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Conscious access to fear-relevant information is mediated by threshold

The present report proposed a model of access consciousness to fear-relevant information according to which there is a threshold for emotional perception beyond that the subject makes hits with no false alarm. The model was examined by having the participants performed a confidence-ratings masking task with fearful faces. Measures of the thresholds for conscious access were taken by looking at the receiver operating characteristics (ROC) curves generated from a three-state low- and high-threshold (3-LHT) model by Krantz. Indeed, the analysis of the masking data revealed that the ROCs had threshold-like-nature (a two-limb shape) rather continuous (a curvilinear shape) challenging in this fashion the classical signal-detection view on perceptual processing. Moreover, the threshold ROC curve exhibited the specific y-intercepts relevant to conscious access performance. The study suggests that the threshold can be an intrinsic property of conscious access, mediating emotional contents between perceptual states and consciousness.

Keywords: *consciousness, access, threshold model, fear*

Introduction

A common view on the intersection of consciousness and emotion is that consciousness creates access to somatosensory representation of the body state with its underlying emotional and motivational processes, including feelings of distress or pleasure (Baars, 1998; Tsuchiya & Adolphs, 2007). Thus, the emotional contents implied by somatosensory representations, that we are conscious of, can be further elaborated into their phenomenal aspects and the basis for knowing and reporting (Tsuchiya & Adolphs, 2007). Yet, the content of emotional experience is consciously reportable, but the emotional processing triggered by conscious events remains in a large extent autonomous, and unconscious (Baars, 1998). Evidence of this claim is provided by cognitive concepts explaining mediators between the occurrence a fear-eliciting stimulus and conscious response. For instance, a fear module with its behavioral and psychophysiological components, evolutionarily tailored to defend against predators and threats, is known to be impenetrable to conscious influences (Öhman, & Mineka, 2001). However, there are influences in other direction, because the fear module itself can affect consciousness by biasing and distorting its content (Öhman, and Mineka, 2001). Thus, the important question is what are agents that have capability of mediating emotion into access consciousness.

Masking studies by Deheane and colleagues (2006, 2008) provide conclusive evidence that consciousness can operate in a threshold-dependent fashion, and conscious reporting needs some kind of the ignition level to be exceeded. In other words, conscious access is associated with crossing a threshold for global ignition at which contents can be maintained online and used for higher-level executive processes (Dehaene, 2008). A masking paradigm with faces offers a suitable perspective on measuring thresholds for conscious detection of facial emotional expressions (Esteves & Öhman, 1993; Merikle, Smilek, & Eastwood, 2001). For instance, Szczepanowski and Pessoa (2007) have demonstrated that consciousness seems to be needed to access even very rapidly presented and masked fearful faces, lasting for 17 ms. Within the masking paradigm, limits of access consciousness can be established by having participants presented with minimal visible stimuli conditions. In particular, in a forced-choice masking task with fearful faces conscious access can be manipulated by degrading visibility of targets and stimulus strength can be varied by the mask and time duration. The subject views a target face that is fearful or non-fearful followed by a mask, and then is instructed to report the

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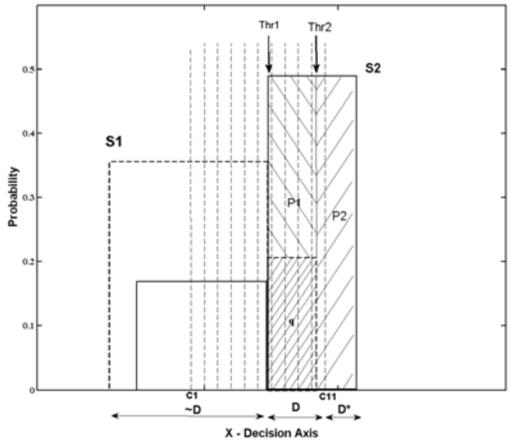
level of confidence of her "yes" and "no" responses. Until a low-detection threshold, performance in the forced-choice task is at chance and subject fails to detect presence vs. absence of the fearful target. As facial affective information improves, more aspects of emotional percepts become visible, and subject can detect alternative stimulus states. Despite the fact that fear-relevant information is accessible, its content is partially processed, because there is no systematic reporting of seeing fearful targets with highest confidence. This clearly corresponds to the findings on subliminal semantic processing by Kouider and Dupoux (2004) who proposed several levels of awareness, and apparently partial awareness is associated with unconscious states where the participant can perceive a few letters of the prime but not the entire prime. Thus, emotional content of the face could gain access to consciousness, for instance with more attentional resources, but they are not consciously accessed at the moment (Dehaene et al., 2006). In other words, although response strength results in higher confidence, the information is still retrieved with "some" cognitive effort reflecting performance in which contents are processed unconsciously. Above the high-threshold, fearful targets can be consciously accessed and denoted with highest-confidence judgments. In this conscious access state, the fear-relevant information can be considered as conscious since emotional content is assumed as granted in subjective reports.

How to make observer thresholds for conscious processing measurable? One can use a threshold theory that allows an indirect measure of the observer thresholds via the analysis of the variability of confidence responses. The threshold model posits that decision space underlying perception has „all-or-none" (discrete) property that are observer's thresholds (Krantz, 1969; Luce, 1963; Macmillan & Creelman, 2005). These thresholds are dividing boundaries in decision space between internal states, and are not correlated with the presence or absence of the signal. Figure 1 presents observer's decision space in a hypothetical fear detection task according to a three-state low-and high-threshold (3-LHT) model by Krantz (1969). On each trial of the fear detection task, one of two classes of emotional stimuli (fearful or non-fearful targets, i.e., signal-pluse-noise or noise) are presented and the participant makes „yes" or „no" responses followed by confidence ratings. The subject can enter internal detection state D whenever she has a perceptual basis for judgments about fearful targets, while she goes into a non-detection state ~D when judgments about the target are no different whether fear was present or absent. The 3-LHT model implies also third supra-state D* apart from states D and ~ D which is important for access consciousness. This is beyond the boundary where two distributions no longer overlap. The supra-state has been therefore qualitatively different from other states of the model, and seems to be a gateway to conscious knowledge of the emotional target. Particularly, when the participant goes into supra-state D*, she is certain that a fearful target was perceived by making highest confidence hits with no highest false alarm. Apparently, the longer fearful face exposure more frequent supra-state present, and more fearful targets become consciously accessed. Given these potential predictions, the 3-LHT model seems to be a good candidate for establishing measurable conditions for conscious performance.

Figure 1. Decision space consistent with the 3-LHT threshold model by Krantz. S1 and S2 rectangular distributions correspond to non-targets and targets, respectively. Emotional perception is associated with three internal states (D, ~D, D*) that are separated by the low-(Thr1) and high-threshold (Thr2). The high-threshold is a boundary between states *D and D, while the low-threshold is defined as a boundary between states D and ~D. When the subject enters supra-state D*, she or he is certain that a fearful target was perceived by making highest confidence hits with no highest false alarm. In this state, the fear-relevant information is considered as consciously accessed.



The main goal of this report was to examine whether the threshold model was able to account for conscious access to emotional information. The model posited that (i) emotional perception strength underlying observer's decision space would be supported by the discrete dimension (multiplicity of thresholds), and (ii) emotion-laden information would be consciously accessed when the emotional input was capable to cross the high threshold. To investigate whether conscious performance was discrete or continuous, an analysis of receiver operating characteristics (ROC) was employed (Krantz, 1969; Macmillan & Creelman, 2005). The ROC analysis helped distinguish between these two models of perception by inspecting two different shapes of the ROC curves (Slotnick & Dodson, 2005). In particular, it was hypothesized that when observer's performance was better described by a linear ROC, there would be evidence that emotional perception occurs in the discrete fashion. Whereas a curvilinear shape of the ROC would tell us that perception strength varies along the continuous dimension as the classical signal-detection theory implicates. Moreover, the threshold ROCs for conscious access performance would be expected to have the specific intercepts along the y-axis due to highest confidence hits with no highest confidence false alarm.

Experiment

To probe thresholds for conscious access, subliminal vision technique was used where participants were supposed to detect briefly presented and masked fearful faces. In particular, the present study replicated, with slight modification, a backward masking with confidence ratings by Szczepanowski and Pessoa (2007). The experiment employed a 2 x 3 factorial design, providing the subjects with briefly presented target-mask pairs (fearful-neutral or neutral-neutral) at three degraded visibilities (25, 33 and 41 ms).

Method

Participants

Fifteen undergraduate students (13 females) of Warsaw School of Social Sciences and Humanities, Faculty in Wroclaw, participated in this study in exchange for course credit. Their age ranged from 19 to 25 years, with an average of 22.3 years. All participants performed the study with the right-hand. All but one participant were right-handed. The left-handed participant chose the right hand to perform the task. The research was approved by Ethics Committee of the Warsaw School of Social Sciences and Humanities. The consented participants had normal or corrected-to-normal vision. Datasets from three subjects were removed, because of failure to use the whole range of confidence ratings (two subjects), and due to unacceptably high error rates (one subject).

Stimuli and Apparatus

Face stimuli were obtained from the Ekman set (Ekman & Friesen, 1976), a second set elaborated by Öhman and colleagues (KDEF, Lundqvist, D., Flykt. A., and Öhman, A.;Karolinska Hospital, Stockholm, Sweden) and a third set provided by Alumit Ishai at NIMH (Bethesda, USA). Faces were presented on an Iiyama MA203DT Vision Master Pro 513 monitor with a refresh rate of 120 Hz. A viewing distance was of about 60 cm. The experiment was performed in a dim light condition. The subjects were seated at the front of the monitor, and their heads were fixed by a chin rest. As emotional targets 40 of fearful, and 40 of neutral faces that were employed, and additional 80 neutral faces used as masks. To prevent the "detection" of fear based on subtle motion cues from the transition between fearful and non-fearful faces, mask stimuli were randomly displaced so as to not perfectly overlap the target face. Specifically, on approximately half of the trials (chosen randomly), the mask stimulus was shifted along one of the four diagonal directions by a small spatial offset of ~0.5° of visual angle (Phillips et al., 2004).

Procedure

Each trial started with a white fixation cross that was displayed for 300 ms on a black screen, followed by a 50 ms blank screen, followed by a fearful or neutral item, which was immediately followed by a neutral face which was a mask. The identities of faces in successive trials were always different as well as the identities of the target face or the mask in a given trial. Viewed faces subtended 4 x 5° of visual angle. To degrade visibility of targets, a range of subliminal time exposures was employed such as 25, 33, and 41 ms (Szczepanowski & Pessoa, 2007). The total duration of the target-mask pair was fixed at 100 ms. After the presentation of each target-mask pair, subjects had 2 s to indicate "fear" or "no fear" via the button press on the numerical keyboard, and then had 2.5 s to rate the confidence in their response using a scale of 1 to 6 (from low to high confidence). The subjects were told to respond by pressing '6' when they were highly certain that they could consciously access having seen the item. Since the study followed a 2 x 3 design, 160 target-mask pairs (fearful-neutral, and neutral-neutral) were assigned per one target duration. Overall, the subjects performed 480 trials in total shown in a random order. Participants did not receive any feedback on their performance as well as about the information about time exposures and trial types. The experiment lasted up to 1 hour and 15 minutes.

Threshold model

A threshold model by Krantz (1969) was employed to generate a threshold ROC curve. Under the 3-LHT model, there is third supra state D* apart from states D and ~ D, and there are low- and high-thresholds separating these states. The high-threshold is a boundary between states *D and D, while the low-threshold is defined as a boundary between states D and ~D. The 3-LHT model with all underlying conditional probabilities is summarized in Table 1. The parameters P1 and P2 are functions of the signal strength of targets (fearful faces), while the parameter q is a relevant function for non-targets (neutral faces). The P1 is the probability that a target generates state D, while the probability P2 that only a target generates state D*. The parameter P0 equals to 1 – (P1+P2) and indicates that non-zero signals are processed below the low-threshold. The signal parameter q represents the true probability that a non-target passes the near-threshold into state D. The threshold ROC curve, shown in Fig.2, consists of two characteristic limbs: the bottom one from (0, P2) to (q, P1 + P2), and the upper one from (q, P1 + P2) to (1,1). The point (0, P2) on the lower limb accounts for true false-alarm rate of zero indicating the presence of state D*. Under the masking condition, the probability P2 should indicate that fearful targets are visible in the extent to which they can be consciously accessed. Therefore, the subject who is in access conscious state should have a

Figure 2. The threshold ROC curve predicted by the three-state model. The point (0, P2) on the y-axis, where the lower limb originates, accounts for conscious access. The limb's intersection is the point formed by the pair of false alarm q and the sum of the hits rate P1 and P2.

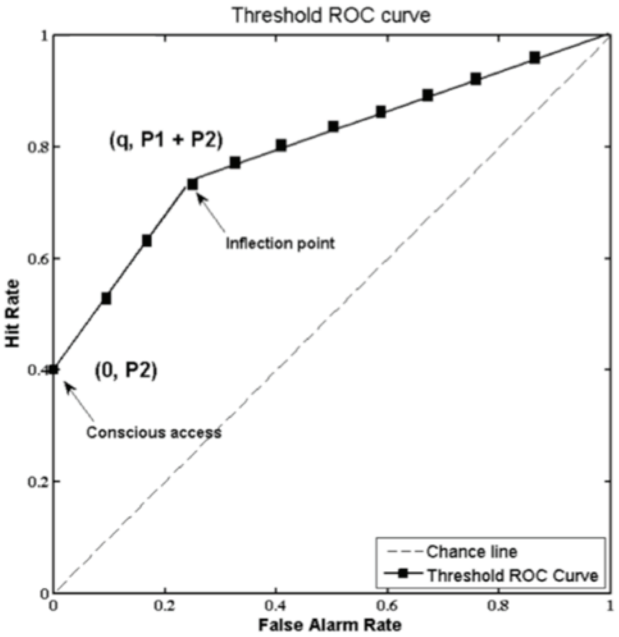


Table 1
Signal parameters for the 3 –LHT model.

	D~	D	D*
Noise (N)	1-q	q	0
Signal plus Noise (SN)	P0	P1	P2

specific threshold ROC arrangement with the y-intercepts of point (0,P2). That is the participant is highly certain that targets were present by using highest confidence hits and making no highest false alarms to acknowledge conscious access of fear. One may also expect the longer fearful target presentation results the higher probability of P2 because of more frequent conscious access across ongoing trials.

Fitting threshold and signal-detection ROCs

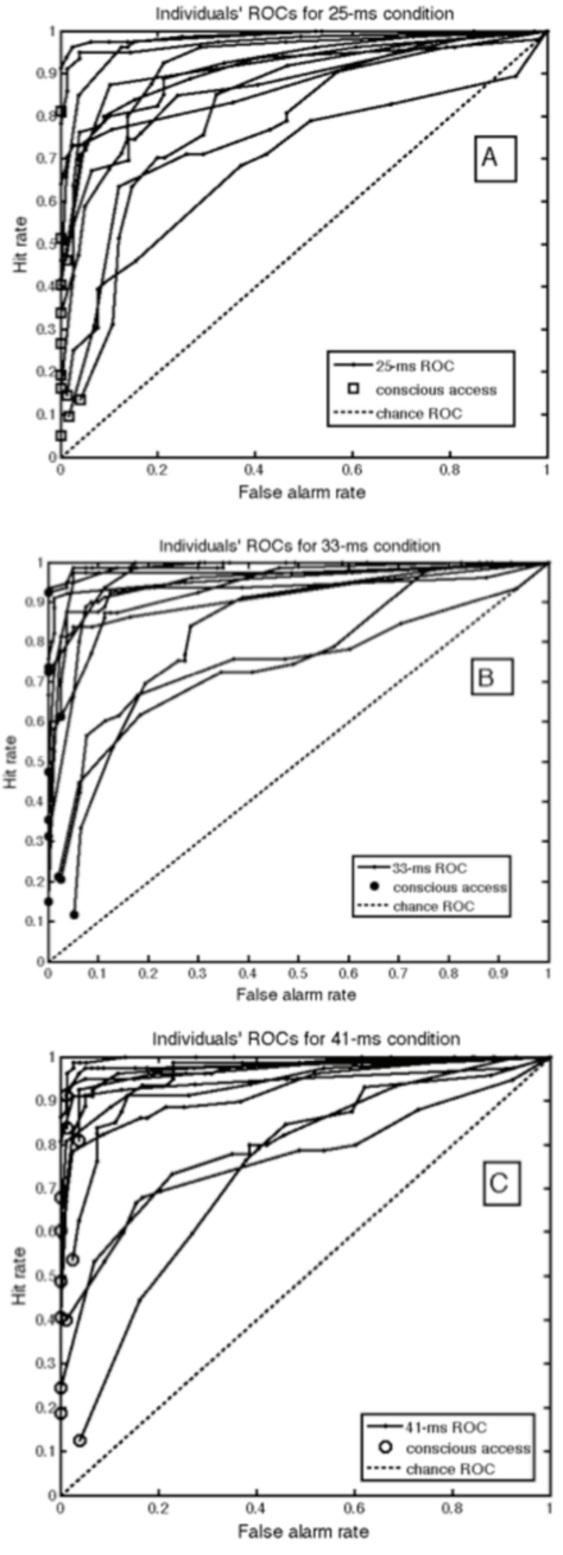
For each target duration, the individual 11-points behavioral ROCs were generated by computing pairs of the cumulative probabilities at subsequent confidence levels, corresponding to hit and false alarm rates for (Macmillan & Creelman, 2005). The cumulative data were the sums of proportions over confidence ratings, ranging in order from high confidence for fearful targets to high confidence in non-fearful targets. An error-minimization procedure used a least-square Levenberg-Marquardt algorithm (Press et al., 1988) to find the best-fitting threshold ROC to each dataset. To provide comparative fits with the threshold ROCs' prediction, a signal-detection model with normal-unequal variance (a "null model") was employed. This Gaussian model enables to plot asymmetrical ROC curves (Green and Swets, 1966; Macmillan and Creelman, 2005). The signal-detection ROCs were computed by establishing the slope *s* of the ROC in the z-coordinates and the index of sensitivity, measured by taking the horizontal distance from the z-ROC to the major diagonal at the point where z(H)=0 (Macmillan & Creelman, 2005). The best-fitting signal-detection ROCs were obtained also with the least-square algorithm. Coefficients of determination (R^2) were used to measure a goodness of the model fits to the data.

Results and Discussion

The individual behavioral ROC curves were generated for each target duration as shown in Fig.3. A visual inspection of the plots revealed that the behavioral ROCs clearly exhibited the y-intercepts indicating a subjects' tendency to make hits without false alarms at the highest confidence level. The examination of the individual's ROC data revealed that many datasets complied with ideal observer's performance or datasets included only one highest false alarm. For 25-ms targets (Fig.3A), there were eight datasets with no false alarm and three datasets with pairs of hits accompanied by one false alarm (11 of 12 cases, binomial test, $p<.01$). There were eight datasets for 33-ms targets (see Fig.3B) with no conscious false alarm and one dataset pair of one false alarm (9 of 12 cases, binomial test, $p<.05$). For the 41-ms condition (see Fig.3C), the behavioral ROCs performance indicated six datasets with no conscious false alarms, and three ones with one false alarm (9 of 12 cases, binomial test, $p<.05$). Indeed, this pattern of behavioral ROCs could be suggestive that participants could gain conscious access to the fearful targets and they did not produce many false alarms at the highest confidence level.

The behavioral ROCs' data was then fit with the threshold and signal-detection models. Data from two representative individuals (the Subject 4 and 10) are shown in Fig.4. As can be seen, the 3-LHT predicted the behavioral ROCs surprisingly well (Fig.4A, 4C); for all time durations the threshold ROCs' points were adjacent to the observed ROC data including nearly the observed inflection points. Moreover, lower and upper limbs tended to adjoin the monotonic course of the observed ROC very closely. In addition, the lower limbs clearly exhibited the y-intercepts indicating the presence of conscious access state. The signal-detection fits (Fig.4B, 4D) exhibited distinct departures from the observed ROCs as time duration increased. A detailed comparison from fitting both models to all individuals' data is given in Table 2 suggesting that the majority of the subjects exhibited patterns of ROC performance towards threshold prediction. The statistical comparisons of the R^2 differences between both models with a non-parametric Friedman's test were shown to be

Figure 3. The observed ROC curves for all target durations generated by computing pairs of the cumulative probabilities at subsequent confidence ratings for 25-ms (A), 33-ms (B), and 41-ms conditions (C). The observed ROCs exhibit the y-intercepts, as marked by the originating points, indicating the participants' tendency to make "conscious" hits without false alarms.



nonsignificant across all target durations, $\chi^2(2)=0.667$, indicating that the threshold model provided better fits. The comparison of average R^2 coefficients, taken as a mean from column cells also indicated that prediction by the threshold ROCs was superior over the signal-detection ROCs. In particular, the paired t-tests ($p<.05$) indicated that for the 25-ms threshold ROCs, the mean coefficient of determination R^2 was 0.90 and was higher than this taken from the signal-detection model, $R^2=0.83$, $t(11)=2.6$. Similarly, the comparison of the mean R^2 values for the 33-ms targets resulted in significant differences between models in favor of the 3-LHT, $t(11)=3.95$; the value of R^2 for the threshold ROCs was 0.90 and for the signal-detection ROCs was 0.72. The same results were obtained for the 41-ms condition, because the R^2 value of 0.91 for the threshold ROC was higher than the R^2 for the signal-detection ROC that was 0.79, $t(11)=2.26$. Therefore, in case of individual's data, there was clear evidence that emotional perception was more often discrete than continuous process.

To examine the effects of target duration on access consciousness, the P2 estimates were submitted into the repeated measures ANOVA with a Greenhouse-Geisser correction. The ANOVA indicated that there was the significant overall effect of the time duration on conscious access, $F(1.8,41.2)=9.94$, $MSE=.01$. A plot of the mean estimate of conscious access as a function of the target duration is shown in Fig.5. Moreover, the ANOVA indicated that there was a significant linear in the slope for the estimate, $F(1,11)=14.84$, $MSE=.01$. Taken together, these results suggested that there was more frequent conscious access present across ongoing trials as target exposure increased. It must be mentioned that the threshold ROC measure implies the ideal conscious observer whose performance at the highest confidence is associated with non-zero hits but zero false alarms. However, one can imagine a situation in which the participant might have consciously detected non-fearful targets as fearful targets. The examination of the individual's datasets revealed that the ratio of false alarms was on average quite low across all time durations. In particular, for 25-ms targets the false alarm ratio at the highest confidence was 0.6%, for 33-ms targets the highest false alarm ratio was 0.8%, and the false alarm ratio for the 41-ms condition yielded 1.0%. To make sure that the measurable highest false-alarms for the highest hits had no impact on conscious performance, it was needed to test empirically whether or not the model estimates (P1, P2 and q) could be affected by cancelation of "conscious" false alarms from the signal-response table. To do so, the old model estimates for all responses and the new model estimates for the responses table with no "conscious" false alarms were submitted into the repeated measures ANOVA with two within-subjects factors (model parameters, and a time duration) and one between-subjects factor (consciousness for false alarms). The violation of

Table 2
Comparison of coefficients of determination R² for 3-LHT and SDT models

Subject	R^2(25 ms)		R^2(33ms)		R^2(41ms)	
	3-LHT	SDT	3-LHT	SDT	3-LHT	SDT
S1	0.789*	0.64	0.56	0.636**	0.621*	0.551
S2	0.946*	0.933	0.957*	0.952	0.985*	0.979
S3	0.962*	0.805	0.947*	0.659	0.858	0.918**
S4	0.947*	0.862	0.995*	0.564	0.988*	0.69
S5	0.742*	0.73	0.784*	0.53	0.868*	0.765
S6	0.948*	0.786	0.917*	0.845	0.974	0.975**
S7	0.974*	0.716	0.93*	0.777	0.971*	0.857
S8	0.977*	0.973	0.989*	0.88	0.994*	0.973
S9	0.929	0.962**	0.979*	0.579	0.677	0.749**
S10	0.825	0.86**	0.997*	0.691	0.976*	0.578
S11	0.986*	0.928	0.966*	0.947	0.97*	0.935
S12	0.775*	0.769	0.817*	0.558	0.99*	0.548

* winning 3-LHT instances
** winning signal-detection (SDT) instances

Figure 4. The ROCs from two representative individuals predicted by the threshold three-state model (A, C) and the unequal-variance Gaussian model (B, D). The lower limbs of the threshold ROCs originate from the point (0, P2) indicating access conscious state D*.

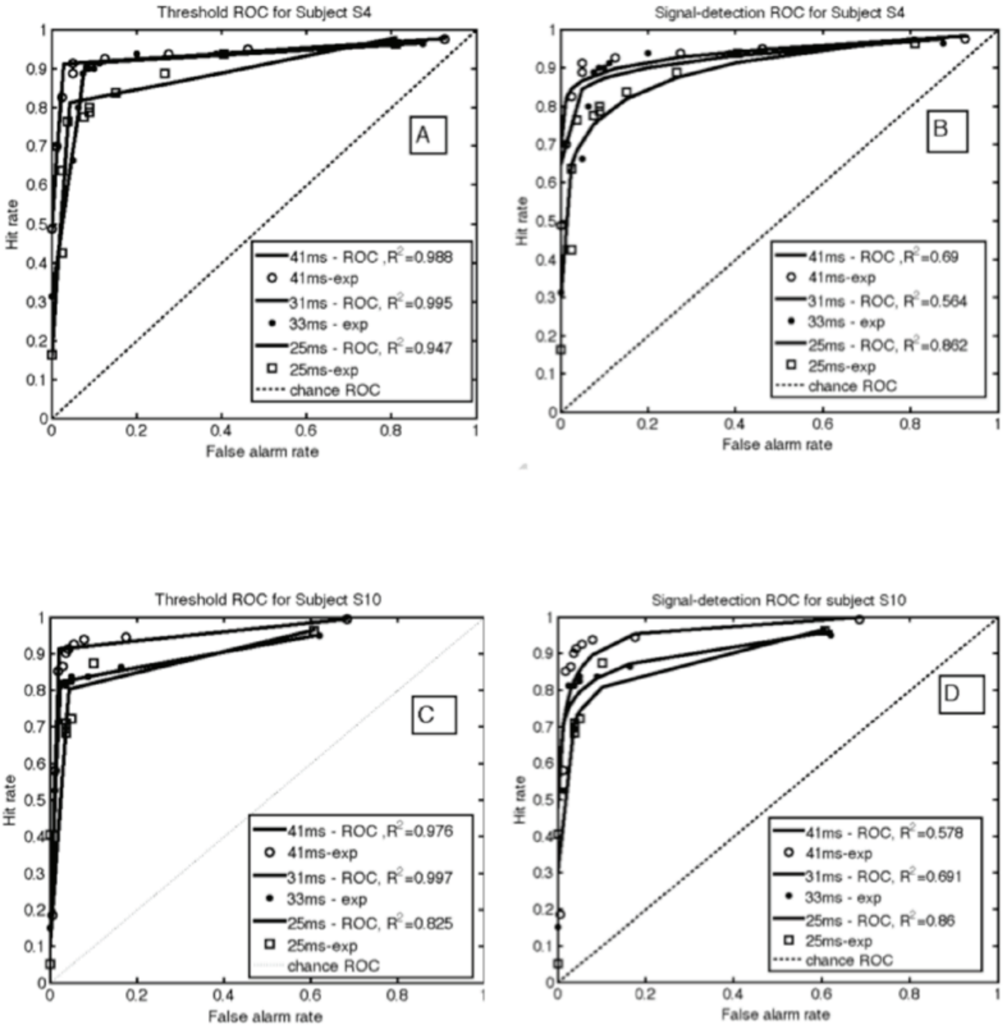
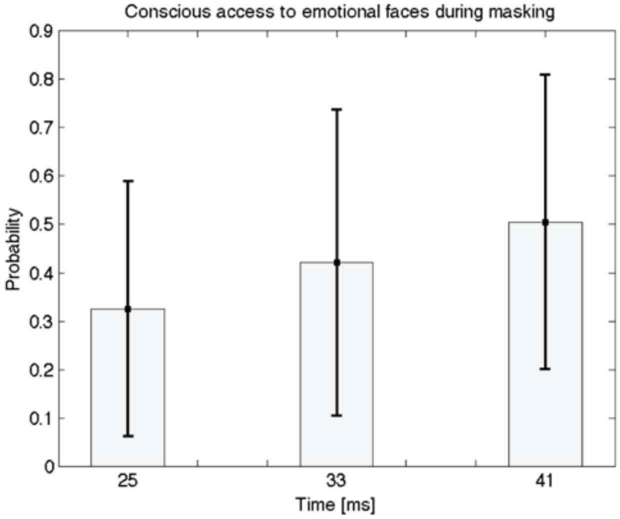


Figure 5. Conscious access to emotional faces during the masking predicted by the 3-LHT model. Note that the estimate of conscious access as a function of the target durations increases.



the sphericity assumption was accommodated with the Greenhouse-Geisser correction. The ANOVA indicated that there was no significant three-way interaction between factors, Fs < 1, as well as no significant two-way interaction, Fs < 1, between the model parameters and consciousness of false alarms indicating that the false alarms at the highest confidence had no impact on conscious performance.

General discussion

The present report examined access consciousness by evaluating threshold vision for briefly presented fearful targets under the masking condition. The model of conscious access performance posited that there is the threshold for emotional perception beyond which stimulation is strong enough for participant to make highest confidence hits without any false alarms. It was shown that the individual behavioral ROCs for all target durations exhibited the specific y-intercepts relevant to conscious access state. The masking ROC data were then fit by the three-state threshold theory, where the highest state of the model was identified with conscious access. The study provided clear evidence that the threshold theory enabled the successful ROC measure of conscious access performance. The behavioral ROCs were better described by the linear shape (the two-limbs curve) than the curvilinear ROC predicted by the signal-detection theory. Moreover, the threshold ROCs showed that the visibility of emotional targets was positively associated with conscious access across the ongoing trials as initially hypothesized.

The study provides strong computational arguments that the threshold model can be a reliable nonparametric measure of emotional perception. Although there is a variety of literature devoted to threshold theories and the ROC analysis, there is a little or none data support given to this subject. This study provides a reliable experimental verification of the threshold model based on the masking data. The two-limb curves handled the behavioral ROCs fairly well, and the individual best-fitting threshold ROCs yielded fits to the experimental data up to the R^2 value of 0.99. The curvilinear ROCs predicted by the unequal-variance Gaussian model were unable to fit the behavioral ROC data in many cases. Thus, when the normality for signal and noise distributions is potentially violated by highest confidence hits, the two-limbs ROC can be an alternative for modeling detection designs with confidence ratings.

Of major implications of the model of conscious access is that the emotion-laden information can be mediated by the threshold in order to be accessible to consciousness. The threshold model suggests that such threshold is a sort of an integral mechanism of conscious access that helps shifting emotional contents between perceptual states and consciousness. The threshold model distinguishes unconscious from conscious states by showing that unconscious perceptual states may be assigned to perceptual states that yet are not accessed by participants. This is situation where the emotion-laden information is still processed but the threshold for conscious access is turned off. Results of the masking studies have led Dehaene and colleagues (2006, 2008) to similar taxonomy in distinguishing conscious and unconscious perceptual states. In fact, the model by Dehaene posits that unconscious states are linked with transient preconscious states in which the information is potentially accessible, but yet not accessed at the moment. Prediction of the threshold model is also clearly parallelized in memory research on conscious recollection, which has demonstrated that memories that are inaccessible to conscious recollection are available after all (Tulving & Pearlstone, 1966; Kihlstrom, 2004).

The present results suggest that highest state posited by the 3-LHT model leads to plausible effects in predicting conscious behavior, although given the existing brain imaging studies alternative explanations of the experimental effects cannot be ruled out. The neuroimaging and neuropsychological studies provide compelling evidence that cortical vision for face detection in adult humans is being supported by an extra subcortical face processing route (Johnson, 2005). For instance, fMRI studies on emotion face perception show that activity in the face-selective fusiform cortex may be modulated by amygdala signals without explicit voluntary control (Vuilleumier & Pourtois, 2007). In addition, blindsight patients with a lesion to the primary visual cortex suggests were shown to have residual ability to detect certain facial expressions, including fear (Morris, deGelder, Weiskrantz, Dolan, 2001). Thus, unseen emotional facial expressions presented to the “blind” hemifield still can enhance conscious visual experience (de Gelder, Pourtois, van Raamsdonk, Vroomen, & Weiskrantz, 2001). These results could suggest that highest confidence judgments given by our participants depended not only on consciously perceived information, but were also guided by unconsciously processed cues driven by this extra subcortical route. In other words, it was likely that for some participants there were proportions of the fearful targets judged with the highest confidence that were both consciously and unconsciously perceived. One could also argue that feasibility of the threshold model of access consciousness was only due to a backward masking effect on face processing. It is known that the masking procedure can block or attenuate responses of magnocelluar visual pathways, possibly preventing the activity of quick subcortical pathways involved in the processing of fearful expressions (Vuilleumier & Pourtois, 2007). Thus, it was likely that many subjects in the present study complied with ideal observer's performance because their facial subcortical route was suppressed at some point.

It is important to note that the threshold as the internal mediating mechanism of conscious access provides no explanation of the immediacy between the conscious access and the conscious state of being conscious. In that fashion, the threshold model of conscious access supports a view by Ned Block on consciousness (1995, 2008) that perceptual state of being conscious is not merely a matter of having conscious access to emotional contents. It must be involved another property of the perceptual state, such as phenomenal consciousness, to say what it's like for one to be conscious of having fear. The threshold model of access consciousness does not also account for volition. Since conscious input and voluntary motor output responses are closely tied in the masking experiment one may argue that conscious access is relevant to voluntary control. In other words, there would be an inherent correlation between conscious contents and contents that "are made directly available" for the voluntary control of behavior (Chalmers, 2000). However, unlike conscious access is needed to nonroutine decision-making points, routine aspects of control are managed unconsciously (Baars, 1993). Therefore, a loss of access consciousness to the action, here the button press, might have caused a loss of voluntary control, however voluntary actions were not fully conscious while detecting emotional faces.

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