The short-term effect of video editing pace on children's inhibition and N2 and P3 ERP components during visual go/no-go task

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Abstract

We investigated the immediate consequences of differently paced videos on behaviour and neural activity during response inhibition. Forty 7-year-olds watched a fast- or slow-paced video and completed a go/no-go task. Compared to the slow-paced-video group, children in the fast-paced-video group made more no-go errors. There was also an interaction between pace and no-go response type (correct, wrong) for the N2 and P3 peak latencies. In the slow-paced group, both components peaked earlier for correct response withholds. This usual pattern of activation was absent in the fast-paced group. Video pace appears to affect behaviour and the neural responses involved in inhibition.

Television viewing remains the most popular screen-based activity in early childhood (Kostyrka-Allchorne, Cooper, & Simpson, 2017; Lauricella, Wartella, & Rideout, 2015). Much of children's television is rapidly paced (i.e., contains a large number of cuts and scene changes; McCollum & Bryant, 2003) and it has been proposed that frequent onscreen changes engage children's attention in a bottom-up perceptual fashion by eliciting orienting responses (Singer, 1980). Moreover, keeping up with the rapid changes on the screen is cognitively challenging. To understand the content, a viewer needs to have a grasp of the symbolic meaning of editing. This may be particularly difficult for young children, whose cognitive skills are not yet fully developed (Singer & Singer, 1983). To reduce the cognitive burden, children may switch to bottom-up control by 'allowing' their focus to be exogenously maintained by visually salient changes on the screen. A question of whether such bottom-up processing extends to activities that immediately follow exposure to a fast-paced programme has been tested in several studies with mixed results.

Research (i.e., Anderson, Levin, & Lorch, 1977; Geist & Gibson, 2000; Kostyrka-Allchorne, Cooper, Gossmann, Barber, & Simpson, 2017) investigating the effects of editing pace on children's ability to focus attention and resist distractors during unstructured play, have utilised both commercial television programmes (which varied in content as well as pace) and experimental videos (which controlled content and manipulated pace). Although Anderson et al. (1977) did not provide the support for the hypothesis that fast editing pace is detrimental to children's attention, two more recent studies suggested that children who watched a fast-paced programme subsequently struggled to engage in one activity for a longer period (Geist & Gibson, 2000; Kostyrka-Allchorne, Cooper, Gossmann, et al., 2017), perhaps due to a reduced ability to focus attention.

In contrast, the findings of Cooper, Uller, Pettifer, and Stolc (2009) showed some limited, positive effects of watching a fast-paced programme. These authors investigated whether exposure to a brief experimental video affected children's performance on the Attention Networks Test (ANT; Fan, McCandliss, Sommer, Raz, & Posner, 2002). ANT is a flanker-type continuous performance task, which uses cues to test the efficiency of three attention networks: alerting, orienting and executive attention (Petersen & Posner, 2012; Posner & Petersen, 1990). In Cooper et al. (2009), irrespective of trial type, the responses of the children who watched a fast-paced video were *more* accurate than the responses of the children who watched the slow-paced version.

In addition to these studies of attention, the related constructs of executive function and response inhibition (Hrabok, Kerns, & Müller, 2007; Johansson, Marciszko, Gredebäck, Nyström, & Bohlin, 2015; Reck & Hund, 2011) have been investigated, although the findings have again been inconclusive. Lillard and Peterson (2011) demonstrated that, compared to a control group of children who were drawing, a group who watched a fast-paced cartoon performed significantly worse in a post-viewing assessment of executive function, which included a measure of response inhibition. However, a recent study, which focused on measuring children's inhibition, rather than broad executive function, failed to provide evidence that pace had consequences for children's inhibitory behaviour (Kostyrka-Allchorne, Cooper, & Simpson, 2019) .

A substantial limitation to this literature, and perhaps an explanation for the conflicting findings, is a potential confound between pace and other unmeasured features present in the commercially available cartoons. Very few studies, which examined the effects of television or video watching, used stimuli that allowed one to isolate the effects of pacing (i.e., Cooper et al., 2009; Kostyrka-Allchorne et al., 2019; Kostyrka-Allchorne, Cooper, Gossmann, et al., 2017). The paucity of research limits our current understanding of how pace *in isolation* affects children's post-viewing behaviour. Considering the concern that exposure to fast-paced material might have negative short-term effects (Geist & Gibson, 2000; Kostyrka-Allchorne, Cooper, Gossmann, et al., 2017; Lillard & Peterson, 2011), further data are necessary to clarify the inconsistencies in the previous findings and to allow more robust inferences to be made about the effects of editing pace on children's behaviour.

The current study investigated the effect of editing pace on response inhibition using the Sustained Attention to Response Task (SART; Robertson, Manly, Andrade, Baddeley, & Yiend, 1997). In this well-established go/no-go task, children need to remain vigilant to *avoid* responding to rare no-go stimuli (11% of trials; Smilek, Carriere, & Cheyne, 2010). In the task, pressing a 'go' key becomes a habitual response associated with stimulus presentation, making it *prepotent* (i.e., automatically activated by stimulus onset irrespective of the participant's intentions - Simpson & Riggs, 2007). The high frequency of go trials in the SART creates strong inhibitory demands, so that successful no-go performance requires inhibition to suppress the prepotent go response (Carter, Russell, & Helton, 2013).

Singer (1980) proposed that frequent on-screen changes, which characterise fast-paced video, might strengthen stimulus-driven processing. Shifting the balance to stimulus-driven processes would necessarily reduce the relative effect of goal-driven executive processes including response inhibition. Thus, we hypothesised that watching the slow- and the fast-paced videos would differentially affect go and no-go performance on the SART. Specifically, compared with the slow-paced group, the performance of the fast-paced group would be characterised by shorter response times on the stimulus-driven go trials and a greater number of errors on goal-driven no-go trials. Moreover, as the duration of the potential effects of video pace is unclear, consistent with the previous literature (Marchetti, Koster, & De Raedt, 2012; Seli, Cheyne, & Smilek, 2012), the SART data were analysed in two blocks.

The second aim of this study was to investigate whether editing pace would modulate the neural activity involved in inhibition on the no-go trials. Bearing in mind the longevity of research into the effects of visual media on children's cognition, it is surprising that, to our knowledge, no research has previously investigated the underlying neural mechanisms. Event-related potentials (ERPs) allow examination of changes in electrical activity in the brain that underpin cognition and behaviour with exquisite timing (Luck & Kappenman, 2011). In the present context, the ERPs are time-locked to the stimulus onset (Hoyniak, 2017) and thanks to their excellent temporal resolution, they allow the detailed examination of the processes involved in inhibition (Chevalier, Kelsey, Wiebe, & Espy, 2014). The N2 and the P3 are the two ERP components proposed to chiefly reflect processes involved in inhibition in adults (e.g., O'Connell et al., 2009; Sehlmeyer et al., 2010; Zordan, Sarlo, & Stablum, 2008) and in children (e.g., Cragg, Fox, Nation, Reid, & Anderson, 2009; Johnstone et al., 2007).

In previous studies, which utilised go/no-go tasks, the N2 peak in no-go trials is usually recorded in frontal locations in children (Abdul Rahman, Carroll, Espy, & Wiebe, 2017; Johnstone et al., 2007) and central brain locations in adults (Dockree, Kelly, Robertson, Reilly, & Foxe, 2005; Falkenstein, Hoormann, & Hohnsbein, 1999; Zordan et al., 2008) occurring at a latency of 200-450 ms after stimulus onset. The P3 in no-go trials is typically found in frontal (Zordan et al., 2008) or fronto-central locations in adults and children (Falkenstein et al., 1999; Jonkman, 2006). The exact time window of this peak varies; it is typically 300-500 ms in adults (Zordan et al., 2008) and 300-600 ms in children (Jonkman, Lansbergen, & Stauder, 2003; Jonkman, 2006; Piispala, Kallio, Bloigu, & Jansson-Verkasalo, 2016).

Moreover, the latency of the N2 and P3 appears crucial for inhibition. First, evidence that successful inhibition requires an *earlier* N2 component activation was provided by Falkenstein et al. (1999), who demonstrated that no-go N2 began 30 ms earlier for adult participants who made fewer errors on no-go trials compared with those whose performance was characterized by a high no-go error rate. Furthermore, Garavan, Ross, Murphy, Roche, and Stein (2002) observed that, relative to no-go errors, correct no-go responses were characterised by *shorter* P3 latencies. This finding led the authors to develop a hypothesis proposing that *successful* inhibition was characterized by a specific timing of these ERP components' activation.

Further support for this proposal was provided by Roche, Garavan, Foxe, and O'Mara (2005), who showed that the N2 and P3 occurred earlier on correct versus erroneous no-go trials. Thus, withholding a response requires N2 and P3 to occur during a limited time window; the lack of a timely component activation results in an error (Zordan et al., 2008). Although this hypothesis was developed in relation to studies with adult participants, the results of a recent meta-analysis of childhood N2 component are consistent with this proposal: after controlling for age, shorter no-go N2 latencies were associated with significantly higher accuracy on no-go trials (Hoyniak, 2017).

Considering this literature, the present study aimed to examine whether cortical responses that underpin inhibition would be affected by video pace. That is, whether children in the fast-paced group would differ from the slow-paced group regarding the strength and the timing of the N2 and P3 component activation on no-go trials. Given a lack of the previous research in this area, no specific predictions were made regarding the direction of the effects; however, we expected to see significant differences in the electrophysiological responses between the two experimental groups.

Method

Participants

Forty (girls: n = 25) 7-year-old children (M = 84.6 months, SD = 4.7) recruited via opportunity sampling at two primary schools located in a semi-rural county of England, UK, took part in the study. Four further participants had completed the study but were later excluded due to technical problems. The University of Essex Ethics Committee approved the experiment. Before the study began, the children's parents received a letter explaining the experimental procedure and signed individual consent. Children were quasi-randomly assigned to one of the two experimental conditions.

Apparatus and Materials

The experimental videos were presented on a 13-inch Apple laptop computer running QuickTime video player. Audio playback was delivered via Sony speakers. A Dell Optiplex 745 personal computer with a 17" ACER AC713 monitor was used to present the SART.

Experimental videos

A popular children's story called 'Winnie at the Seaside' (Paul & Thomas, 2005) was used to produce the experimental videos. A female narrator reading a storybook was filmed from three different cameras: front view, side view and hand-held. This footage was edited together with the still images from the book to produce a slow- and a fast-paced video; the material recorded with the hand-held camera was used only in the fast-paced version of the video. An edit was defined as a change from the narrator view to a still book image or change between the two different narrator views (e.g., from a front view to a side view). Each video lasted 3 minutes 51 seconds and was produced from identical raw recordings. The slow-paced video included five still images and had on average 3.7 edits per minute. The fast-paced video contained 14 still images and had on average 12.3 edits per minute.

SART data collection and data analysis

Stimuli and procedure

The stimuli were 225 single digits from 1 to 9 presented in 25 blocks of nine in a random sequence. The digits were white and appeared in the centre of the black background. Each digit was displayed for 300 ms and the length of the inter-trial interval was 1440 ms. These timings were determined based on the previous studies, which used the SART in research with children (e.g., Bellgrove, Hawi, Kirley, Gill, & Robertson, 2005; Johnson et al., 2007). Participants were required to press a left button on a computer mouse each time a digit appeared on the screen (go trials), except for the target “3”, which required withholding the response (no-go trials). To ensure that children understood instructions and to confirm their ability to discriminate between the target non-target digits, each child completed 27 practice trials.

SART data analysis

The dependent variables included: 1) go trial response time (RT); 2) RT variability, computed for each participant using standard deviation of go response time; 3) proportion of go trial errors (i.e., omission errors: failures to respond on go trials); 4) proportion of no-go trial errors (i.e., commission errors: failures to withhold a response on no-go trials). Go trials RTs were scrutinised for responses with latencies of less than 100 ms (as these are either random or anticipatory; Conners & Staff, 2000). There were zero go trials with latencies of responses < 100 ms. However, one child in the slow-paced group completed 211 (including 24 no-go trials) rather than 225 trials.

The data were analysed in a mixed analysis of variance (ANOVA) with pace (fast, slow) as the between-participant variable and time (SART 1st half: 113 trials, SART 2nd half: 112 trials) as the within-participant variable. The assumption of homogeneity of variance was tested with Levene's test. Partial eta-squared (η_p^2) was used as a measure of effect size. Significant interactions were further investigated with bootstrapped t-tests, based on 5000 iterations.

ERP data acquisition, pre-processing and analyses

Acquisition and pre-processing

Children were fitted with an electrode cap and the electroencephalogram (EEG) data were recorded from six electrodes (FPz, Fz, Cz, Pz, FCz and CPz) arranged according to the International 10-20-system (Jasper, 1958). The recording was acquired with a NeuroScanSynapse2 headbox, a NeuroScan STIM Audio System P/N 105 amplifier, and a Dell Optiplex 755 personal computer running NeuroScan 4.5 software. Data were recorded at a sampling rate of 500 Hz, a band-pass filter at 0.15-100 Hz and a notch filter at 50 Hz. Impedances were set below 10 kΩ prior to recording.

Data pre-processing was conducted using NeuroScan 4.5 software. For ERP analysis, data were average referenced and filtered with a bandpass zero-shift, 12 dB filter between 2 Hz and 30 Hz and segmented into epochs from 100 ms before to 650 ms after stimulus onset. After initial visual inspection for large movement artefacts and bad electrodes, a further, automated artefact rejection transformation was carried out excluding epochs containing data above or below +/- 75 mV respectively.

Data were then averaged across epochs to separately calculate ERPs for correct and wrong responses on no-go trials. Mean amplitude and peak latency were calculated for two EPR components: N2 and P3. For each component, mean amplitude was the average amplitude within the pre-specified time window (see below); peak latency was measured as the time from the stimulus onset to the maximum component peak within the pre-specified time window.

The individual components' time windows were selected based on the analyses of Zordan et al. (2008), who were the first researchers to investigate ERPs recorded in adults using a random version of the SART. For the N2 component, mean amplitude was measured in the 220-350 ms time window post stimulus onset and automatic peak detection was carried out to find the most negative score at Fz electrode. For the P3 component, mean amplitude was measured in the 300-500 ms time window post stimulus onset and automatic peak detection was carried out to find the most positive score at Cz electrode. Further manual adjustment of peaks was not carried out.

ERP data analyses

The mean number of no-go trials after artefact rejection for the slow- and the fast-paced group was 24.4 and 23.9, respectively (an average proportion of 2.4% and 4.4% rejected trials, respectively). Mean latencies and amplitudes of N2 and P3 components for no-go trials were analysed in a mixed ANOVA with trial type (correct, wrong) as the within-participant variable and pace (fast, slow) as the between-participant factor. The assumption of homogeneity of variance was tested with Levene's test. Partial eta-squared (η_p^2) was used as a measure of effect size. Significant interactions were further investigated with bootstrapped t-tests, based on 5000 iterations.

Procedure

Children were tested individually in a quiet room that was separate from the main classroom area. Children were fitted with an electrode cap and prepared for EEG data acquisition. They were also encouraged to remain still and relaxed. Following this set-up, children watched either a slow- or a fast-paced experimental video. Immediately after they finished watching the video, the experimenter explained the rules of the SART, and following a short practice, which comprised 27 trials (three of which were the target “3”), children completed the SART. The children completed the whole SART in about 4.5 min, with each half taking over 2 min to complete. Upon finishing the test session, each child received a small reward and a certificate for taking part.

Results

SART data

Descriptive statistics for response times, response times variability and go and no-go error data in each experimental condition in the 1st and 2nd half of the SART are presented in Table 1.

Table 1. Mean (SD) for proportion of no-go trial errors, go trial errors, RT and RT variability in the 1st and 2nd SART half in the fast- and slow-paced video conditions.

Dependent variable	**FAST pace**		**SLOW pace**	
	1st SART half	*2nd SART half*	*1st SART half*	*2nd SART half*
No-go trial errors (%)	70 (16)	58 (24)	55 (19)	58 (31)
Go trial errors (%)	9 (13)	16 (16)	7 (14)	14 (19)
Go trial RT (ms)	440 (97)	487 (96)	444 (85)	454 (94)
Go trial RT variability (ms)	160 (46)	208 (75)	142 (46)	185 (67)

No-go errors, go errors, RTs and RT variability data were analysed in a mixed 2 (condition: fast vs. slow) x 2 (time: 1st SART half vs. 2nd SART half) ANOVA. For the no-go errors, there were no significant main effects of Time (p = .275) or Pace (p = .212). However, the analysis showed a significant Pace x Time interaction, F(1,38) = 4.37, p = .043, η_p^2 = .103 (Figure 1). A follow-up bootstrapped independent-samples t-test showed that in the first half of the SART, the children who watched a fast-paced video made more commission errors than the children who watched a slow-paced video, t(38) = 2.88, p = .008, 95% CI: 4.97 to 26.48. Thus, watching a fast-paced video resulted in poorer inhibition but only in the first half of the task.

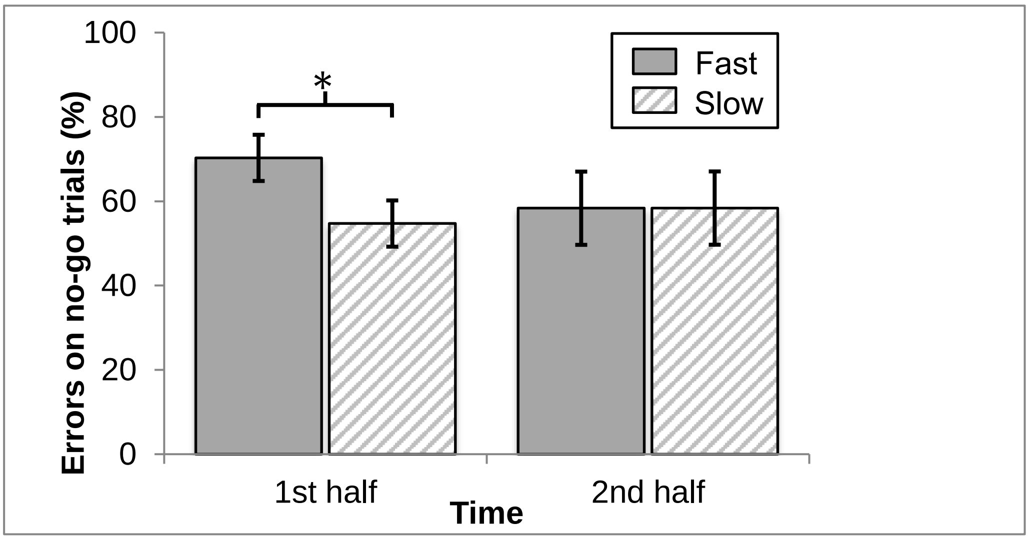

Figure 1. Mean proportion of errors on no-go trials in the first and the second half of the SART. Error bars represent 95% confidence intervals (*denotes a significant difference; p < .05).

Analysis of go trial errors showed a main effect of Time, F(1,38) = 39.39, p < .001, η_p^2 = .516. In both fast- and slow-paced groups, children made fewer omission errors in the first than in the second half of the SART (M = 8, SD = 13 vs. M = 15, SD = 17, respectively). However, there was no significant main effect of Pace (p = .788), nor a significant Pace x Time interaction (p =.983). Similarly, for RT data, there was a main effect of Time, F(1,38) = 4.89, p = .033, η_p^2 = .114. In both experimental groups, children responded faster in the first than in the second half of the SART (M = 442, SD = 91 vs. M = 473, SD = 96, respectively). There were no main (p = .572) or interactive effects of Pace (p = .161).

Finally, analysis of RT variability data also showed a main effect of Time, F(1,38) = 30.06, p < .001, η_p^2 = .442. Irrespective of experimental condition, children's responding on go trials was less variable in the first than in the second half of the task (M = 152, SD = 46 vs. M = 198, SD = 72, respectively). However, there was no significant main effect of Pace (p = .263) nor a significant Pace x Time interaction (p = .736). Together, the data pertaining to go trial errors, RTs and RT variability showed that the children's performance deteriorated as the task progressed but that there was no speed-accuracy trade-off occurring.

ERP data

Table 2 presents descriptive statistics for N2 and P3 ERP components' peak latencies and mean amplitudes for correct and wrong no-go trials in each experimental condition. Figure 2 shows grand mean N2 and P3 waveforms computed for correct and wrong no-go responses in the fast- and slow-paced groups.

Table 2. Mean (SD) no-go correct and no-go wrong N2 an P3 latencies and amplitudes in the fast- and slow-paced video conditions.

Dependent variable	**Pace - no-go response**			
	Fast-correct	*Fast-wrong*	*Slow-correct*	*Slow-wrong*
N2 latency	288 (35)	286 (26)	273 (31)	295 (32)
P3 latency	432 (59)	407 (64)	399 (62)	422 (49)
N2 amplitude	-2.1 (5.2)	-5.1 (3.4)	-1.2 (5.5)	-7.5 (7.7)
P3 amplitude	3.9 (4.3)	3.0 (2.5)	3.9 (2.5)	3.1 (2.3)

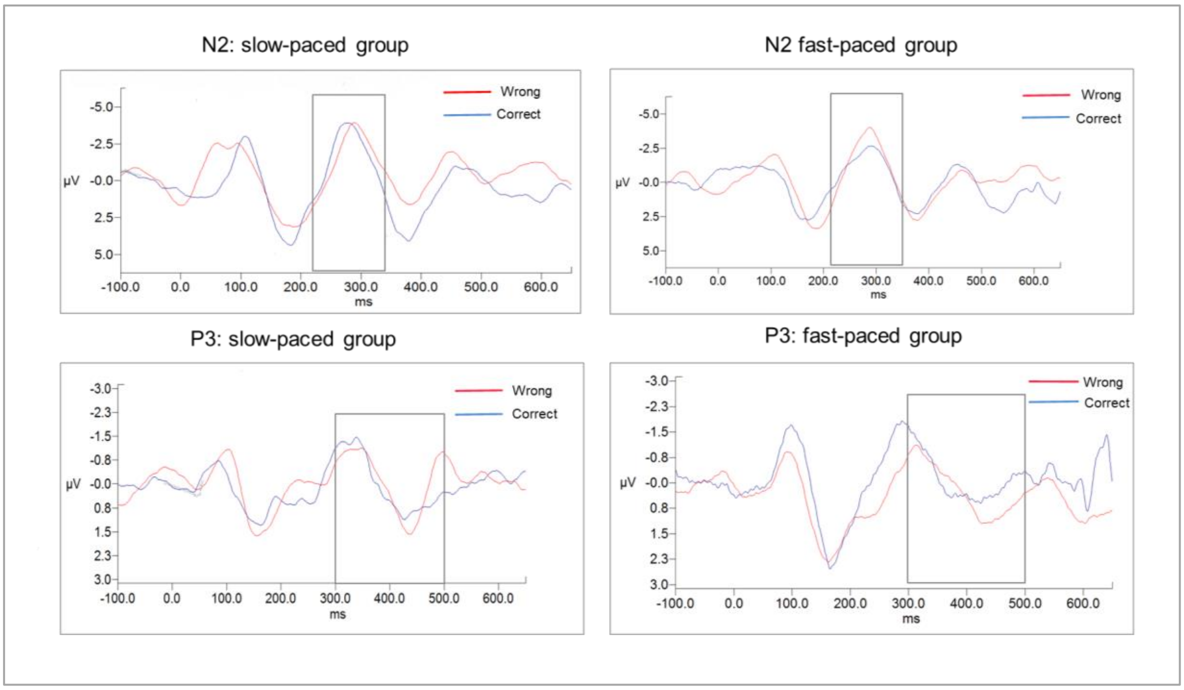

Figure 2. Grand mean N2 (at Fz) and P3 (at Cz) waveforms computed for correct and wrong no-go responses in the fast- and slow-paced groups. The time windows of N2 and P3 peaks are indicated by the grey boxes.

N2 and P3 amplitude and latency were analysed in a mixed 2 (condition: fast vs. slow) x 2 (response: correct vs. wrong) ANOVA. N2 peak latency analysis did not show a significant main effect of Pace (p = .699) or Response (p = .091). However, there was a significant Response x Pace interaction, F(1,38) = 4.88, p = .033, η^2_p =.114 (Figure 3). A follow-up t-test revealed that in the slow-paced group, but not the fast-paced group, the N2 peak occurred earlier for correct no-go trials than it did for no-go errors, t(17) = -2.72, p = .017, 95% CI: -37.3 to -6.9. These data are consistent with the proposal that successful inhibition in go/no-go tasks requires earlier N2 activation.

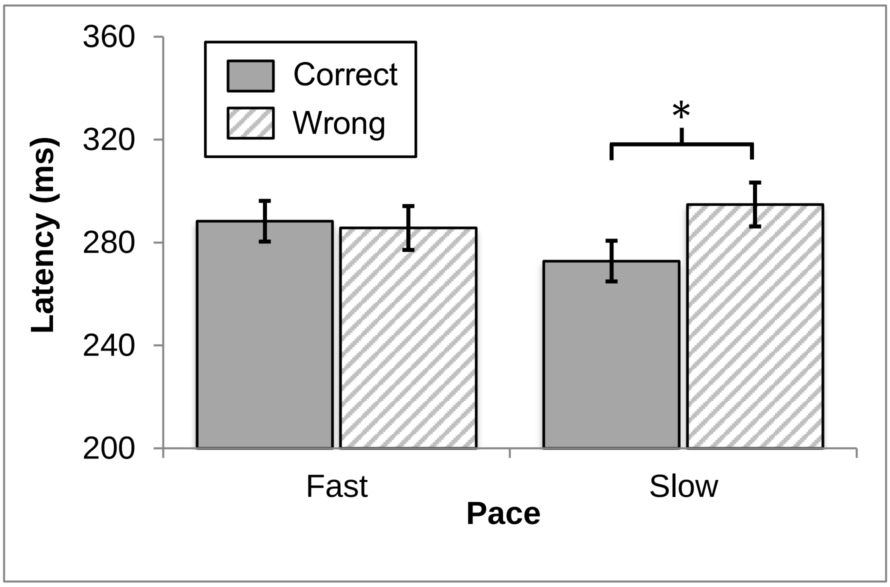

Figure 3. Mean N2 peak latencies for correct and wrong no-go trials in the fast and the slow-paced groups. Error bars represent 95% confidence intervals (* denotes a significant difference; $p < .05$).

The N2 amplitudes analyses did not show any significant main ($p = .542$) or interactive effects of Pace ($p =.209$). There was however a main effect of Response, $F(1,38) = 12.85$, $p = .001$, $\eta^2_p =.253$. The no-go N2 was more negative for wrong responses compared to the correct responses ($M = -6.1$ mV, $SD = 5.8$ vs. $M = -1.7$ mV, $SD = 5.3$, respectively). It is important to note here that, despite the lack of statistical significance (most likely due to the low power), a comparison of N2 waveforms shown in Figure 2 suggests that the amplitude difference is confined to the fast-paced group.

Analysis of P3 latency showed no significant main effect of Pace ($p = .587$) or Response ($p = .933$) but there was a significant Response x Pace interaction, $F(1,38) = 5.31$, $p = .023$, $\eta^2_p = .123$ (Figure 4). Follow-up t-tests conducted within each pace group were not significant.

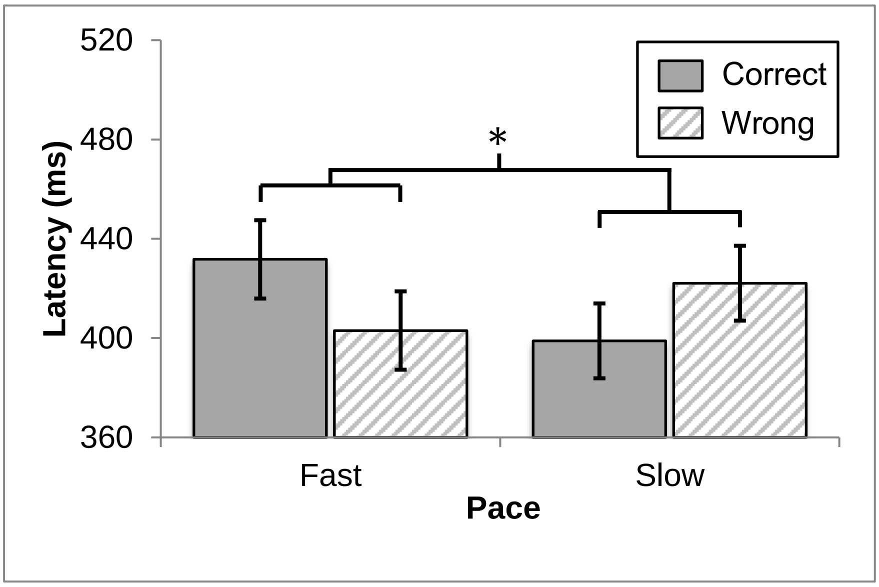

Figure 4. Mean P3 peak (at Cz) latencies for correct and wrong no-go trials in the fast- and the slow-paced groups depicting the Response x Pace interaction; error bars represent 95% confidence intervals (* denotes a significant interaction, p < .05).

Nevertheless, the significant interaction shows that the correct-wrong difference in P3 latency was reliably more positive in the fast-paced group than in the slow-paced group. In the slow-paced group, the P3 peaked earlier on correct no-go trials than it did during erroneous responses. In contrast, in the fast-paced group the timing of P3 peaks appears to be reversed; the P3 peaks earlier during wrong responses.

The analysis of P3 amplitude data did not produce any significant findings for the main effects of Pace (p = .993), Response (p = .111), nor for Pace x Response interaction (p = .926).

Discussion

This study had two aims: to investigate whether watching differently paced videos affected both children's behaviour and their cortical activity during a go/no-go task. First, we examined the effect of editing pace on children's performance on the SART, which has high inhibitory demands on rare no-go trials. Second, we investigated whether editing pace modulated the neural activity involved in the inhibition required for no-go trials in this task.

The behavioural data supported our prediction regarding the negative short-term impact of the fast pace for performance on this task. In the first half of the task, the children who watched the fast-paced video made more errors on the no-go trials than those watching the slow-paced version. This suggests that immediately following the video, executive processing of children in the fast-paced group was less efficient. Moreover, the use of psychophysiological measures allowed us to demonstrate that editing pace had consequences for the neural responses that underpin inhibition in the no-go trials of the SART, specifically in the timing of the N2 and P3 activation. For the slow-paced group, the timing of these ERP components varied between correct and wrong no-go trials in a usual way (Roche et al., 2005). That is, the N2 and P3 peaked *earlier* when the children correctly withheld a response on no-go trials compared to the trials when they made an error. Conversely, in the fast-paced group, the timing of activation of these cortical processes was unusual, as it did not differ between the correct and wrong no-go trials. Thus, to our knowledge, this is the first study to demonstrate in children the evidence that watching fast-paced videos has short-term consequences for the neural responses.

Although the no-go error data support our suggestion that exposure to fast-paced video may weaken inhibition, the effects observed in the present study were short-lived. In the second half of the SART, the rate of no-go errors in the fast-pace group decreased and did not differ from that of the slow-pace group. This transient character of the detrimental effects of the fast pace may be a result of a very brief exposure to the experimental video (less than 4 minutes). Alternatively, the children in the present study were older (7-year-old) than children who participated in the previous experimental studies (e.g., Geist & Gibson, 2000; Kostyrka‐Allchorne, Cooper, Gossmann, et al., 2017; Lillard & Peterson, 2011), and thus, perhaps were less sensitive to the effects of the video pace. Whether the effects of the editing pace are moderated by the viewers' age or the duration of exposure remain open questions. Importantly, it is yet unclear whether repeated exposure to fast-paced programming leads to more persistent deficits in inhibition.

It is also important to note that other indices of performance, namely, go trial errors, response times and response times variability, showed that the children's performance deteriorated with time on task. However, as the study did not include children who did not watch a video, these changes in performance might be a consequence of video watching (irrespective of the pace), or a typical effect observed in the SART. Future research should attempt to discern the effects specific to video exposure by including a control group.

Turning again to the ERP findings, the data showed that the peaks of the N2 and P3 were earlier for the correct compared with wrong responses (about 22 ms and 23 ms earlier, respectively) following the slow-paced video, but this usual pattern was not found with the fast-paced video. Considering our behavioural data, which suggested that watching a fast-paced video resulted in weaker inhibition, these ERP findings are consistent with the literature showing that the N2 and P3 components play an active role in inhibitory processes (Abdul Rahman et al., 2017; Davis, Bruce, Snyder, & Nelson, 2003; Duan et al., 2009; Falkenstein et al., 1999). Moreover, the differences in N2 and P3 component latencies support the proposal made in the adult (Garavan et al., 2002; Roche et al., 2005) and developmental literature (Cragg et al.,

2009) that successful inhibitory processes are dependent on the specific timing of component activation.

These latency data, suggesting that editing pace influences the timing of the N2 and P3 components, are consistent with our prediction regarding the differences in the cortical activity in the fast- and the slow-paced groups. However, considering that the ERP analysis could not parallel the approach to analysing the SART data (i.e., ERPs were not split into 2 blocks) caution should be applied when linking latency data to behaviour. Given that this is the first study to investigate this effect, further work is necessary to establish the reproducibility of the specific latency pattern and to allow clear interpretation of these findings.

Irrespective of the video pace, examination of the latency data shows that the N2 peak occurred over 100 ms before children made an erroneous press on no-go trials. This supports the suggestions that the N2 may be an index of active inhibitory processes operating at a pre-motor level (Falkenstein et al., 1999). In comparison, the P3 peaked relatively late in relation to the stimulus onset, around the time of the erroneous motor response execution. It is, therefore, unlikely that the timing of the peak of this component underpins successful inhibition. Finally, the finding of larger N2 amplitudes in unsuccessful no-go trials is consistent with data reported in the adult (Kok, Ramautar, De Ruiter, Band, & Ridderinkhof, 2004) and developmental literature (Lo et al., 2013).

This study provides further support for a short-term detrimental effect of watching fast-paced videos on children’s behaviour, and also shows the first evidence that video pace affects cortical responses that underpin inhibition. Nevertheless, is it important to consider that the use of short, novel, experimental videos may have reduced the ecological validity of this experiment. However, it did allow us to maintain strict experimental control over content and other programme features, which is not possible when using commercially available children's TV shows (Kostyrka-Allchorne, Cooper, & Simpson, 2017). Considering the pervasiveness of screen use among young children, it is, therefore, crucial to investigate electrophysiological correlates of inhibition in children who are habitually exposed to high levels of fast-paced programming. Whether prolonged exposure to frequent changes on the screen leads to changes in the brain organisation and function remains an important open question.

In conclusion, using specially designed experimental videos, which varied the pace of editing, whilst controlling for the content and other production features, this study showed that children's behaviour was affected by the editing pace. After watching the fast-paced video, children made more erroneous responses on no-go trials. These effects were short-lived, and the children's behaviour matched the performance of the group exposed to the slow-paced video in the second half of the task. Furthermore, this is the first study to provide evidence that video exposure has consequences for the neural responses that underpin inhibition. Specifically, the no-go peak latencies of the N2 and P3 components were affected by the editing pace. Only for the slow-paced group, did the N2 and P3 occur in the expected timing pattern, that is, these components peaked earlier on the correct than on the wrong no-go trials. Together, these findings demonstrate that the pace of video editing affects both behaviour and neural processing in children.

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