequate performers to examine whether differences in motivation or lexical decision task performance existed between the groups.

With ERP measures, we delved further into the differences between the adequate and poor stop-signal task performers on a stop-signal task by looking directly at neural mechanisms rather than solely behavioral performance. We hypothesized that the poor stop-signal task performers will be less engaged in the stop-signal task than their adequately performing peers, as reflected by a larger P3 in response to the lexical decision stimuli, as well as a reduced ERN in response to errors made in the stop-signal task.

Method

Participants

Participants were recruited from a screening process in the Vanderbilt University Hospital Emergency Room waiting area. Twenty-five people were contacted and offered monetary reward for participating in a multi-part study, which included the current lexical decision and stop signal task. Of these, six fell into the poor stop-signal performers group by successfully inhibiting on less than 38.3% of the stop-signal trials, a level of response inhibition failure that would be found less than 0.5% of the time by chance alone in this task. The mean age of the poor stop-signal performers was 37.7 years (3 women), while the mean age of the sixteen adequate stop-signal performers was 38.1 years (8 women).

Experimental Stimuli and Design

Participants were shown word stimuli taken from the Affective Norms for English Words (ANEW; Bradley & Lang, 1999). The words were separated by valence into lists of pleasant, neutral, and aversive stimuli by normed valence ratings taken from ANEW. On the 9-point scale of ANEW, we defined pleasant words as being above a rating of 7, neutral words as being between the ratings of 4 and 6, and aversive words as being below the rating of 3. Words were also only selected if they had a frequency between 5 and 50 in order to ensure that the words were reasonably common but not overly familiar. Thirty words were chosen from each of these valences.

The pleasant and aversive words were equidistant from the midpoint of the valence scale, *M*s (*SD*s) = 7.78 (0.45) and 2.29 (0.43), respectively, and were also balanced on their arousal ratings, *M*s (*SD*s) = 5.88 (0.92) and 5.83 (1.47), and frequency *M*s (*SD*s) = 22.93 (12.14) and 23 (13.48). Pleasant and aversive words were also balanced for word length, *M*s (*SD*s) = 5.60 (1.30) and 5.67 (1.18), respectively. The neutral words were selected to be at the midpoint of the valence scale (*M* = 5.05, *SD* = 0.48) and were also balanced to match the pleasant and aversive words for frequency (*M* = 23, *SD* = 10.45) and word length (*M* = 5.60, *SD* = 0.86). The arousal ratings for the neutral words were also lower than those for pleasant and aversive words (*M* = 3.90, *SD* = 0.54). Lists of nonwords were also created from the list of words by changing one vowel.

The 90 words that comprise the three affective groups were shown to the participants in a series of five blocks that select words at random, using a program developed in E-Studio. Each block has a different list of 30 non-words, also selected at random, making a total of 120 stimuli per block, and 600 stimuli in the entire experiment. Each stimulus was displayed for 1500 ms, in which time the participant was asked to identify the stimulus as a word or a non-word and reaction times were recorded in milliseconds by the computer presenting the stimuli. Between each stimulus, a fixation cross was displayed for 500 ms in order to keep the participant's attention on the center of the screen.

A tone (stop signal) sounded after 20% of the stimuli indicating the participant to inhibit his or her response. The onset of the tone varied between 0 ms and 1000 ms after word onset depending on the success of the participant to inhibit a response. The first tone was presented at 500 ms and if the participant was successful at inhibiting, the next tone would be presented 50 ms later. If the participant was unsuccessful at inhibiting, the next tone would be presented 50 ms earlier, making it easier for the participant to inhibit. The stop-signal consistently changed according to this pattern throughout the experiment, thus creating a response-dependent dynamic design. Each of the words was followed by a stop signal at least once during the experiment, and the selection was randomized.

The participants were seated in a padded recliner at a distance of 100 cm from a 20-inch computer screen positioned directly in front of them. A computer running Neuroscan software (version 4.4) collected physiological data. The sensors were applied at the standard international 10-20 EEG sites. The information was recorded on a SynAmps2 system with an online high-pass filter of .05 Hz and a low-pass filter of 500 Hz at a 2000 Hz sampling rate. Offline, data were rereferenced to linked mastoids, epoched within a window 250 ms before stimulus or response onset to 1500 ms after stimulus or response onset, and filtered with a low-pass filter of 30 Hz. A correction was applied to reduce artifact from blinks (Semlitsch, Anderer, Schuster, & Presslich, 1986), and trials exhibiting activity greater than 100 μV during the baseline or 200 μV during the epoch of interest were excluded from signal averaging.

Procedure

Participants entered the lab and were given a consent form. Once consent was obtained, the participant was led into the interpersonal testing room of the laboratory and asked to begin filling out a series of personality questionnaires while experimenters prepared the participant's face for sensor attachment. Preparation was done using gauze pads and conductive gel in order to reduce impedances. After the sensors on the face were placed, the experimenters measured the participant's head and fit him/her with an EEG cap. After grounding and referencing, the participant took part in an interpersonal study in which he/she delivered a series of talks to two undergraduate participants, the data for which are not reported here.

After the undergraduates were dismissed, the experimenters began reducing impedances on the rest of the scalp. After all impedances were brought below 5 kilo-ohms, the experimenters waited for the participant to finish another series of questionnaires. As soon as the questionnaires were completed, the experiment began.

The participant read a set of instructions describing the experiment and then completed practice trials to make sure that he/she understood the task. The experimenter then asked if the participant had any questions, answered those questions, and left the room. As soon as the participant finished the first block of 120 trials, there was a short break to allow for preparation for the next block. The participant completed five blocks, each with a short break in between. Having completed the five blocks, the participant was debriefed and sent to the next experiment. Participants rated on a 9-point scale how hard they tried to perform the lexical decision task (1 = *not at all*, 5 = *about half my possible effort*, 9 = *most effort possible*) and how much they tried to avoid responding to the stop signals (1 = *not at all*, 5 = *reasonably*, 9 = *the most possible*).

Data Analysis

P3 amplitude to the words and nonwords was assessed as the peak within the window 450-700 ms after stimulus onset relative to the 200 ms prestimulus baseline. ERN amplitude to the responses was assessed as the negative peak within the window 0-150 ms after the response onset relative to the 200 ms pre-response baseline. N1 amplitude to the stop signal was assessed as the negative peak within the window 75-125 ms after stop signal onset relative to the 200 ms pre-stop signal baseline.

After the participants had been separated into groups based on their stop-signal task performance, we used independent sample *t* tests to compare the groups' personality characteristics based on their responses on the brief form of the Multidimensional Personality Questionnaire (MPQ-BF; Patrick, Curtin, & Tellegen, 2002) as well as their behavioral performance on the lexical decision task. To analyze the P3 for words and nonwords in the experiment, we used a mixed 3 (front/middle/back Anterior/Posterior) x 3 (left/middle/right Laterality) x 2 (word/nonword Condition) x 2 (adequate/poor stop-signal Performance) ANOVA. To analyze the P3 valence effects for words in the experiment, we used a mixed 3 (front/middle/back Anterior/Posterior) x 3 (left/middle/right Laterality) x 3 (pleasant/neutral/aversive Valence) x 2 (adequate/poor stop-signal Performance) ANOVA.

For the response-locked ERN, we used a mixed 3 (front/middle/back Anterior/Posterior) x 3 (left/middle/right Laterality) x 3 (correct/incorrect lexical decision/incorrect press to stop-signal Condition) x 2 (adequate/poor stop-signal Performance) ANOVA. In all ANOVAs, Anterior/Posterior, Laterality, and Valence or Condition were the within-subjects factors, and Performance group was the between-subjects factor. The Huynh-Feldt correct for nonsphericity was applied in all ANOVAs. For all statistical tests, an alpha level of .05 was used.

Results

Personality and Behavior

As displayed in Table 1, the groups did not differ significantly on any of the scales of the MPQ; poor performers tended to be higher on Aggression than adequate performers, $t(23) = -1.81$, $p = .08$. The groups also did not differ in their reaction times or accuracy, as shown in Table 2, *t*s < 1.76, *p*s > .09. Likewise, there were no differences between the groups in their ratings of how important it was to perform well on the lexical decision task (poor performer $M = 8.00$, $SD = 2.00$; adequate performer $M = 8.05$, $SD = 1.51$) or of how important it was to avoid committing an error when the stop signal was presented (poor performer $M = 7.75$, $SD = 1.89$; adequate performer $M = 7.89$, $SD = 1.70$), *t*s < 0.2, *p*s > .85.

ERPs

Figure 1 presents the average P3 amplitude to words, nonwords, and stop-signals. There was no significant difference in P3 amplitude between the two groups in responding to words or nonwords, Condition x Performance $F(1, 23) = 0.01$, $p = .939$. However, there was a significant Valence x Performance interaction in the word stimuli, $F(1.76, 40.5) = 4.40$, $p = .022$. As depicted in Figure 2, there was no effect of word Valence on P3 amplitude for the adequate performers, but there was for the poor performers. However, the groups did not differ in mean P3 amplitude during words, $F(1, 21) = 0.43$, $p = .518$. Thus, the poor stop-signal performers were making relatively nuanced discriminations among words in the lexical decision that the adequate performers were not, even though both groups showed significant discriminations between words and nonwords.

Figure 3 depicts the ERN amplitude for correct responses, incorrect lexical decision responses, and inhibition failures to the stop signal. There was a significant effect of Condition on ERN amplitude, $F(2.00, 46.0) = 7.15$, $p = .002$, in which incorrect responses generated larger, more negative ERNs than correct responses. There was also a significant Condition x Performance interaction, $F(2.00, 46.0) = 6.13$, $p = .005$. The poor stop-signal performers had a more negative peak than correct responses only in the incorrect lexical decision condition whereas the adequate stop-signal performers peaked in the incorrect press to stop-signal condition (see Figure 4). The groups did not differ in their overall ERN amplitudes, $F(1, 21) = 0.50$, $p = .490$.

These differences raise the question of whether the poor stop-signal performers processed the stop signal because of their focus on the lexical decision task. The N1 ERP to the stop signal, however, was not significantly different between subjects (*M* poor performers = -7.06, *SE* = 2.32; *M* good performers = -9.13, *SE* = 1.30), $F(1, 23) = 0.61$, $p = .44$, suggesting that both groups heard it, but the poor stop-signal task performers focused on the lexical decision task.

Discussion

As we hypothesized, the ERP data showed a fundamental difference between the adequate and poor stop-signal performers. While the adequate stop-signal performers were very clearly focused on the stop-signal task, the poor stop-signal performers seemed to ignore the stop-signal task completely, and instead focus their energy on the lexical decision task. The behavioral data, however, suggests that both groups performed equally well on the lexical decision task. In order to determine the differences between the two groups, the ERP data proves to be an invaluable measure of task attention and importance (Bernstein et al., 1995; Hansenne, 2000; van der Molen et al., 1991).

As discussed in the Introduction, the P3 measure has been hypothesized to reflect a measure of cognitive processing and attention (Kramer & Spinks, 1991). The interaction between valence and performance group suggests that the poor stop-signal task performers may have made subtle discriminations among word stimuli better than the adequate stop-signal task performers. As Figure 2 shows, the poor stop-signal task performers showed the expected amplified P3s to emotional words over neutral words, while the adequate stop-signal task performers did not show this pattern. This result suggests that the poor stop-signal performers allotted more cognitive resources to the lexical decision task, resulting in more extensive processing of the emotional words, while the adequate stop-signal performers only processed the superficial word-nonword distinction.

The ERN results further this interpretation. The ERN in this study is maximal at the frontal central recording sites, consistent with previous findings in the literature (Bernstein et al., 1995; Carter et al., 1998, Gehring et al., 1993). One of the most telling results however is the significant interaction of condition by performance group. As Figure 4 clearly shows, the poor stop-signal performance group has amplified ERNs to making an error on the lexical decision task, whereas their ERNs to making an error on the stop-signal task is almost equal to that of their correct identifications in the lexical decision task. The adequate performers on the stop-signal task show the activation pattern hypothesized, with ERNs maximal on incorrect responses to the stop-signal and smallest to correct responses. This is one of the most striking pieces of evidence that the poor stop-signal performers did not pay attention to the stop-signal at all and only attended to the lexical decision task. In addition, the lack of a significant difference between groups on the stop signal-locked N1 ERP suggests that while the poor stop-signal performers performed poorly on the stop-signal task, they still processed the stop signal in a similar way. This suggests that the poor stop-signal performers made a choice to attend to the lexical decision task and ignore the stop-signal task.

Limitations and Future Directions

Although the results seem to provide a relatively clear picture of the performance differences between the groups, there were a number of limitations to the current study. Power to detect significant effects in each group separately was limited due to the small sample size, particularly in the poor stop-signal performer group, even though we found significant interactions involving stop-signal task performance group. Future studies should attempt to include more participants in their analysis to conduct simple effects decompositions of the interactions to better understand these results. Adding more participants to each group would also confirm that the null findings for group differences in overall ERP amplitudes were not due to a lack of power to detect those differences.

More research also needs to be done using alternative tasks in which to embed the stop signal. While other studies have used alternative tasks, the poor stop-signal task performers in those tasks were excluded from analysis altogether. Future studies should use an alternative task and include ERP recording in order to determine if poor stop-signal performers have similar patterns of activation to other tasks as they did in the emotional lexical decision task.

The results of this experiment have significant ramifications for the field of stop-signal experimentation. The task in which the stop-signal is embedded clearly has a strong effect on the performance of participants on the stop-signal task. If a task such as the emotional lexical decision can affect participants' performance so drastically, it will be crucial for stop-signal experimentation in the future to use a task to embed the stop-signal that will not have the same distraction effect.

The current study also provides support for removing poor stop-signal performers from data analysis in future stop-signal studies. The results of the ERP measures show that the poor stop-signal performers did not attend to the stop-signal task and therefore cannot be considered valid datasets for analysis of inhibitory processes. Future studies should exclude poor stop-signal performers because they are not performing the task as it is designed.

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Table 1

Means and Standard Deviations of Subscales of the Multidimensional Personality Questionnaire

	Performance Group			
	Poor		Adequate	
MPQ Subscale	Mean	Standard Deviation	Mean	Standard Deviation
Well-Being	46.00	15.58	49.00	12.59
Social Potency	55.17	7.78	53.37	10.08
Achievement	58.67	10.29	52.84	7.13
Social Closeness	43.67	13.34	49.16	10.94
Stress Reaction	51.83	10.55	51.95	13.69
Alienation	62.83	11.97	60.89	10.39
Aggression	61.83	12.61	52.74	10.14
Planful Control	45.33	11.08	48.00	9.06
Harmful Avoidance	48.33	11.62	45.05	10.99
Traditionalism	51.00	8.48	47.16	5.55
Absorption	52.50	8.92	55.16	6.62

Table 2

Behavioral Performance Data on the Emotional Lexical Decision Task

	Performance Group			
	Poor		Adequate	
Measure	Mean	Standard Deviation	Mean	Standard Deviation
Accuracy (%)				
All Trials	64.8	25.4	75.5	17.2
Nonwords	60.0	27.6	71.6	25.9
All Words	66.4	25.7	76.8	17.7
Pleasant	68.3	29.3	81.6	21.9
Neutral	64.3	31.0	73.2	20.3
Aversive	66.7	22.5	75.8	18.3
Reaction Time (ms)				
All Trials	903.01	82.11	886.21	114.84
Nonwords	942.65	111.47	984.58	119.62
All Words	889.79	79.54	853.41	123.71
Pleasant	865.60	60.32	853.88	160.56
Neutral	934.24	110.00	848.22	129.05
Aversive	869.54	134.60	858.14	126.10

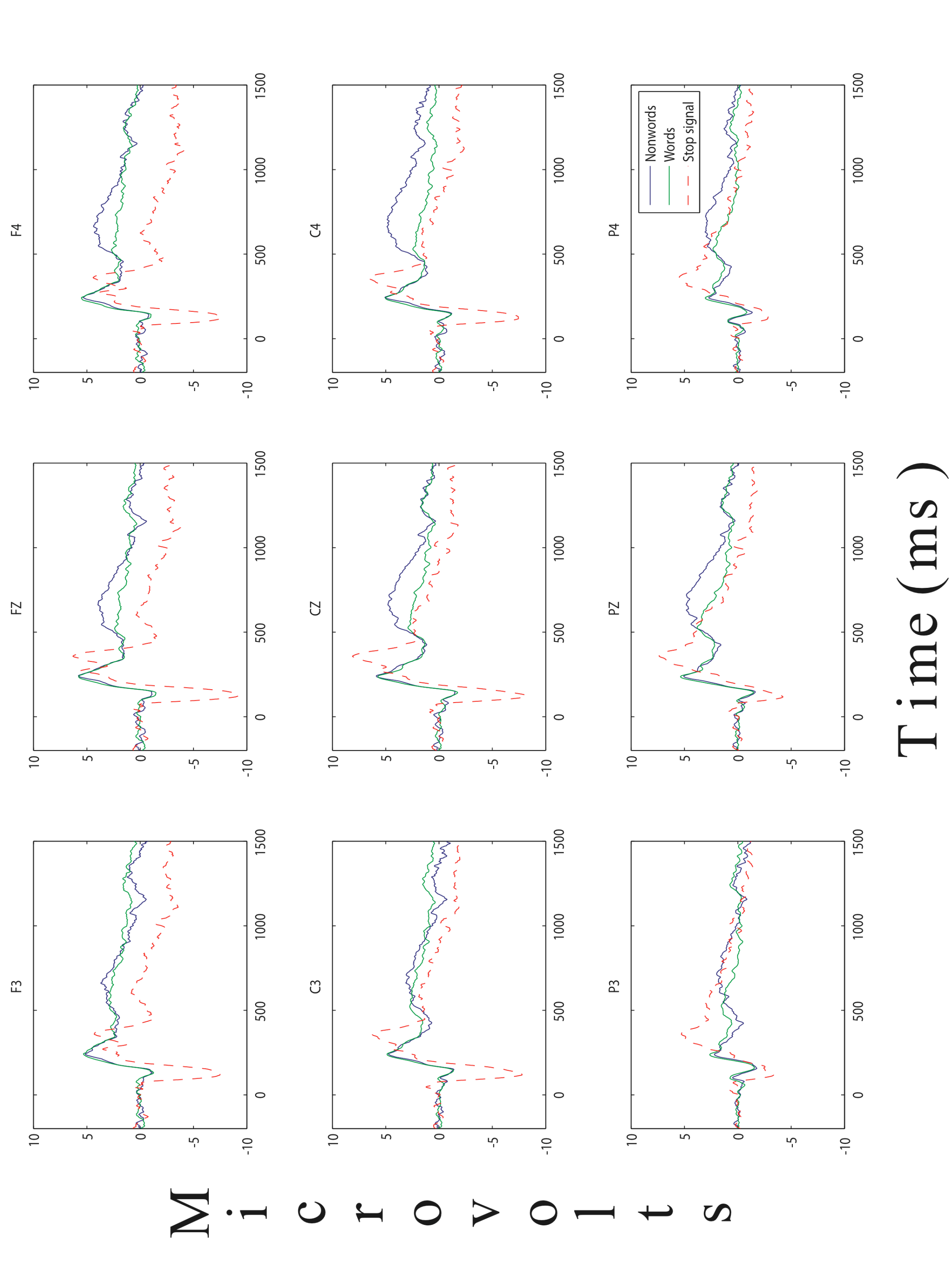

Figure 1. Grand average stimulus-locked ERPs to words, nonwords, and stop signals.

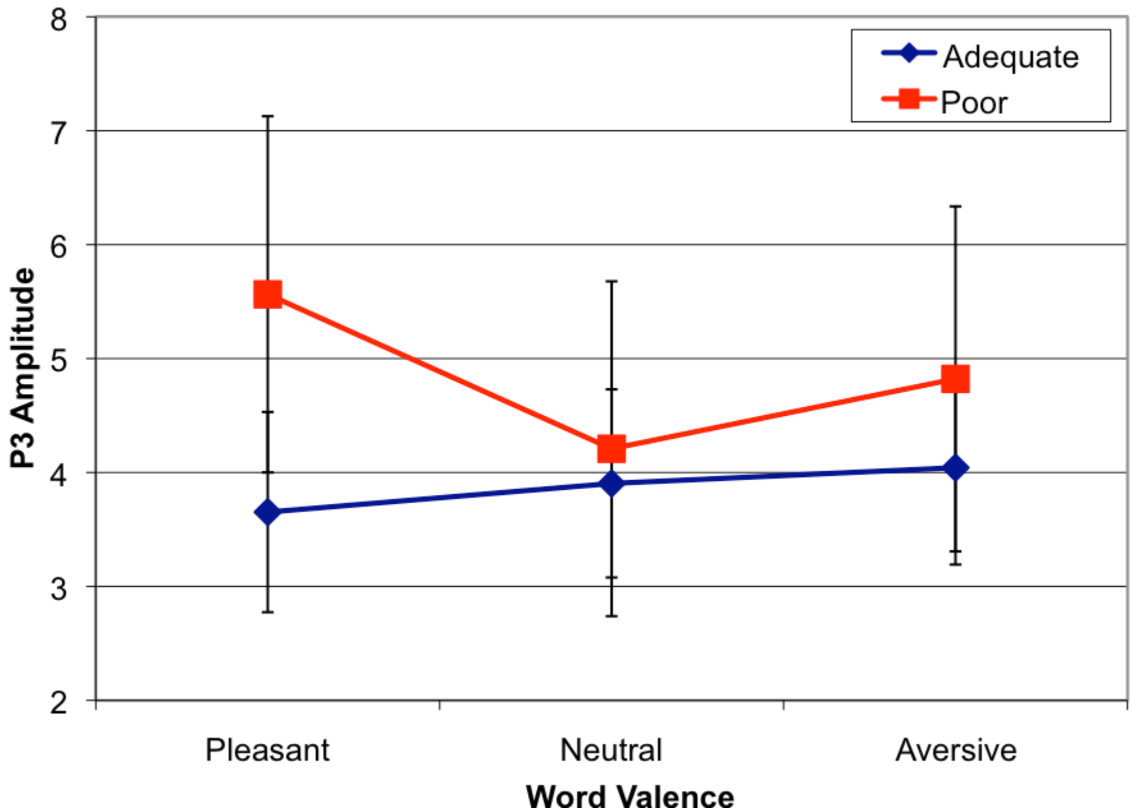

Figure 2. P3 amplitude for each word valence by stop-signal task performance group. Error bars represent standard error of the mean.

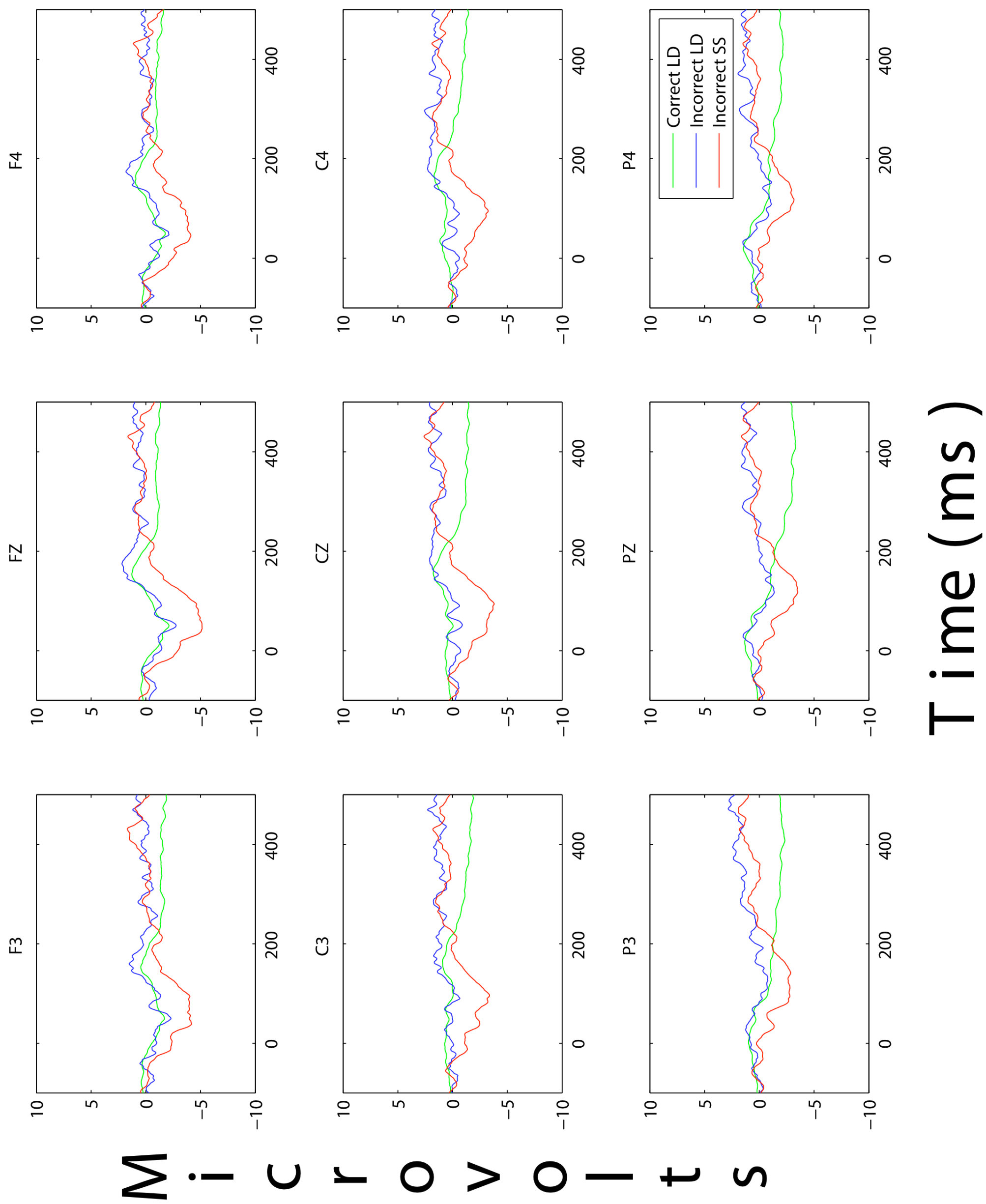

Figure 3. Grand average ERN amplitude for correct responses, incorrect lexical decision responses, and inhibition failures to the stop signal.

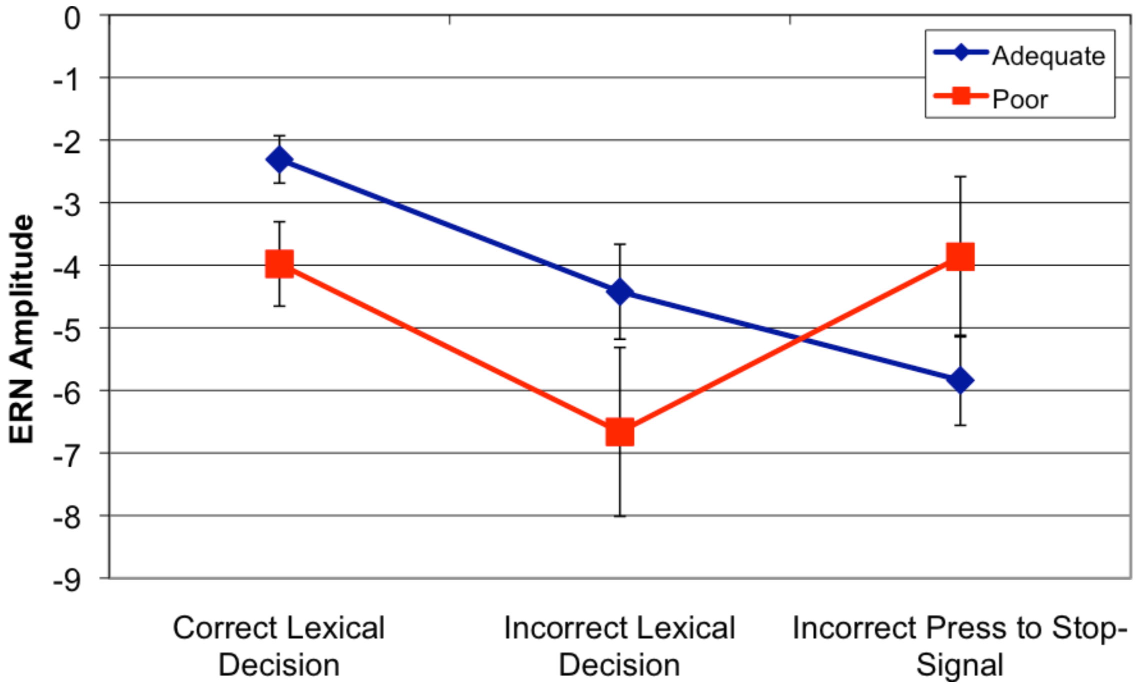

Figure 4. ERN amplitude for each type of response by stop-signal task performance group. Error bars represent standard error of the mean.