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Amplitude modulation depth discrimination of a sinusoidal carrier: Effect of stimulus duration[a)]

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Abstract

Discrimination of the change in depth of sinusoidal amplitude modulation (AM) was investigated as a function of stimulus duration. The carrier frequency was 4000 Hz, the standard modulation depth (m) was either 0.1, 0.18, or 0.3, and the modulation rate was either 10, 20, 40, or 80 Hz. For all standard depths and modulation rates, threshold (Δm) decreased by more than a factor of two as stimulus duration doubled from the shortest duration used up to a certain duration (critical duration), beyond which the threshold decreased only slightly or remained constant. The critical duration corresponded to about four cycles of modulation. Psychometric functions were measured for different stimulus durations to examine the extent to which a multiple-looks model could explain the present data. This model provided a reasonable prediction of the change in AM depth discrimination threshold as a function of stimulus duration.

INTRODUCTION

This study investigated the effect of stimulus duration on amplitude modulation (AM) depth discrimination. A general characteristic of auditory behavior is that detection and discrimination improve with increasing stimulus duration. This improvement suggests the operation of a temporal-integration process. Previous studies have measured the effect of stimulus duration on the detection of beats or AM (Viemeister, 1970, 1979; Sheft and Yost, 1990) and on the discrimination of AM rate (Lee, 1994). In general, they showed that performance improved with increasing stimulus duration, although the results differed with regard to the function relating performance to stimulus duration.

Viemeister (1970) investigated the effect of stimulus duration on beat detection. He found that at a beat frequency of 4 Hz, detectability improved with increasing stimulus duration from 125 to 500 ms. The detectability increased by roughly the square root of the number of beats. In 1979, Viemeister examined the effect of stimulus duration on AM detection, using stimulus durations of 250, 500, and 1500 ms. More recently, Sheft and Yost (1990) studied AM detection for durations from 400 ms to a duration corresponding to one cycle of modulation. Both studies showed that the detection threshold decreased gradually with increasing stimulus duration.

For AM rate discrimination, however, Lee (1994) found that at modulation rates of 20 and 40 Hz, the discrimination threshold decreased abruptly (more than a factor of two) as the stimulus duration increased to a certain duration (critical duration), beyond which threshold

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decreased slightly or remained constant. The critical duration corresponded to about five cycles of modulation.

To date, no one has studied the effect of stimulus duration on AM depth discrimination. The function relating AM depth discrimination to stimulus duration might be predicted to be more like that for AM detection, because the critical variable for both tasks is related to modulation depth. On the other hand, the function for AM depth discrimination might be more like that for AM rate discrimination, because both are related to envelope discrimination. It will be worthwhile, therefore, to investigate how AM depth discrimination is affected by stimulus duration.

I. EXPERIMENT 1: DISCRIMINATION OF AM DEPTH AS A FUNCTION OF DURATION

A. Method

1. Subjects—Three normal-hearing subjects participated in this study. They ranged in age from 23 to 30 years. Each subject's absolute thresholds were not worse than 10 dB HL (ANSI, 1989) at any of the octave frequencies from 0.25 to 8 kHz. All subjects had experience in other psychoacoustic experiments. One of the subjects (S1) was author JL; the other two subjects were paid an hourly wage for their participation.

2. Stimuli—The stimuli throughout the experiments are as follows

$$s(t)=A\{1+[(m+\Delta m)\cos(2\pi f_m t+\phi)]\} \times [\cos(2\pi f_c t)], \quad (1)$$

where m is the standard modulation depth, Δm is the change in the modulation depth, f_m is the modulation rate, ϕ is the phase of modulation, and f_c is the carrier frequency.

The stimuli were generated digitally and produced (TDT DA1) at a 20-kHz sampling rate. The output of the 16-bit digital-to-analog converter was low-pass filtered at 8 kHz (Kemo VBF25.01, 135 dB/oct). The onsets and offsets of all stimuli were shaped by a cosine-squared function giving a rise–fall time of 5 ms. The duration of the stimulus, including rise–fall time, was either 25, 50, 100, 200, 400, or 800 ms. The modulation rate was 10, 20, 40, or 80 Hz. The standard modulation depth (m) was 0.1, 0.18, or 0.3. The carrier frequency was 4000 Hz. The overall level of the carrier was fixed at 60 dB SPL.[1] The phase of modulation was randomly chosen between trials.

3. Procedure—A two-interval, forced-choice paradigm was used to measure the threshold (Δm) for discriminating modulation depth. The psychophysical task was to discriminate a ‘‘standard’’ stimulus having a modulation depth of m, from a ‘‘signal’’ stimulus having modulation depth of $m + \Delta m$, by identifying the interval having the greater modulation depth. Figure 1 shows an example of the standard and the signal stimulus. The modulation depth of the signal was varied in steps of 1 dB [in 20 log($m + \Delta m$)] using a three-down, one-up procedure, estimating the 79.4% correct point on the psychometric function (Levitt, 1971). The two observation intervals were separated by 500 ms. Each run consisted of 60 trials. The first two or three reversals were discarded (two if the total number of reversals was even, three if it was odd) and the remaining reversals were averaged to obtain the threshold estimate for that run. Threshold estimates were discarded on the rare occasions when the standard deviation of the reversals was greater than 5 dB or when there were fewer

[1]Intensity compensation was not used here because the modulation depths were very small. Additional measurements with overall level randomized (20-dB range) between intervals confirmed that an overall level cue was not used in the present study: Threshold for the random-level condition was almost the same as that for the fixed-level condition.

than six reversals in the mean. Each threshold reported is the mean of the estimates from at least three runs. When the standard deviation of the three estimates exceeded 3 dB, an additional estimate was obtained, and all estimates were averaged. This continued until the standard deviation of the estimates was less than 3 dB or until six estimates were obtained. All of the thresholds reported here had standard deviations less than 3 dB.

Subjects listened monaurally through a TDH-49P head-phone while seated in a soundproof room and responded by pushing one of two buttons on a response panel. Lights were used to indicate the observation intervals and then to provide correct-response feedback.

B. Results

Figure 2 shows the discrimination threshold, Δm, as a function of the stimulus duration at modulation rates of 10, 20, 40, and 80 Hz. The different symbols in each panel represent the different standard modulation depths: 0.1 (triangles), 0.18 (squares), and 0.3 (circles). Only mean results are presented in this figure. Individual data are presented in Table I.

For each modulation rate, the discrimination threshold decreases with increasing stimulus duration, regardless of the standard modulation depth. The threshold decreases by more than a factor of two as stimulus duration is doubled from the shortest duration used up to a certain duration (critical duration), which is indicated by an arrow in Fig. 2. The critical duration corresponds to four cycles of modulation for each modulation rate. For the stimulus durations beyond the critical duration, the threshold decreases only slightly if at all.

The results for each modulation rate are analyzed with a two-factor (stimulus duration by standard modulation depth) repeated measures ANOVA. The analysis indicates that the effect of stimulus duration is significant (for a 10-Hz rate, $F_{(3,24)} = 120.343$, $p < 0.001$; for a 20-Hz rate, $F_{(3,24)} = 37.163$, $p < 0.001$; for a 40-Hz rate, $F_{(4,30)} = 28.810$, $p < 0.001$; for a 80-Hz rate, $F_{(5,36)} = 97.121$, $p < 0.001$), but that the effect of standard modulation depth is not (for a 10-Hz rate, $F_{(2,24)} = 1.159$, $p > 0.1$; for a 20-Hz rate, $F_{(2,24)} = 2.907$, $p > 0.1$; for a 40-Hz rate, $F_{(2,30)} = 2.253$, $p > 0.1$; for an 80-Hz rate, $F_{(2,36)} = 0.079$, $p > 0.1$). In addition, the interaction between stimulus duration and standard modulation depth is not significant (for a 10-Hz rate, $F_{(6,24)} = 1.814$, $p > 0.1$; for a 20-Hz rate, $F_{(6,24)} = 0.879$, $p > 0.1$; for a 40-Hz rate, $F_{(8,30)} = 0.651$, $p > 0.1$; for an 80-Hz rate, $F_{(10,36)} = 1.813$, $p > 0.05$).

C. Discussion

Consider first the results for longer durations (400 and 800 ms). For all modulation rates, discrimination thresholds were between about 0.04 and 0.07 for the standard modulation depth of 0.1 and 0.18, and between 0.07 and 0.1 for the standard depth of 0.3. These values are consistent with those in other studies (Grantham and Bacon, 1988; Ozimek and Sek, 1988; Wakefield and Viemeister, 1990; Moore *et al.*, 1991).

The functions relating discrimination threshold to stimulus duration are consistent with those for AM rate discrimination (Lee, 1994), where the critical duration corresponded to about five cycles of modulation. The present results, however, are not consistent with those of AM detection (Viemeister, 1979; Sheft and Yost, 1990), where it has been shown that thresholds decrease gradually with increasing stimulus duration, without showing a clear breakpoint at the duration corresponding to four or five cycles of modulation. Viemeister's (1970) results on the effect of stimulus duration on beat detection did not show a breakpoint either, although his range of stimulus duration resulted in only one-half to two beats per observation interval.

The difference between the effect of stimulus duration on AM detection and AM discrimination is shown in Fig. 3, where the AM depth discrimination thresholds from the present study (averaged across the three standard depths) are plotted together with the AM detection thresholds from Sheft and Yost (1990; averaged across their two subjects). The discrimination thresholds (unfilled circles) are referred to the left-hand axis, whereas the detection thresholds (filled circles) are referred to the right-hand axis. Both types of thresholds are plotted in decibels, as 20 log Δm or 20 log m. For all modulation rates, the detection and discrimination thresholds show similar trends at stimulus durations yielding four or more cycles of modulation (the arrows in each panel indicate the duration corresponding to four cycles). The functions diverge, however, at shorter durations.

One possible reason for the separation of the detection and discrimination functions at the shorter durations may be related to the inherent difficulty of the two tasks. For modulation detection, the subject needs only to determine which of two stimuli was modulated. For the discrimination task, on the other hand, the subject must determine which of two stimuli had the greater modulation depth. This could conceivably require a better internal representation of the stimuli, and this representation might be adversely affected at the shorter durations yielding a small number of modulation cycles. As pointed out by an anonymous reviewer, this line of reasoning implies that AM depth discrimination at short durations should improve as AM depth increases, assuming that the internal representation of AM improves with increasing AM depth. In fact, consistent with this notion, the discrimination thresholds at short durations tend to decrease as standard AM depth increases from 0.1 to 0.3 (see Table I). This effect is even more apparent when the thresholds are examined in terms of $\Delta m/m$.

The discrimination thresholds in the present study generally decreased with increasing stimulus duration, suggesting that a temporal-integration process was operating. Viemeister (1970) showed that the threshold for the detection of beats improved by roughly the square root of the number of beats. His result was evaluated in terms of a multiple-looks hypothesis that suggests that changes in performance with duration are determined primarily by the number of ‘‘looks’’ at the amplitude fluctuations. Recently, Viemeister and Wakefield (1991) proposed a multiple-looks model to explain temporal integration. It is of interest to consider whether such a model can explain the present results. According to the multiple-looks model, the AM depth discrimination should improve by the square root of the number of looks if individual looks of equal d' are mutually independent, and the information from the different looks is optimally combined (Green and Swets, 1988). The prediction based on the multiple-looks model is evaluated here in experiment 2.

To apply the multiple-looks model to AM depth discrimination, we must consider how to define a look. It seems reasonable to assume that one well-defined peak and valley in a modulation cycle defines a look. However, except for the 10-Hz modulation rate, subjects were not able to do the task at the duration corresponding to one cycle of modulation (see Fig. 2). This is likely due to the fact that a well-defined peak and valley generally did not exist within one complete modulation cycle, because the stimuli were shaped by a cosine-squared function with a 5-ms rise–fall time. In order to achieve one ‘‘clean look,’’ given the rise–fall time, it may be necessary to present more than one modulation cycle. Because only an integer number of cycles was presented in the present study, this suggests that the number of looks may be defined as $n - 1$, where n represents the number of modulation cycles. Thus, two cycles of modulation may have been necessary to achieve one optimum look. Consistent with this definition are pilot data from one subject (S1) showing that the discrimination threshold was almost the same for durations corresponding to 1.25, 1.5, and 2.0 cycles of modulation at a 20-Hz modulation rate (this subject could not do the task for a duration corresponding to 1.0 cycle).

II. EXPERIMENT 2: PSYCHOMETRIC FUNCTIONS FOR AM DEPTH DISCRIMINATION

The second experiment examined the extent to which the multiple-looks model can explain the effect of stimulus duration on AM depth discrimination. In order to do that, psychometric functions were measured at different stimulus durations, and comparisons between obtained *d′* and predicted *d′* based on the multiple-looks model were made.

A. Method

1. Subjects—Two subjects (S2 and S3) from experiment 1 participated.

2. Stimulus—Stimulus generation was identical to the previous experiment. A standard depth of 0.18 was used. Two modulation rates were used: 10 and 20 Hz. For each modulation rate, psychometric functions were measured at different stimulus durations. For the 10-Hz modulation rate, the stimulus duration was 200, 400, or 800 ms. For the 20-Hz modulation rate, the stimulus duration was 100, 200, 400 or 800 ms.

3. Procedure—To obtain a psychometric function for each condition, several signal modulation depths were chosen that would cover the range of percent correct values between 50% and 100%. As in the first experiment, a two-interval forced-choice paradigm with feedback was employed. The signal modulation depth was fixed within a block of trials. For each condition, the resulting percent correct values for five 60-trial blocks were averaged and taken as the percent correct for a particular modulation depth.

4. Fitting the psychometric function—Each psychometric function was fitted with a cumulative Gaussian probability function (for details, see Dai, 1995). The detectability (*d′*) is defined as

$$d'=\left(\frac{x}{\alpha}\right)^{\beta}, \quad (2)$$

where α is the signal strength at threshold ($d' = 1$ when $x = \alpha$), and *x* is defined as $\Delta m/m$. β is the slope of the psychometric function because $\log(d') = \beta \log(x/\alpha)$. The parameters, α and β, were estimated by using a Simplex procedure (the FMINS function of MATLAB software).

B. Results

Figure 4 shows the measured psychometric functions for the different stimulus durations for the two subjects. Percent correct is plotted as a function of $20 \log(\Delta m/m)$. The psychometric functions in the left column are for a modulation rate of 10 Hz, and those in the right column are for a modulation rate of 20 Hz. The upper panels are for S2 and the bottom panels are for S3. In each panel, different symbols represent different stimulus durations. The lines are the fitted functions described above.

In general, within a panel, the psychometric functions overlap (S2) or nearly overlap (S3) at durations yielding four or more cycles of modulation, as expected based on the results from experiment 1 (see Table I). The psychometric functions for the durations corresponding to less than four cycles are shifted to the right, to larger values of Δ*m*. Table II shows comparisons between thresholds obtained with the adaptive procedure (from experiment 1) and those obtained with the fixed-level procedure (from experiment 2); in both cases, thresholds correspond to 79.4% correct. These values are not significantly different for both the 10-Hz ($F_{(1,6)} = 0.262$, $p > 0.1$) and 20-Hz rate ($F_{(1,8)} = 0.19$, $p > 0.1$).

All estimated parameters for the fits to the functions are shown in Table III. There is no systematic change in the slope (β) with stimulus duration for S2, but for S3 the slope is steeper at shorter durations.

C. Discussion

The primary purpose of experiment 2 was to examine the extent to which the multiple-looks model might explain the effect of stimulus duration on AM depth discrimination. This can be done in the context of Fig. 5, which shows obtained (unfilled symbols) and predicted (filled symbols) d' as function of stimulus duration. The predicted function was derived based on several assumptions: (a) one well-defined peak-valley pair provides one ‘‘look’’ (note that, given the rise–fall used here, two cycles of modulation provide one look, and that in general, the number of looks is given by the number of cycles minus 1), (b) individual looks are mutually independent, (c) d' is the same for each look, and (d) the looks are optimally combined. According to these assumptions, the predicted d' should improve by the square root of the number of looks (Green and Swets, 1988). For the present analysis, a value of $\Delta m/m$ corresponding to d'=0.74 (70% correct)[2] was obtained from the fitted function for the condition providing one look (200 ms for 10 Hz and 100 ms for 20 Hz). That value was used to obtain d' values from the fitted functions for the other conditions.

As can be seen in Fig. 5, the multiple-looks model generally provides a reasonable prediction of AM depth discrimination as a function of stimulus duration. The obtained d', however, was underpredicted for both subjects as the looks increased from one to three (from 200 to 400 ms for the 10-Hz rate and from 100 to 200 ms for the 20-Hz rate). One possible explanation for this is that the d' for the first look is lower than that for subsequent looks, leading to a greater improvement with increasing looks than predicted based on the d' for the first look. This first look may not be optimal for this task because of adaptation or onset uncertainty (Viemeister, 1979; Viemeister and Wakefield, 1991). Short-term adaptation might reduce sensitivity to the first look relative to later looks if the initial neural response to the onset of the stimulus is large relative to the change in neural response produced by the sinusoidal modulation (see Viemeister, 1979). Onset uncertainty might also reduce the sensitivity to the first look if the subjects do not know precisely when the signal starts (see Viemeister and Wakefield, 1991).

The change in performance with increasing the number of looks beyond four (from 400 to 800 ms for the 10-Hz rate and from 200 to 800 ms for the 20-Hz rate) was overpredicted. Over that range of duration, the obtained d' tended to stay constant or increase slightly with increasing number of looks, whereas the predicted d' increased steadily. This difference between predicted and obtained performance may reflect memory limitations. For longer stimulus durations, the total detectability may be reduced because the detectability of earlier looks has been degraded by memory limitations (Viemeister and Wakefield, 1991). Taken together, it is possible that the detectability of each look may not be equal (the first look might be degraded by adaptation or onset uncertainty, whereas the later looks may be degraded by memory limitations). With appropriate weighting of each look (Viemeister and Wakefield, 1991), however, the multiple-looks model can almost certainly produce more accurate predictions of the integration data for AM depth discrimination. We did not, however, assign an individual weight to each look in order to improve the predictions: because we did not measure the weight for each look directly, this would have been nothing more than an exercise in curve fitting.

[2]The d' value of 0.74 was chosen arbitrarily. However, the relationship between the predicted and the obtained functions remained essentially the same for initial d' values of 0.545, 0.74, and 1.0.

III. SUMMARY AND CONCLUSIONS

Experiment 1 measured the discrimination of AM depth as a function of the stimulus duration for different modulation rates. Experiment 2 measured the psychometric functions at different stimulus durations to examine the extent to which the multiple-looks model can explain the effect of stimulus duration on AM depth discrimination. The following conclusions may be drawn.

1. The threshold for AM depth discrimination decreased by more than a factor of two as stimulus duration doubled from the shortest duration used up to a critical duration, beyond which the threshold decreased only slightly or remained constant. The critical duration corresponds to four cycles of modulation. These results are similar to those for AM rate discrimination (Lee, 1994).
2. The effect of stimulus duration on AM discrimination was found to be similar to that on AM detection observed previously by others, except at durations shorter than the critical duration. The difference at subcritical durations may be related to the difference in the inherent difficulty of the two tasks.
3. The multiple-looks model provides a reasonable prediction for AM depth discrimination. A better description, however, could be achieved by assuming different weights for the individual looks.

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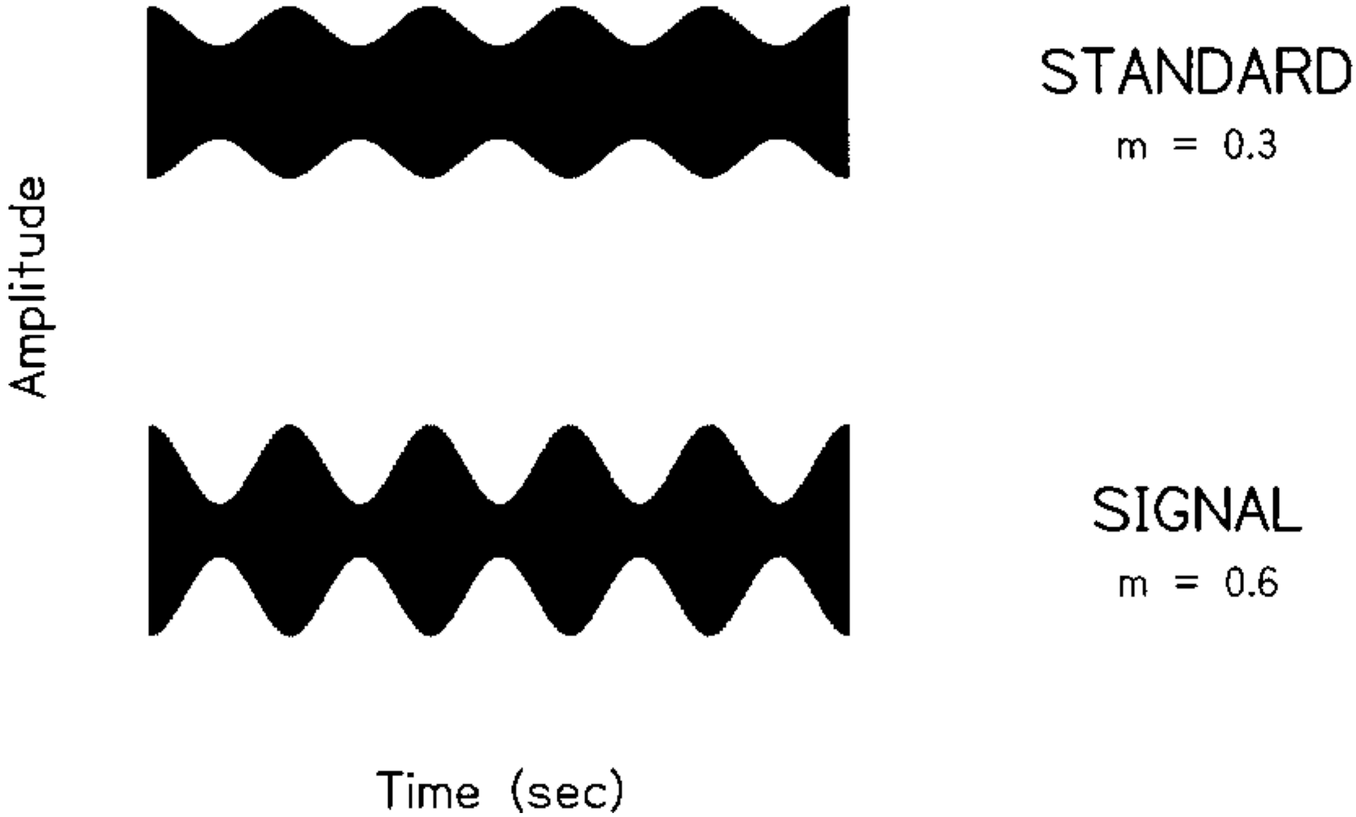

FIG. 1.
An example of the standard (top) and signal (bottom) stimulus.

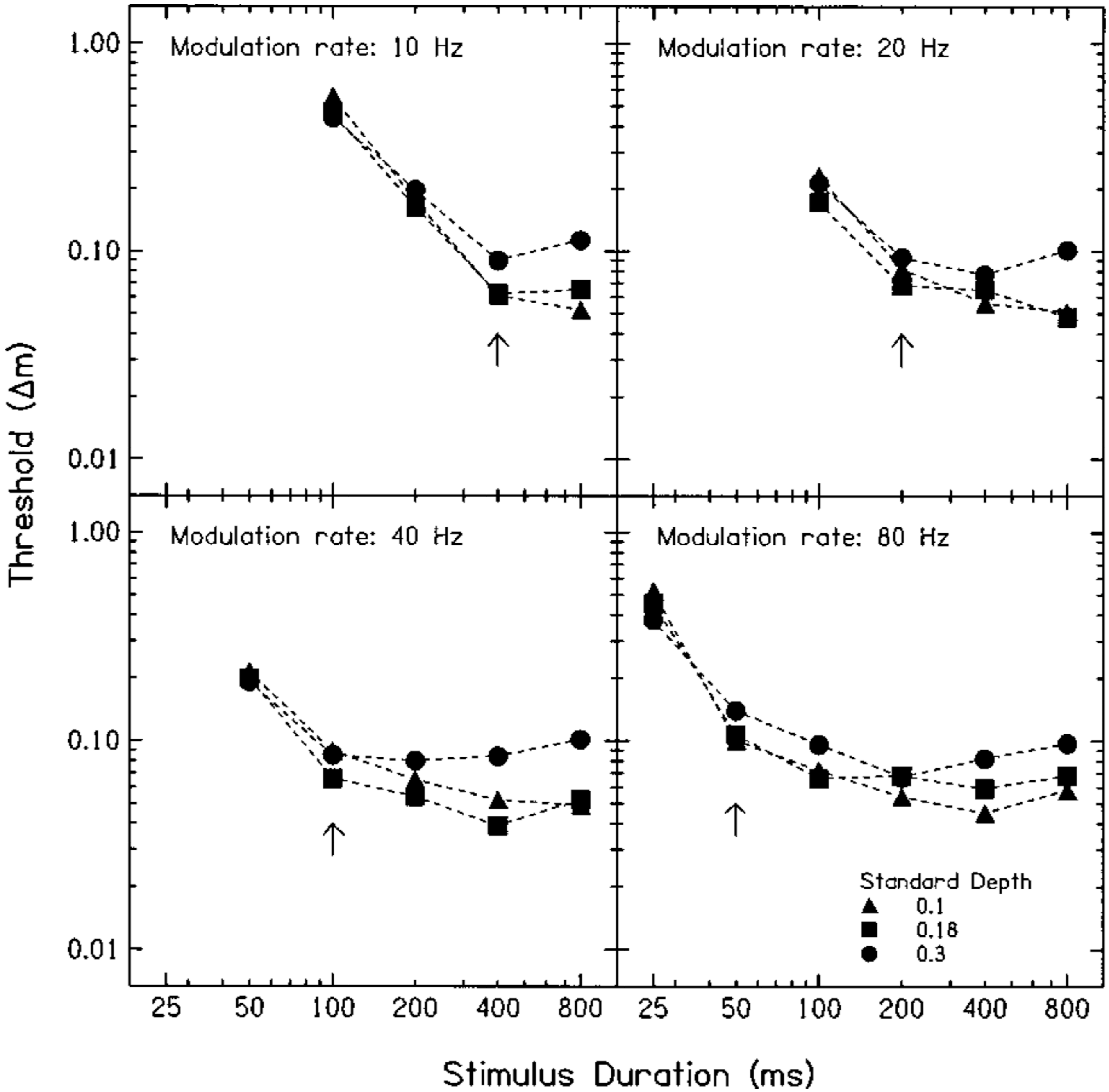

FIG. 2.

Discrimination threshold Δ*m* as a function of stimulus duration at modulation rates of 10, 20, 40, and 80 Hz, results are the average of three subjects. Three standard modulation depth were used: 0.1 (triangles), 0.18 (squares), and 0.3 (circles). The arrows indicate the duration corresponding to four cycles of modulation.

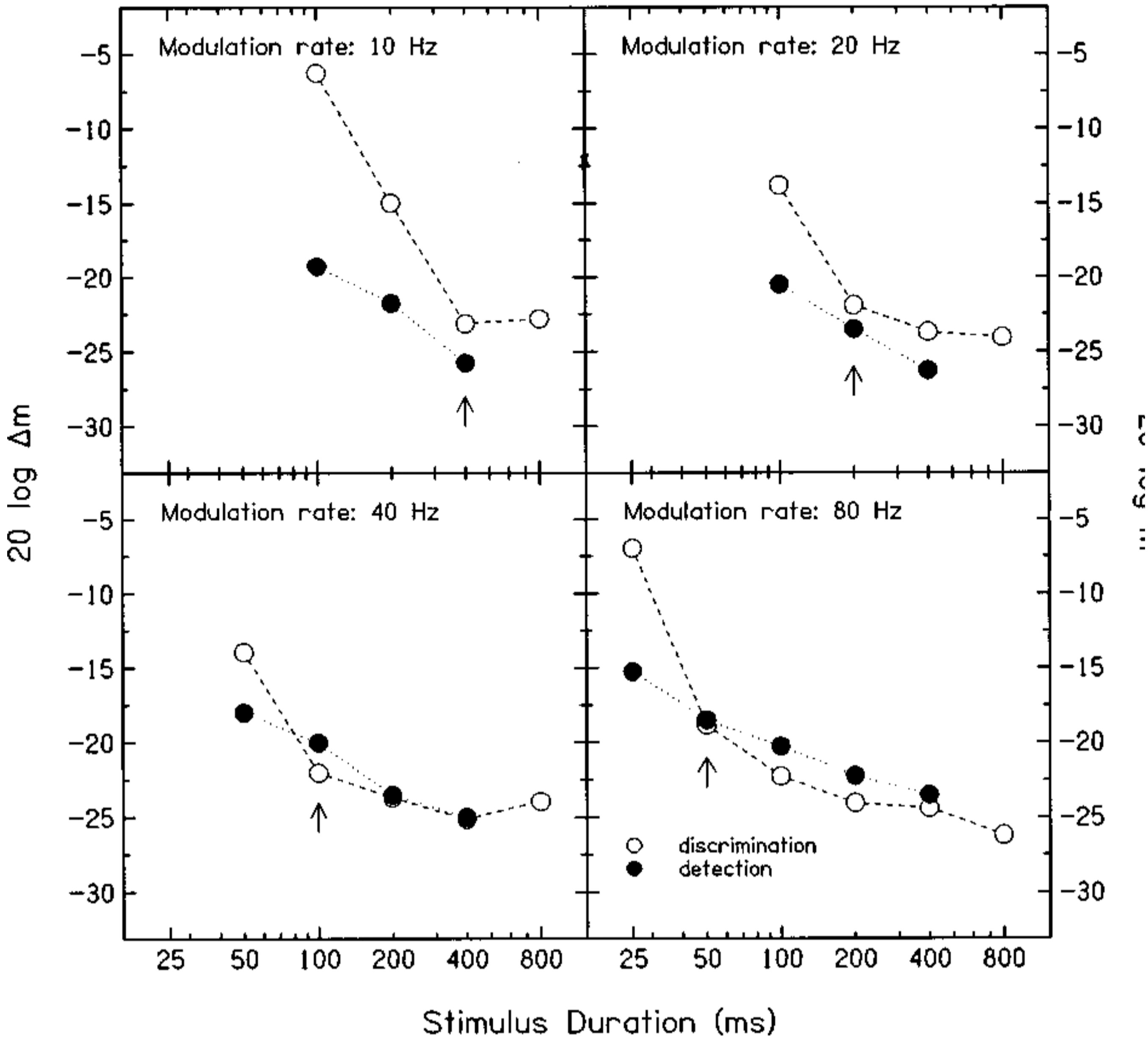

FIG. 3.

Comparison of the effect of duration on AM detection with that on AM depth discrimination. The AM detection thresholds (filled symbols) are from Sheft and Yost (1990; averaged across their two subjects), and are referred to the right-hand axis. The AM depth discrimination thresholds (unfilled symbols) are from the present study (averaged across the three standard depths), and are referred to the left-hand axis. The arrows indicate the duration corresponding to four cycles of modulation.

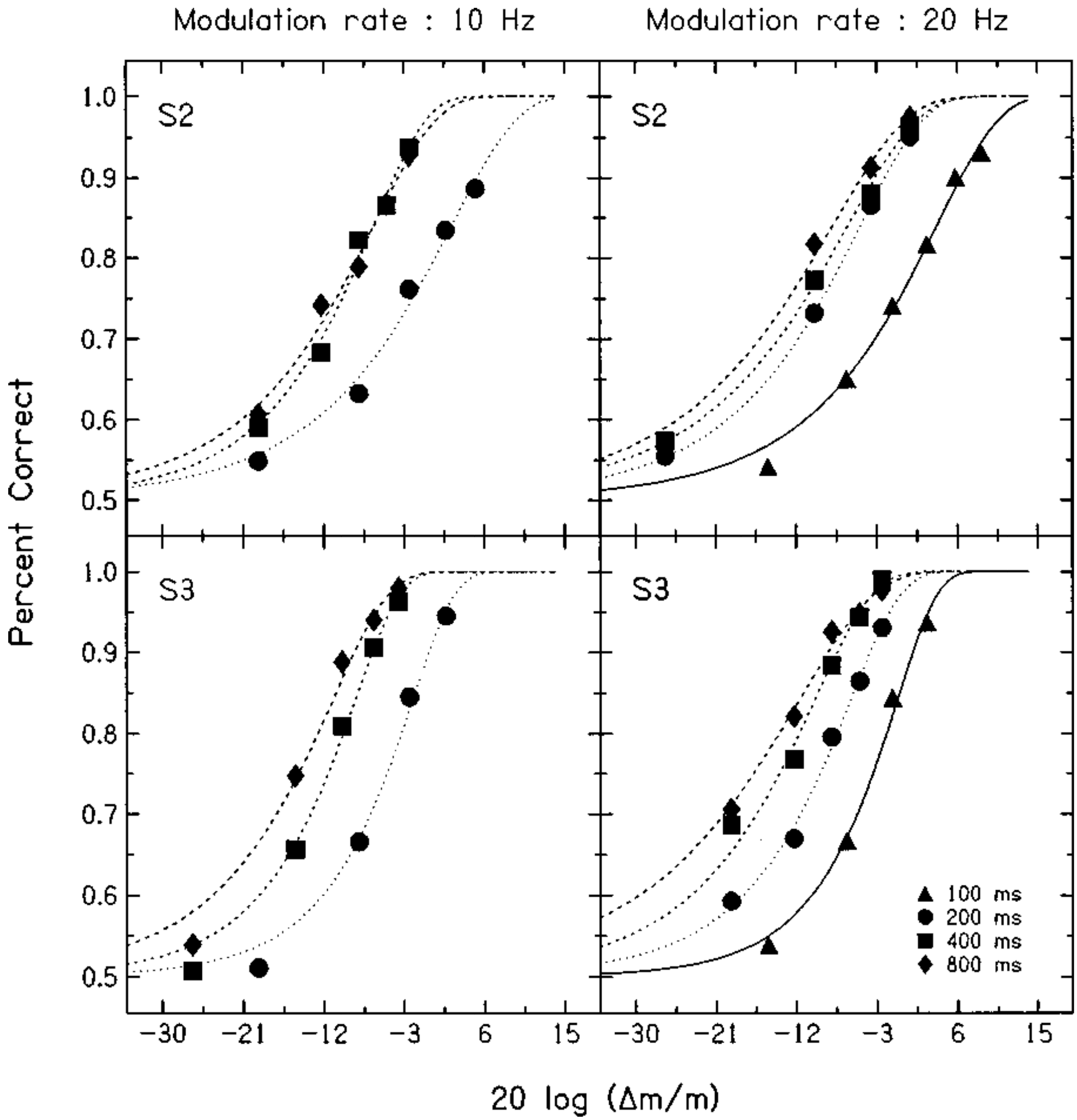

FIG. 4.

Psychometric functions of two subjects (S2 and S3) measured at different durations for the modulation rates of 10 Hz (left column) and 20 Hz (right column). The standard depth was 0.18. The durations were 100 (triangles), 200 (circles), 400 (squares), or 800 ms (diamonds).

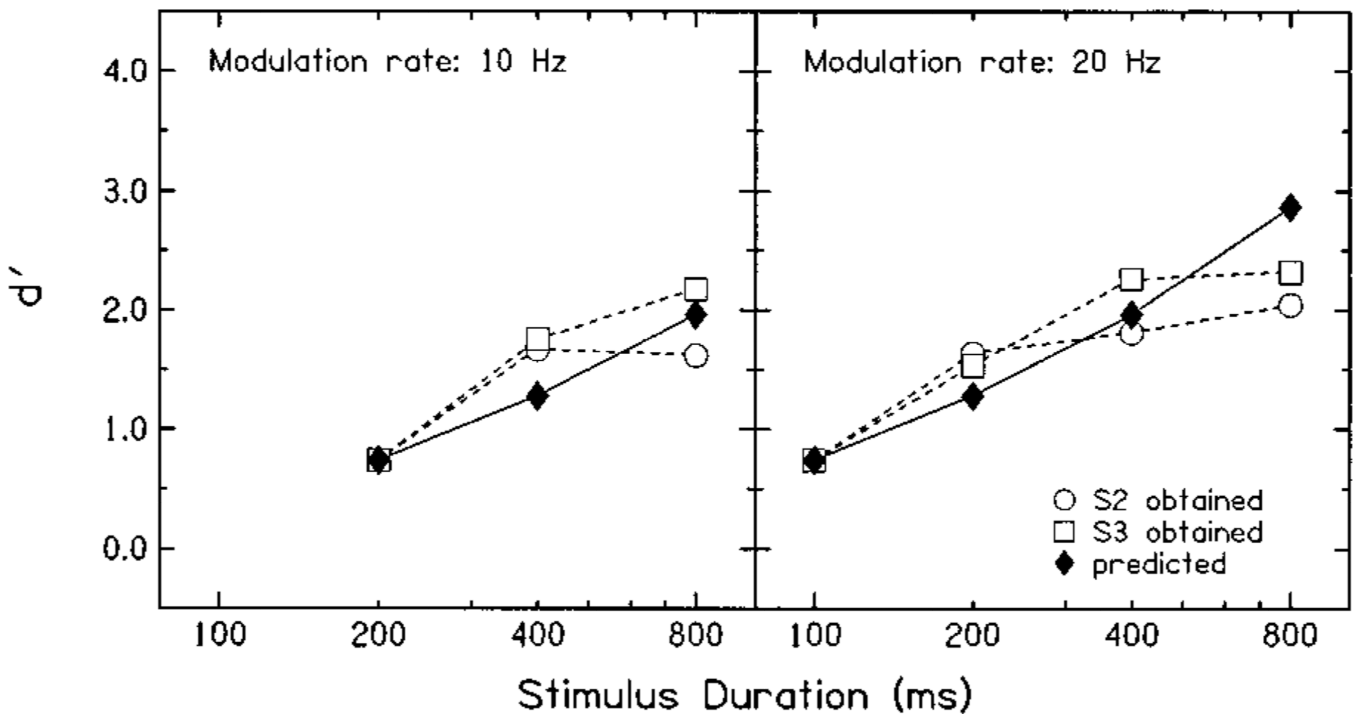

FIG. 5.
The obtained (unfilled symbols) and predicted (filled symbols) values of *d′* as a function of stimulus duration at the modulation rates of 10 Hz (left panel) and 20 Hz (right panel).

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TABLE I

Individual and mean thresholds (Δm) for a standard modulation depth (m) of 0.1, 0.18, and 0.3. Threshold was measured for different modulation rates at different stimulus durations.

		0.1				0.18				0.3			
		S1	**S2**	**S3**	**Mean**	**S1**	**S2**	**S3**	**Mean**	**S1**	**S2**	**S3**	**Mean**
10 Hz	100 ms	0.475	0.580	0.613	0.556	0.402	0.469	0.540	0.470	0.467	0.409	0.447	0.441
	200 ms	0.149	0.246	0.132	0.176	0.128	0.269	0.094	0.164	0.169	0.293	0.132	0.198
	400 ms	0.038	0.096	0.050	0.061	0.043	0.105	0.037	0.062	0.093	0.117	0.060	0.090
	800 ms	0.029	0.077	0.049	0.052	0.049	0.108	0.037	0.065	0.110	0.146	0.082	0.113
20 Hz	100 ms	0.177	0.256	0.259	0.231	0.122	0.248	0.148	0.173	0.195	0.273	0.175	0.214
	200 ms	0.069	0.100	0.077	0.082	0.067	0.057	0.082	0.068	0.067	0.097	0.114	0.093
	400 ms	0.031	0.079	0.058	0.056	0.047	0.086	0.062	0.065	0.074	0.072	0.086	0.077
	800 ms	0.027	0.080	0.046	0.051	0.047	0.057	0.041	0.048	0.088	0.075	0.141	0.101
40 Hz	50 ms	0.152	0.244	0.246	0.214	0.157	0.257	0.182	0.199	0.162	0.234	0.176	0.191
	100 ms	0.068	0.086	0.112	0.089	0.045	0.065	0.089	0.066	0.067	0.108	0.080	0.085
	200 ms	0.054	0.066	0.075	0.065	0.043	0.054	0.065	0.054	0.056	0.124	0.059	0.080
	400 ms	0.030	0.062	0.062	0.052	0.033	0.038	0.046	0.039	0.059	0.137	0.055	0.084
	800 ms	0.036	0.054	0.057	0.049	0.044	0.072	0.039	0.052	0.052	0.170	0.080	0.101
80 Hz	25 ms	0.500	0.665	0.402	0.522	0.458	0.399	0.511	0.456	0.394	0.378	0.364	0.379
	50 ms	0.073	0.111	0.118	0.100	0.058	0.130	0.132	0.107	0.112	0.150	0.156	0.139
	100 ms	0.040	0.076	0.099	0.072	0.040	0.085	0.074	0.066	0.064	0.127	0.096	0.096
	200 ms	0.026	0.061	0.076	0.054	0.037	0.121	0.044	0.068	0.061	0.099	0.040	0.067
	400 ms	0.017	0.060	0.057	0.045	0.033	0.096	0.050	0.059	0.056	0.142	0.049	0.082
	800 ms	0.050	0.060	0.063	0.057	0.037	0.120	0.048	0.043	0.063	0.160	0.069	0.066

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TABLE II

A comparison between the threshold (Δm) from the fixed-level procedure (experiment 2) and that from the adaptive procedure (experiment 1).

	10 Hz				20 Hz			
	S2		S3		S2		S3	
	Fixed	**Adaptive**	**Fixed**	**Adaptive**	**Fixed**	**Adaptive**	**Fixed**	**Adaptive**
100 ms					0.219	0.248	0.142	0.148
200 ms	0.185	0.269	0.121	0.094	0.082	0.057	0.075	0.082
400 ms	0.071	0.105	0.057	0.037	0.068	0.086	0.046	0.062
800 ms	0.068	0.108	0.041	0.037	0.055	0.057	0.035	0.041

TABLE III

Estimated values of α and β from the fits to the psychometric functions for two subjects at different stimulus duration. The standard depth was 0.18.

		α			β		
		S2	**S3**	**Avg.**	**S2**	**S3**	**Avg.**
10 Hz	800 ms	0.315	0.192	0.254	0.802	0.891	0.847
	400 ms	0.337	0.277	0.307	0.953	1.113	1.033
	200 ms	0.849	0.591	0.720	0.775	1.183	0.979
20 Hz	800 ms	0.246	0.156	0.201	0.683	0.667	0.675
	400 ms	0.306	0.213	0.260	0.719	0.860	0.790
	200 ms	0.377	0.358	0.368	0.800	0.994	0.897
	100 ms	1.011	0.700	0.856	0.809	1.248	1.029