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Deployment dynamics of hypnotic anger modulation

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A B S T R A C T

To understand the role that attention plays in the deployment timeline of hypnotic anger modulation, we composed an Attentional Blink paradigm where the first and second targets were faces, expressing neutral or angry emotions. We then suppressed the salience of angry faces through a "hypnotic numbing" suggestion. We found that hypnotic suggestion only attenuated the emotional salience of the second target (T2). By implementing drift-diffusion decision modelling, we also found that hypnotic suggestion mainly affected decision thresholds. These findings suggest that hypnotic numbing resulted from belated changes in response strategy. Interestingly, a contrast against non-hypnotized participants revealed that the numbing suggestion had the instruction-like feature of incorporating emotional valence into the attentional task-set. Together, our results portray hypnotic anger modulation as a two-tiered process: first, hypnotic suggestion alters the attentional task-set; second, provided processing and response preparation are not interrupted, a hypnotizability-dependent response based on said altered task-set is produced through late cognitive control strategies.

1. Introduction

Over the past two decades, hypnosis has been subjected to renewed scrutiny. Our knowledge about individual differences in hypnotizability (Cardeña and Terhune, 2014), and the processes that are amenable to hypnotic modulation (Terhune et al., 2017) have much improved. As a result, novel theoretical models describing hypnosis fundamental mechanisms have emerged (Benham et al., 2006; Dienes & Hutton, 2013; Dienes & Perner, 2007; Lynn et al., 2008; Martin & Pacherie, 2019). While most of these models coincide in characterizing hypnotic responding as the result of top-down control strategies (Terhune et al., 2017), there is still substantial debate concerning the limits of how much can hypnotic suggestion tamper with attentional resources (Jensen et al., 2015). One popular stance is that hypnotic suggestions seeking to disrupt perception (*e.g.* "You can't read these words", "You can't figure out what color this is", "You can't feel pain", etc.) act by de-automatizing early attention allocation, in so preventing the processing of the targeted feature (Lifshitz et al., 2012). A different, opposing view, is that hypnosis alters cognitive processing belatedly: not by preventing attention

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allocation devoted to feature processing, but rather by fostering control changes at the level of decision strategy and response preparation (Augustinova & Ferrand, 2012; Parris et al., 2013; Parris, 2014; Parris, Dienes, & Hodgson, 2012).

In the present work, we contribute to the understanding of the above debate. To do so, we chose a landmark implementation of experimental hypnosis: the use of hypnotic suggestions that curb the behavioral and physiological reactions elicited by negative affective stimuli (Bryant & Mallard, 2002). This "hypnotic emotional numbing" effect has been reliably replicated (Bryant & Kapur, 2006; Bryant, 2005; Sebastiani et al., 2007), but we still know little about the mechanisms behind it, the exact point in the cognitive timeline at which it intervenes, and whether its deployment entails a de-automatization of attention. To tackle these questions, we implemented an emotional numbing suggestion within the framework of an Emotional Attentional Blink paradigm (EAB; McHugo et al., 2013), so that we could track the effects of our hypnotic suggestion over emotional targets within different attentional windows.

Temporal attention manages the distribution of cognitive resources across a task timeline (Potter, 1975; Thorpe et al., 1996). One of the most researched experimental phenomena for probing temporal attention deprivation is the Attentional Blink (AB, Raymond et al., 1992). AB paradigms typically intersperse two targets (T1, T2) within a Rapid Serial Visual Presentation (RSVP) of distractor stimuli. When the time lag between T1 and T2 is short enough, the attentional resources invested in detecting and acting upon T1 fail to be diverted in time to T2. This causes an attentional "blink" that can impact negatively on the performance of T2-related tasks (Nieuwenstein et al., 2009). This impact can range from full failure to detect T2 (Chun & Potter, 1995) to relative performance drops in T2-related tasks (de Jong & Martens, 2007; de Jong et al., 2010; Maratos et al., 2008). The AB demonstrates that perceptual decisions depend on an immediate consolidation process that operates as a bottleneck for the entry of perceptual information into working memory (Vogel et al., 1998).

Crucially, the AB can be enhanced or disrupted by intrinsic target traits evoking arousal and affect (Arend & Botella, 2002; Olivers & Nieuwenhuis, 2006). Many studies have taken advantage of this emotionally-driven blink to explore the link between temporal attention and the perception of emotion (de Jong et al., 2010; Stein et al., 2009). EAB paradigms that employ angry or menacing faces as target stimuli have shown that the Anger Superiority Effect (ASE, *i. e.* the preferential processing of angry faces among crowds or series of other faces; Hansen & Hansen, 1988) can enhance the blink selectively (de Jong et al., 2010). When an angry face, as opposed to a neutral face, is presented as T1, the additional attentional capture fostered by the ASE further impedes the allocation of attentional resources to T2 (de Jong et al., 2010; Maratos et al., 2008). It has been suggested that the affective impact of T1 on temporal attention is automatic in nature, and does not require stimuli to be reported, or acted upon (Arnell et al., 2007; Most et al., 2007; Smith et al., 2006).

Interestingly, the arousal response elicited by menacing stimuli has been shown to be sensitive to top-down hypnotic modulation. "Emotional numbing" hypnotic suggestions successfully change participants' affective response to negative stimuli. In one experiment, hypnotized participants were exposed to negative stimulation, and reported to feel no emotional disturbance or concern, while displaying attenuated behavioral and EMG responses compared to controls (Bryant & Kapur, 2006). This effect has been identified as a direct consequence of hypnotic suggestion, and disentangled from the general soothing and relaxation that customarily accompanies most hypnotic inductions (Sebastiani et al., 2007).

Since the ASE relies on affective appreciation (Öhman, 2002), we predicted that an "emotional numbing" hypnotic suggestion applied to an EAB paradigm of angry vs neutral faces would attenuate the targets' affective-driven attentional capture. This would provide us with an opportunity to study the effects of hypnotic numbing within different attentional windows. We composed an "angry vs. neutral" AB paradigm consisting of two emotionally-relevant target faces (T1, T2), interspersed amongst a RSVP of distractor composite faces. All stimuli were inclined to the right or to the left with respect to their vertical axis. Participants would have to indicate whether T2 was tilted clockwise or counter-clockwise. We predicted that this paradigm would elicit an AB which would be selectively enhanced or dampened depending on whether the ASE favored T1 or T2 processing. Then, we embedded this paradigm within a between-group hypnotic comparison. Following recent consensual guidelines on hypnosis research (Jensen et al., 2017), we composed sub-groups of high, medium and low hypnotizable participants within both the "hypnotic suggestion" and "no hypnotic suggestion" groups, anticipating the efficacy of the intervention would depend on this trait. Participants in the "hypnotic suggestion" group underwent a hypnotic emotional numbing suggestion aimed at reducing affective attentional modulations, while participants in the "no hypnotic suggestion" group did not. We predicted that if the affective value of targets significantly modulated the size of the blink, these modulations would in turn be attenuated by the hypnotic emotional numbing suggestion.

The main goal of this study was to track the hypnotic emotional numbing suggestion effects throughout the timeline of temporal attention deployment (*i.e.*, for T1 and T2, across early and late lags), in order to better understand its relationship to attention. As per our hypothesis, we expected two possible outcomes. If our hypnotic suggestion did foster an early de-automatization of the targets' affective impact, then we would expect the ASE to diminish for both T1 and T2, and across all lags, truly transforming our EAB paradigm into a "standard" AB. If, on the other hand, hypnotic suggestion acted at later processing stages, during the implementation of response strategies, we predicted that its effects would mainly affect T2 (*i.e.*, the target involved in the decisional task), particularly so in later lags (*i.e.*, where decision processes were less constrained by the AB).

2. Materials & procedures

2.1. Participants

Six hundred and fifty native French-speakers, undergraduate and graduate students from the Institute of Psychology of Paris V and the École Normale Supérieure manifested interest in participating in the screening sessions for hypnotizability. Four hundred and twenty one assisted, completed the procedure and were incorporated into the database for the main experiment (age range 18–35, mean age 22.63 (4.62), 298 female). Those who scored between 9 and 12 points were classified as highly susceptible to hypnosis (79 participants), those who scored between 5 and 8 points were determined to have medium susceptibility to hypnosis (212 participants), and those who scored 4 points or less were determined to have a low susceptibility to hypnosis (130 participants) (Anlló et al., 2017; Shor & Orne, 1962).

We conducted *a priori* simulation-based power analyses to estimate the minimum sample size needed to evaluate the effect of the hypnotic suggestion on emotional salience. Simulation-based approaches are ideal in mixed-modelling statistical frameworks due to their flexibility (Green & MacLeod, 2016). The procedure consists of iterating three consecutive steps: simulating values for the response variable using the model provided, refitting the model to the simulated response, and applying a statistical test to the simulated fit. Since the tested effect is assumed to exist, every positive test is a true positive and every negative test is a Type II error. Hence, the power of the test can be calculated from the number of successes and failures at step 3. The simulations showed that for detecting a significant Hypnotic Suggestion × Hypnotizability × Target Emotion interaction with alpha = 0.05 and a power equal or greater than 80%, a minimum of n = 13 per condition was required (See observed and *a priori* simulation-based power analyses in Appendix A for a detailed account on these procedures).

All of the previously screened participants were invited to take part in the main experiment, and a total of 105 (mean age 22.42 (3.9), 77 female) responded. Forty-nine participants were tested under hypnotic suggestion (Hypnotized Group), and 56 were tested without any sort of suggestion or hypnotic induction (Not Hypnotized Group). The Hypnotized Group was composed by 18 participants highly susceptible to hypnosis (11 female), 15 of medium susceptibility (13 female) and 16 of low susceptibility (9 female). The Not Hypnotized Group was composed of 14 Highs (10 female), 24 Mediums (20 female) and 18 Lows (14 female).

2.2. Materials

The experiment was developed with the Matlab Psychophysics Toolbox extension (Kleiner et al., 2007). It consisted of an “angry vs neutral” face-based Attentional Blink (AB) paradigm that both selectively enhanced (for angry T1) and hampered (for angry T2) the blink’s effects, by capitalizing on the Anger Superiority effect (ASE). Each trial presented a RSVP built of three types of stimuli: neutral and angry faces (targets), and distractor faces that were blurry, composite neutral faces. A total of 40 angry and 40 neutral faces were produced as stimuli. In order to produce these stimuli, first, we selected all available male, neutral-looking and angry-looking faces from the Cohn-Kanade (Kanade et al., 2000; Lucey et al., 2010), AR Face (Martinez & Benavente, 1998), ADFES (van der Schalk et al., 2011), NimStim (Tottenham et al., 2009), Chicago Face (Ma et al., 2015) and RaFD (Langner et al., 2010) databases as raw materials. All images were cropped and resized to 228 by 240 pixels. Faces were then converted to grayscale and manually cropped again to a 2.5° major radius oval (using the tip of the nose as center). The resulting oval-shaped faces were sorted out by the first two authors, in order to select those that better represented anger and neutrality.

We then used the SHINE Matlab Toolbox (Willenbockel et al., 2010) to match mean luminance and contrast (i. e. the standard deviation of the luminance distributions) of all selected faces to a template. Said template was the composite face that resulted from averaging all pixel values for all 40 Angry and 40 Neutral Faces combined. Background luminance was set at a nominal 122 value of gray (25 cd/m2). Then, in order to develop the composite faces stimuli in the same range of luminance, we combined all of the already matched neutral and angry faces into a single pool and used them as raw materials: each composite face was the result of averaging 25 faces selected at random from the pool. We produced 40 composite faces. Mean luminance of the stimuli was 18.5 cd/m^2 (SD = 2.21) for the Neutral Faces, 19 cd/m^2 (SD = 1.95) for the Angry Faces and 18 cd/m^2 (SD = 1.48) for the Composite Faces. Mean Michelson contrast was 0.77 (SD = 0.01) for both Neutral and Angry Faces, and 0,76 (SD = 0,03) for the Composite Faces.

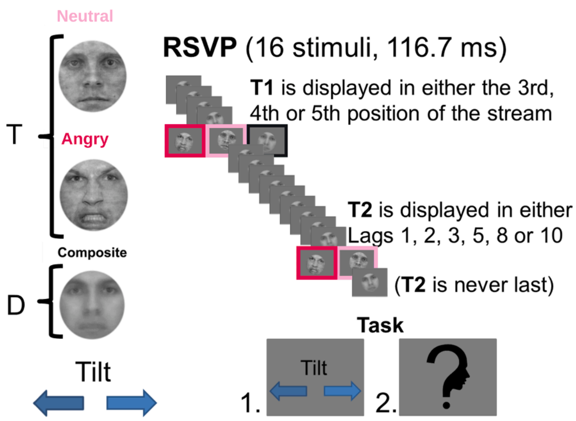

Fig. 1. Face-based Attentional Blink paradigm. The paradigm consisted of the RSVP of 16 faces, for a duration of 117 ms each. Angry and neutral faces were selected as targets, and composite faces as fillers. By the end of each trial, participants were presented with two subsequent response cues, and asked to perform the following two tasks in sequence, as fast as possible: 1) report the tilt of the last *target face* they had seen, and 2) report how many *target faces* had appeared in the stream. Participants were never asked about the actual emotion displayed by the targets or distractors, ensuring that their actual emotional value would remain task-irrelevant.

Each trial of the paradigm consisted of an RSVP stream of 16 stimuli displayed over a gray background (25 cd/m^2), at the center of the screen, for a duration of 117 ms each. Additionally, a blank gray frame of 17 ms would appear between stimuli to avoid face-merging. We designated angry and neutral faces as targets, and composite faces as distractors. All faces were tilted by 12° either clockwise (CW) or counterclockwise (CCW). In each stream of stimuli, Target 1 (T1) would appear in either the third, fourth or fifth position. We then selected a total of six lags: 1, 2, 3, 5, 8 and 10 for the presentation of T2. As control trials, we presented trials in which only T2 would appear, with its position calculated relative to a composite distractor face in the position of T1 (*i.e.*, the composite filler face would too be either the third, fourth or fifth stimulus of the stream). The composite faces and their inclination orientation were randomly selected. Fig. 1 presents a graphical outline of the paradigm's trials.

To assess hypnotizability, we used the published French norms for the Harvard Group Scale of Hypnotic Susceptibility: Form A (Anlló et al., 2017; Shor & Orne, 1962). The French norms' internal consistency and item-scale correlation were on par with the original (Kuder-Richardson for the English original = 0.8; K-R for the French version = 0.8; see Anlló et al., 2017). The procedure was administered in person by the first author, a certified hypnosis practitioner with over 1000 h of experience. The scale was administered in full, and included the 12 standard suggestions of head-falling, eye-closure, hand lowering, arm immobilization, finger-interlocking, arm-rigidity, magnetic palms, eye-catalepsy, head-immobilization, fly hallucination, amnesia and posthypnotic ankle-touching.

For the main experiment, the hypnotic induction was a variation of the Elman induction (Elman, 1984), which demands multiple rounds of eye closure, and asks the participant to "deepen" their hypnotic state with each round. The "emotional numbing" suggestion was based on Bryant's procedure (Bryant & Kapur, 2006), suggesting distance and emotional detachment from all menacing and negative affective traits. Other secondary suggestions for safety and improved concentration were added to ensure the effect would be achieved. A detailed account of the induction and suggestions can be found in Appendix B.[1]

2.3. Procedure

Two calls were launched in parallel, independently of each other, by different research assistants. One was the call for hypnotic susceptibility screenings, the other was the call for the present experiment, in which participants were contacted by e-mail and recruited in several rounds, contingently on whether they had previously participated in the concurrent hypnotic susceptibility screenings, but without knowing that the experiment itself would involve hypnosis. Both calls coexisted under the following rules: (1) pre-screening recruitment had to continue until the pool of pre-screened participants stopped producing volunteers for the main experiment, (2) new screening sessions could only be conducted if recruitment stagnated before the minimal number of participants per condition prescribed by our power simulation was reached, (3) once a new screening session was launched, everyone who participated had to be invited to the main experiment. No optional stopping was used.

For the hypnotizability screening sessions, participation was voluntary, in exchange of university credit for a 2-hour session dedicated to completing the Harvard Group Scale of Hypnotic Susceptibility Form A (Shor & Orne, 1962). Participants self-rated their responses on a pass-or-fail basis, adding one point per suggestion passed (except for the amnesia suggestion, which was rated a posteriori, as prescribed by the HGSHS:A norms, see Shor & Orne, 1962).

For the main experiment, participation was voluntary, in exchange of 15 euros for a 1 h and 30 min session. Interactions with all participants were scripted from first contact, so as to establish equal conditions of motivation for both groups. All participants signed a written consent allowing for the anonymous exploitation of the data they produced. The experiment was conducted in agreement with the Declaration of Helsinki (2008) and approved by the Ethics Committee of the Université Paris Descartes (Paris 5).

Participants were tested blindly, without the hypnosis practitioner knowing their level of hypnotizability at the time of explaining the task instructions or administering the hypnotic suggestion. At this point, they were told that they would be taking part in an experiment that would include their response to hypnotic suggestion, and warned that all levels of susceptibility and hypnotic responding were relevant for the study. Since they did not know that the experiment would involve hypnosis before coming to the session, they were given the opportunity of refusing the hypnotic procedure, without any impact to their monetary compensation. They were also informed that their response, if any, to the procedure would not have any impact on their monetary compensation either. It was also clearly stated that the authors did not have any particular expectations about their performance or hypnotic response. Participants on the Not Hypnotized Group did not receive any information whatsoever regarding the connection between the experiment and hypnosis. The mention of hypnosis and hypnotic susceptibility were explicitly avoided at all times throughout the testing of this group. All participants were informed that they could stop their participation at any time, with no bearing over their monetary compensation.

After signing the written consent, participants sat in a dim-lit sound-proof test booth in front of a standard LCD screen, and a standard AZERTY French keyboard. The main experiment consisted of a total of 600 trials, of which 120 were control (only one target). Of the remaining 480 trials, 288 corresponded to lags 1, 2 and 3 ("Early" lags), and 192 to Lags 5, 8 and 10 ("Late" lags).[2] By the end of each RSVP, two symbolic successive cues were displayed to prompt for speeded responses. These cues asked the participant to perform the following two tasks in sequence, as fast as possible: 1) report the tilt of the last target face they had seen, and 2) report how many target faces had appeared in the stream. There were six blocks of 100 trials each, separated by a 3 min pause. Before the main

[1] Establishing which effects came specifically from hypnotic induction and which came from hypnotic suggestion was beyond the scope of the present work.

[2] The difference in trial allocation was based on the literature and our pilot data, which showed performance started to plateau between lags 5 and 10. We hoped to increase the amount of trials for lags that we estimated would yield a difference in performances.

experiment, participants underwent first a Pre-Training phase in which they learnt the difference between target and composite faces, and between CW and CCW inclinations. Then, a Training phase in which they were presented with an RSVPs identical to the one of the main experiment, but with two modifications: 1) Targets were only Neutral Faces, 2) the stimuli duration were longer (467 ms), and decreased along the course of the 100 trials of the training until matching the target duration intended for the face-orientation task (117 ms). Participants responded by using their left hand, pressing the letters "A" and "Z" to indicate CCW or CW inclination. Participants also performed on each trial an additional target-counting task, for which they used their right hand to indicate the number of faces (either 1 or 2) on the numeric pad of the keyboard. Participants who did not reach an overall 70% accuracy rate on the Training set had to do it again, to a maximum of three times (all participants reached criterion after 2 rounds).

Immediately after the training, the first author delivered the hypnotic induction and administered the "emotional numbing" suggestion for participants in the Hypnotized group. Once the suggestion had been delivered, participants were instructed to get ready for the main experiment, in which they would have to execute the same two tasks as before, as fast and as accurately as possible, while under the effect of the suggestion. Instructions were the same for non-hypnotized participants, minus the reference to the hypnotic suggestion. Participants who did not undergo the hypnotic numbing suggestion received no mention whatsoever regarding the faces' expressions, anger or menace. During the pauses, the experimenter reinforced the hypnotic suggestion (see Appendix B for the complete hypnosis procedure). Participants of the Not Hypnotized group did not receive any kind of induction procedure or suggestion, but were instructed to use the pauses to close their eyes, relax, and hone their concentration in order to perform to the best of their abilities.

Since participants in the Hypnotized Group were exposed to a hypnotic suggestion that alluded indirectly to the emotional value of the targets, they were debriefed after the experimental task to control for suspicion of hypothesis. The debrief was also used to probe for any anomalous or unwanted behaviors elicited by poor understanding of the suggestion, or by convoluted expectations regarding the hypnosis procedure (*e.g., "Hypnosis made me fall asleep completely"* or *"Hypnosis changed the way I controlled my hands"*). No participant manifested any of the latter, and while some participants realized that the faces sported different emotions, none expressed the adoption of emotion-related response strategies.

2.4. Statistical analyses

Our main goal was to evaluate if our paradigm would elicit an AB susceptible to the ASE, and if so, how would hypnotic suggestion interrupt or attenuate the influence of the latter over the former. To this end, we decided to focus on the accuracy scores for the face-orientation task (de Jong et al., 2010). Response times were included in the analysis, but only for developing the drift diffusion models.

Accuracy was modeled by implementing generalized linear mixed models, with a random intercept per participant (lme4; Bates et al., 2015). We chose a hierarchical modeling approach in order to account for individual differences and for imbalances in sample sizes across factors and levels (Agresti, 2002; Jaeger, 2008). We performed significance tests by means of likelihood ratio tests that compared our models to simpler models, in which the relevant predictor was removed (null model) (Bolker et al., 2008; Pinheiro & Bates, 2000). ANOVA tables were computed through Analysis of Deviance (Type II Wald χ^2 test), and post-hoc pairwise comparisons through contrasts of least-squares means setting a 0.95 CI, then Bonferroni-corrected (car and lsmeans R packages; Fox & Weisberg, 2011; Lenth, 2016, respectively). Relevant model predictors used for fitting the data included one 3-level categorical factor (Hypnotizability: Low/Medium/High) and four 2-level categorical factors (Lag Category: Early Lags/Late Lags; $T1_{emotion}$: Angry/Neutral; $T2_{emotion}$: Angry/ Neutral; Hypnotized: Hypnotized/Non-hypnotized). Lags were collapsed into "Early" and "Late" categories to ease the computation of meaningful contrasts.[3]

We also implemented Ratcliff's Drift Diffusion Model (DDM, 1978) to analyze response time distributions through sequential sampling for correct and incorrect trials. The model's parameters were estimated through the Kolmogorov–Smirnov approach with the *fast-dm* software, which allowed us to fit one model per participant and then evaluate goodness-of-fit (Voss et al., 2004). We followed the guidelines of Voss *et al.*, 2015 concerning the application of the DDM framework. The resulting *v, a* and *t0* parameters were then extracted and modeled through mixed models, utilizing the same regressors as for the model for accuracy, a random intercept per participant and the same modeling and statistical procedures.

Effect sizes were estimated by calculating Cohen's d at each contrast, correcting for sample size $n < 20$. Following this computation, a $d = 0.2$ is interpretable as a small effect, $d = 0.5$ as a medium effect and $d = 0.8$ as a large effect.

3. Results

3.1. Attentional blink & anger superiority effect

Before we could analyze the effects of the hypnotic emotional numbing suggestion, we needed to establish whether hypnotized and non-hypnotized participants had presented an AB, and if the blink had been modulated coherently by emotional salience. This was a crucial preparatory step, as failing to elicit an emotional blink in either group would have prevented non-hypnotized participants from

[3] The pre-existing literature on face-based attentional blink (de Jong & Martens, 2007; de Jong et al., 2010) confirms that "Lag 1 sparing" is either negligible or non-existent for these kinds of paradigms. Rather, performance tends to be similar amongst lags affected by the AB's bottleneck. This is also the case for late lags, which usually tend to plateau. Since we observed the same pattern in our data, and we scouted differences between early and late lags that could be of theoretical interest, we created the categories "Early" (lasg 1, 2, 3) and "Late" (lags 5, 8, 10).

operating as a control for hypnotized participants.

We first analyzed accuracy differences between Early Lag and Late Lag trials across conditions. As shown in Fig. 2, we found that mean accuracy was on average 11.75 (SD = 1.26) percentual points higher for Late Lag trials than for Early Lag trials (Lag Category main effect: Hypnotized $\chi^2(1) = 398$, $p < 0.0001$, Non-hypnotized: $\chi^2(1) = 369$, $p < 0.0001$, All: $\chi^2(1) = 763$, $p < 0.0001$). Differences between hypnotized and non-hypnotized participants concerning this effect were not significant (Interaction Lag Category × Hypnotized $\chi^2(1) = 2$, $p = 0.2$). Further, when considering mean accuracy for Angry and Neutral targets collapsed, Late Lag trials were on-par with Single-target trials (Late Lag trials: 78.1% (SD = 40); Single-target trials: 79.9% (40)). Together, these findings evidenced the presence of an AB for hypnotized and non-hypnotized participants. A complete account of the Analysis of Deviance for all model predictors can be found in Table 1. Contrasts and estimates of accuracy differences have been detailed on Table SM 1 in the Appendix A.

We then proceeded to observe accuracy in trials affected by the blink (i. e. Early Lag trials) across the levels of $T1_{emotion}$ and $T2_{emotion}$, to test for any affective-driven modulations of the AB. Higher accuracy for T2 Angry trials would indicate an affective-driven

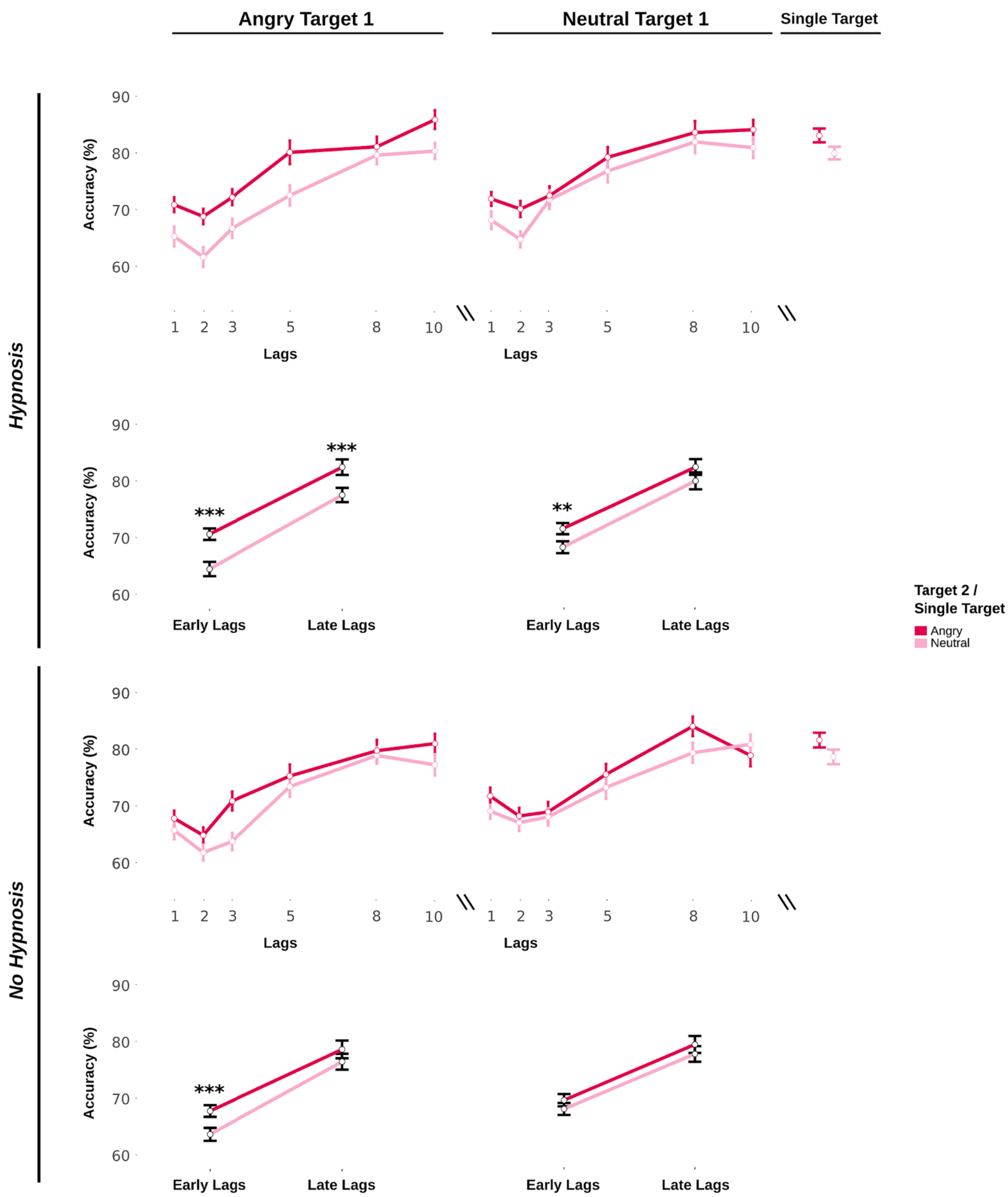

Fig. 2. The Emotion Attentional Blink. Performance differences between T2 Angry and T2 Neutral trials, across lag, lag category and T1 levels. Error bars: Standard Error; post-hoc contrast p-values were Bonferroni-corrected; significance values *=$p < 0.05$, **=$p < 0.01$, ***=$p < 0.001$.

Table 1
Analysis of Deviance (Type 2 Wald χ^2 test) for the model Accuracy ~ Lag Category × $T1_{emotion}$ × $T2_{emotion}$ + εfor hypnotized and non-hypnotized participants.

Predictors	Hypnotized χ^2	DF	Pr(>χ^2)	Non-hypnotized χ^2	DF	Pr(>χ^2)	All participants χ^2	DF	Pr(>χ^2)
Lag Category (Early/Late)	398	1	<0.0001	369	1	<0.0001	763	1	<0.0001
$T1_{emotion}$ (Angry/Neutral)	11	1	<0.001	16	1	<0.0001	27	1	<0.0001
$T2_{emotion}$ (Angry/Neutral)	56	1	<0.0001	21	1	<0.0001	70	1	<0.0001
Hypnotized (Yes/No)	–	–	–	–	–	–	2	1	0.2
Lag Category × $T1_{emotion}$	0.25	1	0.6	2	1	0.2	2	1	0.2
Lag Category × $T2_{emotion}$	0.1	1	0.8	0.1	1	0.8	0	1	1
$T1_{emotion}$ × $T2_{emotion}$	5	1	0.03	2	1	0.1	7	1	0.01
Lag Category × Hypnotized	–	–	–	–	–	–	2	1	0.2
$T1_{emotion}$ × Hypnotized	–	–	–	–	–	–	0	1	1
$T2_{emotion}$ × Hypnotized	–	–	–	–	–	–	5	1	0.02
Lag C × $T1_{emotion}$ × $T2_{emotion}$	0.04	1	0.8	0.6	1	0.5	0.2	2	0.7
Lag C × $T1_{emotion}$ × Hypnotized	–	–	–	–	–	–	0.2	1	0.7
Lag C × $T2_{emotion}$ × Hypnotized	–	–	–	–	–	–	0.2	1	0.7
$T1_{emotion}$ × $T2_{emotion}$ × Hypnotized	–	–	–	–	–	–	0.3	1	0.6
Lag C × $T1_{emotion}$ × $T2_{emotion}$ × Hyptzd	–	–	–	–	–	–	0.2	1	0.6

Type 2 Wald χ2 test for the models' predictors. Includes the model Accuracy ~ Lag Category × $T1_{emotion}$ × $T2_{emotion}$ × Hypnotized + ε for all participants collapsed. χ^2: chi-square; DF: Degrees of Freedom; Pr(>χ^2): probability of obtaining the target chi-square statistic given that the null hypothesis is true.

hampering of the blink. Conversely, lower accuracy for T1 Angry trials would indicate an enhancement of the blink. As shown in Fig. 2, we found evidence for emotional modulation on Early Lag trials, both strengthening and weakening the AB, in all participants. Mean accuracy was on 3.75 (1.71) percentual points higher for T2 Angry trials, indicating an affective-driven hampering of the AB ($T2_{emotion}$ main effect: Hypnotized $\chi^2(1) = 56$, $p < 0.0001$; Non-hypnotized $\chi^2(1) = 21$, $p < 0.0001$; All $\chi^2(1) = 70$, $p < 0.0001$). We also confirmed that accuracy was 2.75 (1.5) lower for T1 Angry trials, which indicated an enhancement of the AB ($T1_{emotion}$ main effect: Hypnotized $\chi2(1) = 11$, $p < 0.001$; Non-hypnotized $\chi2(1) = 16$, $p < 0.0001$; All: $\chi2(1) = 27$, $p < 0.0001$). Post-hoc pairwise-contrasts confirmed that for hypnotized participants, accuracy was consistently higher for T2 Angry trials (T2 Angry minus Neutral (within T1 Angry): Estimate = 6 (95% CI 4, 8), SE = 1, $p < 0.0001$; T2 Angry minus Neutral (within T1 Neutral): Estimate = 3 (1, 5), SE = 1, $p = 0.01$). Additionally, T1 Angry hindered accuracy in T2 Neutral trials (T1 Angry minus Neutral (within T2 Angry): Estimate = −1 (−3, 1), SE = 1, p = 1; T1 Angry minus Neutral (within T2 Neutral): Estimate = −4 (−6, −2), SE = 1, $p < 0.01$). For non-hypnotized participants results were similar, with one exception: T2 salience did not produce a significant accuracy difference when T1 was a neutral face, hinting to an absence of ASE whenever T2 was unencumbered by T1's emotional salience (T2 Angry minus Neutral (within T1 Neutral): Estimate = 2 (0, 4), SE = 1, p = 0.5). Finally, to estimate the overall reach of the ASE, we extended our post-hoc pairwise analysis to Late Lag trials. We found that anger superiority only affected the blink for hypnotized participants, by hindering accuracy on trials where T1 was an angry face and T2 was a neutral face (T2 Angry minus Neutral (within T1 Angry): Estimate = 5 (0, 7), SE = 1, $p < 0.0001$). Analysis of deviance for all relevant predictors can be found in full on Table 1. Contrasts and estimates of accuracy differences have been detailed on Table SM 1 in the Appendix A.

In all, results confirmed the presence of an AB that was permeable to target emotional salience, in both hypnotized and non-hypnotized participants. We observed that while salient T1s generally enhanced the blink, salient T2s had the converse effect, in accordance with our hypothesis.

3.2. Effects of the hypnotic emotional numbing suggestion

After establishing the presence of an EAB, we evaluated whether the hypnotic numbing suggestion had interacted with targets' affective value.

For hypnotized participants, we observed that hypnotizability did not interact significantly with the emotional value of T1 (see Figure SM 2 in Appendix A). However, as shown in Fig. 3, hypnotic suggestion did attenuate T2's emotional impact on accuracy as a function of hypnotizability, in a manner coherent with the content of the hypnotic numbing suggestion (Interaction $T2_{emotion}$ × Hypnotizability: Hypnotized $\chi2(2) = 9$, $p = 0.01$). Pairwise-post hoc contrasts confirmed that the mean accuracy difference between T2 Angry and Neutral trials was maximal for Low participants (Early Lags: 7 (3, 10), Cohen's d = 0.85; Late Lags: 6 (3, 9), d = 0.5), intermediate for Medium participants (Early Lags: 5 (2, 8), d = 0.73; Late Lags: 2 (−1, 4), d = 0.11), and negligible for High participants (Early Lags: 2 (0,5), d = 0.25; Late Lags: 3 (1,6), d = 0.26). Analysis of deviance for the Hypnotizability predictor and its interactions can be found in full on Table 2. A summary of post-hoc contrasts is presented in Table SM 2 in the Appendix A.

For non-hypnotized participants, we observed that once more hypnotizability did not interact significantly with the emotional value of T1. Fig. 3 shows that hypnotizability did interact with T2's emotional value ($T2_{emotion}$ × Hypnotizability $\chi^2(2) = 7$, $p < 0.05$), but we observed that this interaction followed a different pattern than the one we had seen in hypnotized participants ($T2_{emotion}$ × Hypnotizability × Hypnotized $\chi2(2) = 14$, $p < 0.01$). For non-hypnotized participants, Lows showed almost no difference between conditions (Early Lags: 2 (−1, 4), Cohen's d = 0.12; Late Lags: 0 (−2, 3), d = 0), Mediums exhibited an intermediate difference (Early

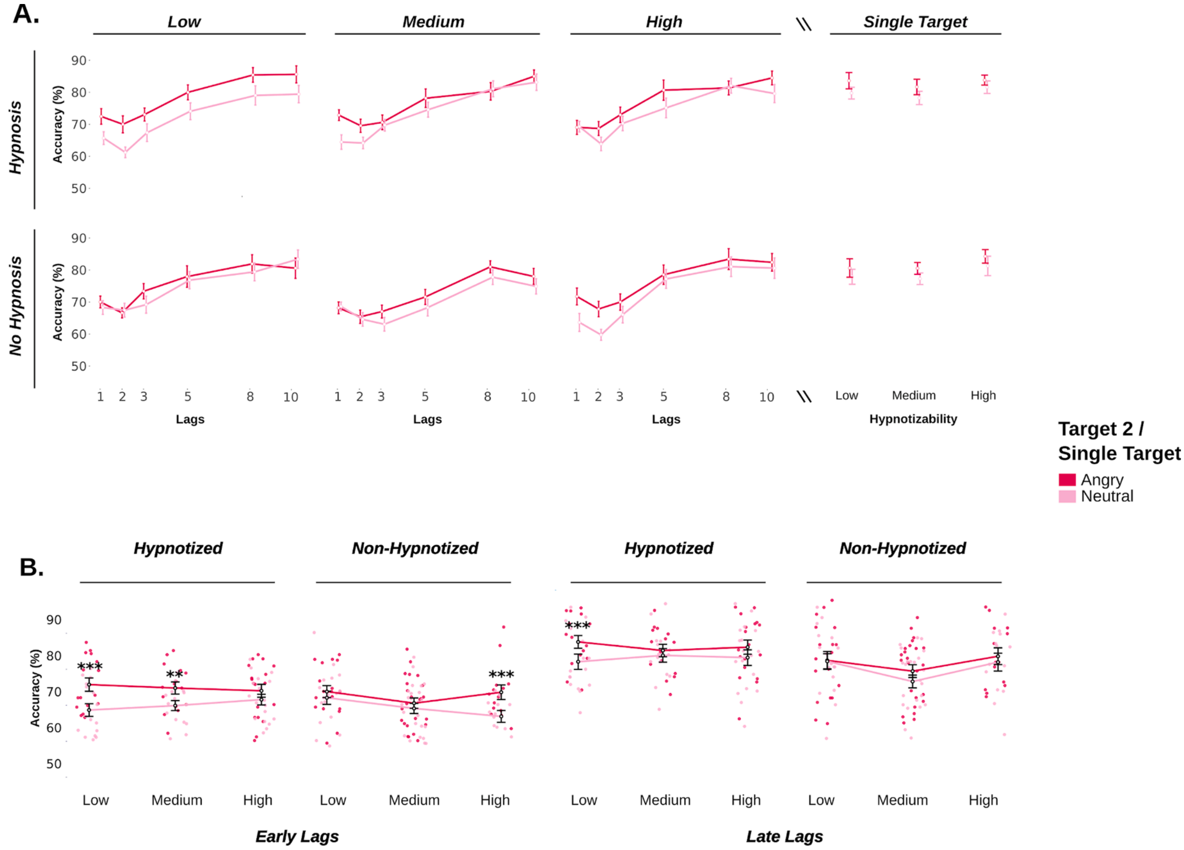

Fig. 3. The Anger Superiority effect, modulated by the hypnotic suggestion. A. Performance differences between Angry T2 and Neutral T2 trials, across all lags. B. Performance differences between Angry T2 and Neutral T2 trials, for Early Lag and Late Lag categories. Error bars: Standard Error; post-hoc contrast p-values were Bonferroni-corrected; significance values *=p < 0.05, **=p < 0.01, ***=p < 0.001; dots represent participants' means.

Table 2
Analysis of Deviance (Type 2 Wald χ^2 test) for the "Hypnotizability" predictor in the model Accuracy ~ Lag Category × $T1_{emotion}$ × $T2_{emotion}$ × Hypnotizability + ε.

	Hypnotized			Non-hypnotized			All participants		
Predictors	χ^2	DF	Pr(>χ^2)	χ^2	DF	Pr(>χ^2)	χ^2	DF	Pr(>χ^2)
Hypnotizability (Low/Med./High)	0.1	2	1	4	2	0.15	2	2	0.3
Lag Category × Hypnotizability	0.4	2	0.8	17	2	<0.0001	9	2	0.01
$T1_{emotion}$ × Hypnotizability	1	2	0.6	6	2	0.06	3	2	0.2
$T2_{emotion}$ × Hypnotizability	9	2	0.01	7	2	0.04	1	2	0.5
Hypnotizability × Hypnotized	–	–	–	–	–	–	1	2	0.5
Lag C × $T1_{emotion}$ × Hypnotizability	1	2	0.5	0.5	2	0.7	1.6	2	0.4
Lag C × $T2_{emotion}$ × Hypnotizability	2	2	0.3	5	2	0.1	0.3	2	0.8
$T1_{emotion}$ × $T2_{emotion}$ × Hypnotizability	0.5	2	0.8	0.1	2	1	0.1	2	0.9
Lag C × Hyptzd × Hypnotizability	–	–	–	–	–	–	8	2	0.02
$T1_{emotion}$ × Hyptzd × Hypnotizability	–	–	–	–	–	–	4	2	0.2
$T2_{emotion}$ × Hyptzd × Hypnotizability	–	–	–	–	–	–	14	2	0.001
Lag C × $T1_{emotion}$ × $T2_{emotion}$ × Hyptzblty	3	2	0.3	0.1	2	1	0.7	2	0.7
Lag C × $T1_{emotion}$ × Hyptzblty × Hyptzd	–	–	–	–	–	–	0.2	2	0.9
Lag C × $T2_{emotion}$ × Hyptzblty × Hyptzd	–	–	–	–	–	–	7	2	0.04
$T1_{emotion}$ × $T2_{emotion}$ × Hyptzblty × Hyptzd	–	–	–	–	–	–	0.4	2	0.8
Lag C × $T1_{emotion}$ × $T2_{emotion}$ × Hyptzblty × Hyptzd	–	–	–	–	–	–	2	2	0.3

Type 2 Wald χ2 test for the models' predictors. Includes the model Accuracy ~ Lag Category × $T1_{emotion}$ × $T2_{emotion}$ × Hypnotizability × Hypnotized + ε for all participants collapsed. χ^2: chi-square; DF: Degrees of Freedom; Pr(>χ^2): probability of obtaining the target chi-square statistic given that the null hypothesis is true.

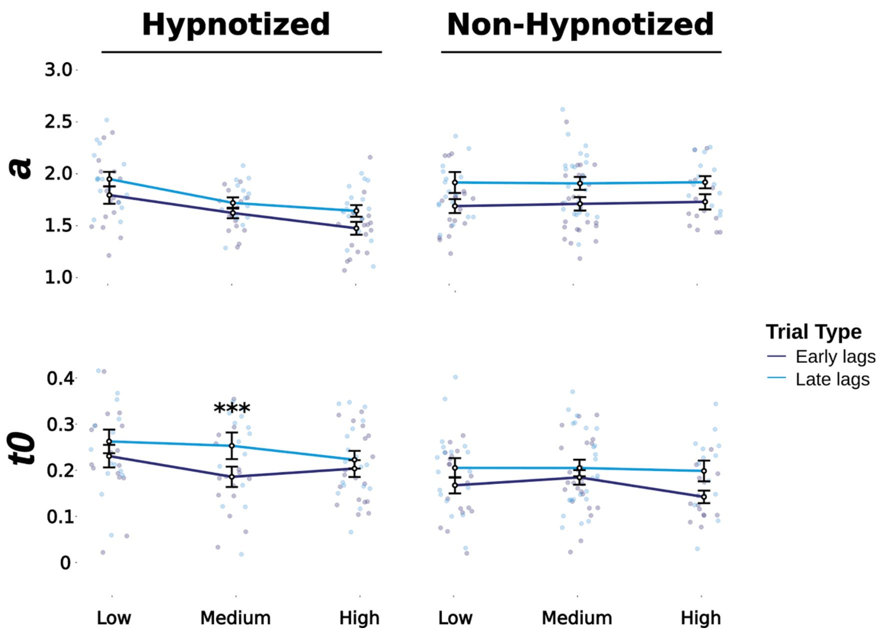

Fig. 4. Evolution of response bounds and non-decisional time in a drift diffusion model across hypnotizability. Error bars: Standard Error; post-hoc contrast p-values were Bonferroni-corrected; significance values *=p < 0.05, **=p < 0.01, ***=p < 0.001; dots represent participants' means.

Lags: 1 (−1, 4), Cohen's d = 0.13; Late Lags: 3 (−1, 6), d = 0.28), and Highs showed the largest difference (Early Lags: 7 (4, 10), d = 0.88; Late Lags: 2 (−1, 5), d = 0.01). A summary of post-hoc contrasts is presented on Table SM 2 in the Appendix A.

In sum, we observed that in the hypnotized group, accuracy differences between angry and neutral T2 Early Lag trials were large in Low hypnotizability participants, and non-significant in Highs. Crucially, the High participants that belonged to the control group presented an important significant accuracy difference for this same contrast. These findings confirmed that the numbing hypnotic suggestion had successfully attenuated the influence of ASE over the blink for participants highly susceptible to hypnosis.

3.3. Drift diffusion analysis

In order to better interpret the effects of the hypnotic procedure, we implemented a drift-diffusion decision model to analyze response time distributions through sequential sampling, for correct and incorrect trials. When inspecting response times prior to running the model, we found that regardless of target emotion and lag, hypnotized participants produced faster responses the higher their hypnotizability (median RT in *ms*, Lows = 806 (SD = 282), Mediums = 650 (207), Highs = 588 (177)). This was not the case for non-hypnotized participants (median RT in ms, Lows = 655 (206), Mediums = 773 (243), Highs = 672 (237)). See Table SM 3 in Appendix A for Response Time statistical modelling).

Drift-diffusion models of the kind we implemented (Ratcliff, 1978; Voss et al., 2004) present three main parameters: a is the threshold for decision, and thus an indicator of the response strategy. Generally, a lower a corresponds to a more liberal response, and higher a to a more conservative, cautious response strategy. The drift rate v is the rate of information accumulation, and thus essentially equivalent to the *d'* in Signal Detection Theory. The non-decision time *t0* represents all other psychological and physiological durations not pertaining to the decision at hand, including encoding and execution. Of these three parameters, a and *t0* were susceptible to interactions with Hypnotizability for participants who had been hypnotized.[4] As shown in Fig. 4, mean a decreased with the increase in hypnotizability for hypnotized participants, pointing to a direct correlation between hypnotizability and lower decisional thresholds, typically associated with cognitive control (mean a for Hypnotized Lows = 1.8 (SD = 0.3); Mediums = 1.8 (0.3), Highs = 1.8 (0.3); Non-Hypnotized Lows = 1.85 (0.3); Mediums = 1.63 (0.2), Highs = 1.47 (0.3)). On the other hand, *t0* was significantly larger for Medium Hypnotized participants during Late Lag trials (mean *t0* for Hypnotized participants during Early Lags = 0.19 (0.09), during Late Lags = 0.25 (0.11)).

We tested the statistical significance of this effect by modelling a, *t0* and v against the same predictors as the previous models. For the a parameter we observed a significant Hypnotizability × Hypnotized interaction ($\chi^2 = 6$, DF = 2, p = 0.04). By repeating the model

[4] As stated above, a (decisional threshold) and *t0* (non-decisional response time) were the only parameters that changed with hypnotizability for participants who were under the effect of hypnotic suggestion. However, changes linked to hypnotizability that are independent of hypnotic induction and suggestion cannot be attributed to the process of hypnosis (Terhune et al., 2017). For the full extent of interactions pertaining a, v and t0, please see Appendix A, Table SM 5).

for the hypnotized participants alone, we found a Hypnotizability main effect ($\chi^2 = 14$, DF = 2, p = 0.0009), which was not significant for the non-hypnotized participants ($\chi^2 = 0.04$, DF = 2, p = 1). For the *t0* parameter we observed a significant interaction Lag Category × Hypnotizability × Hypnotized ($\chi^2 = 14$, DF = 2, p = 0.0007). We observed that this effect was mainly driven by Hypnotized Mediums, who sported a *t0* difference between Early Lag and Late Lag trials ($\chi^2 = 29$, DF = 1, p < 0.0001; post-hoc contrast, Bonferroni-corrected). See Table SM 5 in Appendix A for a full summary of these effects.

3.4. Target-counting task

The secondary task (counting target faces amongst distractors) served the auxiliary purpose of ensuring that participants would sustain their attention throughout the entire RSVP, a condition necessary for the elicitation of the blink. We observed that accuracy scores for this task were similar for all hypnotizabilities, for hypnotized and non-hypnotized participants alike (percentage correct for Hypnotized: Highs 77%, Mediums 79%, Lows 77%; Non-Hypnotized: Highs 76%, Mediums 73%, Lows 78%; interaction Hypnotized × Hypnotizability $\chi^2 = 3$, DF = 2, p = 0.2). We also observed that including participants who had not properly counted both targets did not change the final pattern of results for the face-orientation task. The complete account of effects and interactions for this task can be found on Table SM 4 in Appendix A.

4. Discussion

4.1. The impact of hypnotic numbing under attentional blink constraints

The present work was developed to find out when along the decision processes hypnotic emotional numbing intervened, and how its effects depended on the time course of attention. First, we evaluated if we could identify an AB in Hypnotized and Non Hypnotized groups separately, and if so, whether the blink was affected by target affective salience. Second, we considered the different outputs produced by Low, Medium and High hypnotizability participants for each condition, as means of establishing the precise effect of hypnotic emotional numbing. We observed that hypnotic suggestion reduced the ASE for hypnotized High participants (as opposed to hypnotized Lows and non-hypnotized Highs), but only for the second target in the visual stream (T2). This finding suggests that hypnotic emotional numbing did not act in a "numb-all" ballistic fashion (as we could have expected from a rapid, early, automatic process), but rather, belatedly and in connection with late-stage processes incumbent upon T2.

The mechanisms behind the ASE remain a matter of discussion (Frischen et al., 2008). Several accounts consider it an automatic bottom-up process (Öhman, 2002; Öhman et al., 2001), but numerous studies have exposed its vulnerability to top-down effects (de Jong et al., 2010; Stein et al., 2010; Stein et al., 2009; Yao et al., 2014). Our results fall in line with this second trend, by showing that the ASE can be attenuated through top-down hypnotic modulation. This "numbing effect" was not just a global subjective phenomenon; rather, it was evidenced by performance changes in the execution of a task unrelated to the appraisal of facial emotion. Remarkably, Highs were permeable to hypnotic effects even though the suggestion content did not target task-relevant stimuli features. This entails that the hypnotic modulation of a global (emotional) state of mind can successfully propagate to lower-level appraisal mechanisms.

The potential reasons why T1 was spared by the hypnotic numbing suggestion are numerous and not exclusive. It is unclear whether the ASE results from a cognitive emotional appraisal process, a purely perceptual bias favoring emotional facial features, or a combination of both (Frischen et al., 2008; Mermillod et al., 2009). Since the processing dynamics of T1 and T2 differed in terms of task execution and temporal attention constraints, maybe the low-level *perceptual* and high-level *appraisal* components of the ASE contributed differently to targets' salience. At each trial, participants had to scan every stimulus in the visual stream to count the targets and then indicate the inclination orientation for the last perceived target. Namely, after spotting T1, participants had to count it as one target, evaluate its inclination, commit the information to memory and switch their focus towards the subsequent stimulus. In contrast, T2's late processing was unconstrained, and led directly to response preparation (Lagroix et al., 2018; Marti et al., 2011). Because of these differences, it is possible that T2's ASE relied more on high-order affective appraisal, while T1's hinged mainly on low-level perceptual advantage. If hypnosis propagated down to the affective appraisal level, but no further, this would explain the sparing of T1 emotional salience.

Trials constrained by the AB often exhibit identical sensory processing as unencumbered trials, but delayed (or even absent) frontal cortex activation (Marti et al., 2011). This AB effect on attention-specific downstream frontal functions would be coherent with an effect on response preparation. If hypnotic suggestion effects were restricted to a time *after* encoding, *i. e.* to the response preparation stage (Sigman & Dehaene, 2005), then less-constrained lags where response preparation was less disturbed would necessarily be more affected by it. Our results confirm this premise: hypnotized Mediums and Highs displayed smaller performance differences for later lags.

Our diffusion model findings also strengthen the case for hypnotic effects being tied to response processes. Changes in response thresholds that do not harm performance can be associated with optimality-driven control strategies (Bogacz et al., 2006). Of the three main parameters of the model, "*a*" is the only one associated directly to the development of response strategies (Voss et al., 2004). Here, in hypnotized participants "*a*" decreased as hypnotizability rose, and as performance differences decreased. This idea of "hypnotic suggestion-driven" control strategies intervening with response processes is consistent with theories situating hypnotic effects within the range of response processes (Augustinova & Ferrand, 2012; Parris, 2014). Neuroimaging research contributes to this conclusion as well, implicating the dorsolateral prefrontal and anterior cingulate cortices as recurrent participants of multimodal hypnotic responding (Jiang et al., 2016; Landry & Raz, 2015). Incidentally, ERPs elicited by visual stimuli while under a hypnotic blindness suggestion have also been shown to conserve their integrity for early subcomponents (N1, P2), but degrade and reduce in amplitude up to 37% for late subcomponents (P3b) (Schmidt et al., 2017). In this same vein, suggestions for hypnotic safety and protection from menace have recently been shown to reduce stimulus processing preferentially for later processing stages (Schmidt et al., 2020).

While our results clearly portray a late effect, they do not necessarily rule out the potential impact of hypnotic numbing on early components through proactive control processes (Braver, 2012; Braver et al., 2009). In our experiment, the suggestion asked participants not to react to facial emotions, instead of asking them not to perceive facial emotional content (*i.e.* to experience some form of hypnotic emotion prosopagnosia). It is possible then that because of this specific semantic nuance, our suggestion ended targeting late cognitive processes exclusively, rather than de-automatizing existing trigger-response contingencies. Further research exploring the role of different wording and proactive control in hypnotic emotional numbing would be necessary to conclusively support this alternate view. This could indeed prove a promising research venue, as a series of recent studies have shown that posthypnotic suggestion can effectively modulate proactive control mechanisms (Parris et al., 2021; Zahedi et al., 2019; Zahedi et al., 2017; Zahedi et al., 2020).

An additional finding, albeit unexpected, was related to the salience of T2 outside hypnotic suggestion. Within the control group, Highs exhibited a large ASE at early lags while Lows presented a very small one. Previous research has shown that the impact of emotional salience on performance depends largely on whether emotion belongs in the attentional task-set (Stein et al., 2010). Thus, it is possible for these results to be indicating attentional task-set differences between hypnotized and non-hypnotized participants, produced by the implementation of the hypnotic suggestion (given that otherwise, instructions and tasks were the same for both groups).

In our paradigm, the emotional valence of targets was task-irrelevant by design: instructions were delivered without alluding to targets' facial expressions, and training was conducted on an "all-neutral-faces" version of the paradigm. By construction, participants never heard any reference to emotion. Our motivation behind this was simply to prevent the potential effects of demand characteristics unrelated to hypnosis. However, it was possible that our hypnotic numbing suggestion may have had the "instruction-like" effect of updating the attentional task-set by introducing target emotion into task context. Our results could then be explained as hypnotized participants responding through an updated task-set, producing responses that depended on hypnotizability. Possibly, Lows ignored T2 emotional features when not hypnotized, but found themselves under their influence after hypnotic suggestion introduced them into the task set. Highs found themselves in the same situation, but produced the opposite response because of their permeability to the suggestion's effects. By the same token, in the control condition, their increased susceptibility could have rendered them unable to ignore emotional salience, despite it being task-irrelevant (a lack in cognitive control consistent with previous findings; see Cardeña and Terhune, 2014). These theoretical conclusions would require further validation; here, we simply suggest that while hypnotizability as a personality trait is yet not fully understood (Cardeña and Terhune, 2014; Terhune et al., 2017), Highs could be more inclined to engage in the appraisal of facial emotion as a social suggestion regardless of relevance (Colloca & Benedetti, 2009; Wickramasekera & Szlyk, 2003).

5. Perspectives and limitations

The advantages of the EAB were unique for answering our experimental question, both for its emotional nature (compatible with hypnotic numbing) and its temporal qualities (which allowed for distinguishing between early and late processing). To be able to exploit such a paradigm and combine it with hypnosis, we sought to lessen the impact of demand characteristics (but see Lynn et al., 2019). In our view, this required a design in which the features targeted by the hypnotic suggestion and the features relevant for the main task remained different, and for participants' own hypotheses regarding our experiment to be kept to a minimum. Hence, we opted for a design where being hypnotized would be a between-participant factor, and where targets' affective value would remain task-irrelevant (Greenwald, 1976). However, it is important to underscore that this too has come at a cost, as between-participant designs can induce potentially atypical effects between groups, and particularly so in hypnosis research, where large sample sizes are hard to secure. Further, we acknowledge that such a design could be potentially detrimental and incomplete if, as Lynn et al. (2019), Lynn et al. (2015) and others suggest, unconscious compliance with the hypnotists' expectations is the underlying driver of suggestion effects. Considering how many recent pivotal hypnosis studies have been successfully implemented under within-participant designs, we posit that a replication of the present work under such conditions would be of great scientific interest and an excellent contribution to the question at hand.

We also need to underscore the fact that our design combined two different types of EAB effects, one where T1 increased the blink and affected performance negatively, and another one where T2 decreased the blink and affected performance positively. This allowed us to contrast the effects of our numbing suggestion at the different levels of attentional constrain that the AB fosters for each of its targets. Certainly, this goal could have been achieved by running two different experiments: one focusing on T1 and another one focusing on T2. However, given the known difficulties in recruiting large samples of hypnotized and non-hypnotized participants representative of the entire hypnotizability spectrum, we decided instead to implement multifactorial linear mixed-effect models, since our statistical power enabled us to observe these two effects separately. We understand that this technique is fairly innovative, but one of the key advantages of this type of statistical modelling techniques is the ability to identify and dissociate effects across levels and factors (Bolker et al., 2008; Pinheiro & Bates, 2000).

Concerning sample sizes, we had to make sure that we would pre-screen enough participants to allow for the recruitment of the minimum necessary number of Highs, Mediums and Lows determined in our simulations. Knowing beforehand that very few of the pre-screened participants would accept to take part in the main experiment, our strategy was to invite all pre-screened volunteers (421 finished the screening, 105 participated in the main experiment). As a result, the exact number of participants per condition we ended up with did not exactly match the minimal sample specified in the power analysis simulations, but crucially, was not inferior to it. Surpassing this number was not a problem however, because we did not incur in optional stopping. Further, in simulation-based power analysis for mixed models, pre-specified sample sizes are not entirely prescriptive. Rather, establishing an a-priori sample size only serves the purpose of determining the necessary sample size for comparing null and full models with at least the desired level of power (in the present study, 80% for alpha = 0.05). This is because the process always starts by determining the models in a hypothesis-driven fashion, so as to fit synthetic and observed data to the same model. Like so, as shown in figure SM 1 in Appendix A, increasing the sample size beyond the required n only had the effect of increasing power.

A final point needs to be made concerning sizes of effects. The effects that we reported for the Hypnotized condition were in line with those found in other previous face-based EAB paradigms such as de Jong et al., 2010 and de Jong & Martens, 2007. For non-hypnotized participants, on the other hand, we found ASEs that were statistically robust, but of relatively small magnitude. An important difference that separates our work from the vast majority of ASE research, such de Jong et al work, is that the latter is based on tasks where emotion is task-relevant (such as emotion identification and so on). In our paradigm, targets' affective values remained task-irrelevant by design. The literature on task-irrelevant emotional salience is not abundant, but Stein et al. (2009) have found that when the emotional expression of face stimuli had to be indicated, fearful faces induced a stronger AB than neutral faces. On the other hand, with identical physical stimulation, but asking participants to judge faces' gender instead, they reported that enhancement of the AB by fearful faces was diminished substantially. In light of this precedent, it is less surprising that the (statistically robust) ASE displayed by non-hypnotized participants in our experiment would be small in size. The noteworthy fact here in our view is that the ASE values for the hypnotized condition were on par with those from experiments where emotion was task-relevant. We interpret this as evidence that hypnotic suggestion had the property of "pushing" emotional value into the attentional task-set, even when, just like with Stein et al., 2009, the task itself did not depend on it in the slightest.

Despite these caveats and limitations, we posit that taken together our results argue for interpreting hypnotic effects in terms of response preparation, conditional to the availability of temporal attention (as opposed to early de-automatization). Furthermore, our results portray hypnotic response as the result of a two-tier process. We propose that hypnotic suggestion first catalyzes an alteration of the task-set for participants of all hypnotizabilities; then, depending on their hypnotizability and provided there is enough time to displace attention, participants may enact the actual content of the suggestion, producing a hypnotic response. This model would be compatible with predominating views of hypnosis as top-down control (Terhune et al., 2017), and help disentangle hypnotic responding from the attentional non-hypnotic effects of hypnosis.

CRediT authorship contribution statement

Hernán Anlló: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Validation, Visualization, Writing - original draft, Writing - review & editing. **Joshua Hagège:** Investigation, Data Curation, Methodology, Resources. **Jérôme Sackur:** Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Validation, Visualization, Writing - original draft, Writing - review & editing.

Declaration of Competing Interest

The authors hereby declare no conflict of interest.

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Data availability

Data is licensed for non-commercial use only, and has been made available for download at the OSF repository of the project https://osf.io/md46f/?view_only=2264b3a032bc44358a643bb4e45fc0aa. Please address any questions to hernan.anllo@cri-paris.org.

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Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.concog.2021.103118.

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