Effect of Ticking Rate on User Estimation of System Response Time

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Melanie D. Polkosky
James R. Lewis

IBM Voice Systems

West Palm Beach, Florida

Abstract

We investigated the effect of system response time (SRT) duration and rate of change of a system processing tone on participants' subjective time estimates and affect. Sixteen participants (balanced for gender and age) estimated SRT while listening to silence or ticking tones of varying rates. Participants also rated perceived stress, impatience, and anxiety during the SRT. Results indicated that as SRT and ticking rate increased, participants perceived a longer waiting period and experienced increased negative affect. The report includes a discussion of the implications for auditory interface design.

ITIRC Keywords

System response time
Time estimation
Speech recognition application
Telephony
Audio tones
Waiting tone
Ticking rate
System processing tone
System busy tone
Auditory interface design

Contents

Introduction

The empirical literature has demonstrated that system response time (SRT) is a component of human-computer interfaces that can dramatically affect user acceptance of an application (Shneiderman, 1984). SRT is the time required for a computer to receive a user's input, process the response, and send a reply back to the user (Thadhani, 1981). During SRT, the user's role is to wait for system processing to finish while monitoring the system's task, even if an extended SRT induces the user to temporarily direct his attention elsewhere.

SRT influences a number of user outcomes. Longer SRTs can result in increased user response time (Barber & Lucas, 1983; Butler, 1984), decreased productivity (Kuhmann, Boucsein, Schaefer, & Alexander, 1987), and depressed work quality and performance (Schaefer, 1990; Shneiderman, 1984). SRTs can also induce stress or other negative emotional states (Guynes, 1988; Schaefer, 1990; Schleifer & Amick, 1989). Two studies suggested that the anxiety produced by SRT is transitory state anxiety, as opposed to the long-term anxiety that characterizes some personality types (Eisler & Eisler, 1994; Guynes, 1988).

In addition to personal negative outcomes, it seems intuitively reasonable that SRTs can impact users' overall perception of a human-computer interface. Indeed, the literature has shown that user acceptability of SRT varies based on a number of factors, including the extent of interruption (Galloway, 1981) and variability of SRTs (Shneiderman, 1984).

The acceptability of SRT, and possibly an entire application, relates at least partially to users' perception of time. A significant literature exists on the topic of subjective time estimation and perception (for a review, see Fraisse, 1984). This literature has indicated that the subjective experience of time is a power function of actual time duration (actual time raised to 0.9) multiplied by a constant (Eisler, 1976). If, as Eisler (1976) suggests, the exponent of the subjective time function is 0.9, users' perception of SRT increases approximately linearly as actual SRT duration increases (Meyer, Shinar, & Leiser, 1990). However, researchers have suggested that a number of variables can influence subjective time estimation, including individual differences (age, intelligence, extroversion-introversion), drugs, memory, activity level, and experimental methods used to measure subjective time (Eisler, 1976; Fraisse, 1984; Zakay, Lomranz, & Kaziniz, 1984).

Another variable that influences users' perception of SRT is the sensory stimulus provided during the SRT. Zakay, Nitzan, & Glicksohn (1983) examined the effect of sensory stimulus and task difficulty on subjective time estimation. Ninety-six subjects estimated the length of empty intervals or intervals filled with a fast or slow tempo (manipulated with a flickering light bulb or electronic buzzer). Specifically, they found that a fast tempo resulted in the longest time estimates, while a slow tempo resulted in the shortest time estimates (no tempo produced intermediate time estimates). Yoblick & Salvendy (1970) found that when participants reproduced filled time intervals (auditory tones, visual flicker, or tactile vibrations), they overestimated the duration of lower frequencies significantly more often than higher frequencies only with auditory stimuli. When the time intervals were filled with visual or tactile stimuli, participants estimated high and low frequencies similarly.

In applied human-computer interaction research, Meyer, Shinar, & Leiser (1990) examined the effect of wait messages on participants' estimates of 3 to 16 second SRTs. The wait messages were static (blank screen, printed "please wait," six-word printed epigram) or dynamic (increasing line of printed X letters, round clock drawing, blinking printed "please wait"), with dynamic messages presented at three rates of change (changing every .33, .50, or .67 seconds). Results showed no difference in time estimates for the three static displays and the blinking "please wait" message. The dynamic displays that changed over time (line of Xs and clock) resulted in longer time estimates when rates of change were faster. This result provides additional support for the Zakay, Nitzan, & Glicksohn (1983) finding that an external visual tempo influences subjective time estimation.

Several researchers have described using auditory cues for system processing without determining their effect on user time perception or SRT acceptability. Beaudouin-Lafon and Conversy (1996) describe their use of Sheppard-Risset tones (sounds that appear to go up and down indefinitely) as audio progress bars. Albers and his colleagues used a ticking sound for relative transfer time in a world wide web browser (Albers & Bergman, 1995; Albers, 1996) and in a satellite-ground control application (Albers, 1995). Albers (1995) also used "pops and clicks" to indicate data transfer. Similarly, Balentine & Morgan (1999) advocate the use of "low level ticking" or "pitched wait tones" to indicate the user's need to wait for system processing in telephony applications.

Buxton (1989) has identified a similar monitoring function of auditory cues in interface design which few researchers have explored empirically. Rauterberg (1998) used six machine sounds to assist operators in monitoring a simulated plant. The results showed that auditory cues significantly improved the operators' productivity scores, number of status reports, self-assurance, and social acceptance ($p<0.05$) as compared with a condition without these cues. Although not statistically significant, the operators' ratings of readiness for endeavor, restfulness, and motivation were also higher with auditory monitoring cues. This study suggests that auditory cues may have performance and psychological benefits when individuals are monitoring system processes, as they do during SRT.

In speech interface and telephony applications, the use of auditory stimuli to signal SRT and its completion may have several additional advantages. Obviously, telephony applications demand an auditory cue because they do not typically provide a visual display. Complex sounds draw attention, especially when they are changing, and designers can use them to shift listener attention (Moore, 1989). Gaver (1997) notes that sound is effective at conveying information about processes. If a system provides a processing tone for users, they may be able to divide attention to continue with an ongoing task and monitor the SRT, thereby limiting work interruption. Similarly, the end of the tone may shift the user's primary attention back to system interaction. The particular sound itself may also alter a listener's mood or emotional state (Gaver, 1997). Perhaps the appropriate use of sound in interface design can counteract the negative outcomes associated with SRT in the previous literature (Barber & Lucas, 1983; Butler, 1984; Guynes, 1988; Kuhmann, Boucsein, Schaefer, & Alexander, 1987; Schaefer, 1990; Schleifer & Amick, 1989; Shneiderman, 1984).

The current study expands on previous applied research in human computer interaction and empirical work on subjective time estimation. Because previous studies involving SRT have primarily addressed visual "wait" signals (Meyer, Shinar, & Leiser, 1990), we investigated the use of three rates of auditory processing tone on users' subjective time estimation. Yoblick and Salvendy (1970) also investigated the effect of auditory tones on subjective time estimation but their tones were unchanging over time (36 sinusoidal waves ranging from 80 to 14,000 Hz) and did not represent SRTs. Zakay, Nitzan, and Glicksohn (1983) provided auditory stimuli using a buzzer that "flickered" at rates of 0.5 sec or 2.0 sec during 14-second verbal tasks. Therefore, participants engaged in a competing task in this study (as opposed to simply waiting) and the length of the tasks remained consistent. In contrast, the present study investigated three rates of dynamic auditory stimuli occurring during realistic SRT durations.

Consistent with earlier findings (Meyer, Shinar, & Leiser,1990; Zakay, Nitzan, & Glicksohn,1983), we hypothesized that more rapid rates of auditory tones would result in greater overestimation of actual SRT durations. We used a ticking tone in this experiment, which is the most common processing tone identified in previous literature (Albers & Bergman, 1995; Albers, 1995, 1996; Balentine & Morgan, 1999). We also included a control condition of silence during the SRT, an "empty" time interval, as in Zakay, Nitzan, & Glicksohn (1983).

In addition, we explored the effect of a processing tone on users' negative affect. Since there is no empirical evidence that users prefer the ticking tone, we wanted to determine if it affected user anxiety, stress, and impatience beyond the SRT itself. We hypothesized that processing tones with faster rates of change would increase users' perceived negative affect.

Method

Participants. Sixteen IBM employees volunteered to complete this study. The participant sample included equal numbers of males and females, with equal numbers of each gender group above and below the age of forty. All participants, except one male and female (each over 40 years), described themselves as experienced with speech recognition/telephony applications. All participants reported normal hearing.

Stimuli. Participants heard three waiting tones and silence, counterbalanced across participants to reduce order effects. The waiting tones consisted of a ticking sound, edited so the rate of ticking doubled across the three tones (a tick every 0.5, 0.25, and 0.125 msec, respectively). Each tone and silence played during actual SRT durations of 3 seconds, 8 seconds, 13 seconds, and 18 seconds, creating 16 conditions of the independent variables (4 auditory stimuli and 4 SRT durations).

The SRT durations were consistent with the range of times used in the previous literature (Galloway, 1981; Guynes, 1988; Kuhmann, Boucsein, Schaefer, & Alexander, 1987; Meyer, Shinar, & Leiser, 1990). In addition, Fraisse (1984) has suggested that duration may influence depth of cognitive processing. He proposed that people perceive durations of 100 msec to 5 seconds as being in the present, but involve memory for those over 5 seconds in duration.

To simulate use of the tones in a speech recognition application, the auditory stimuli occurred between two spoken prompts. The initial prompt was a statement announcing the computer's initiation of processing (e.g., "Please hold while we process your request") and the second prompt indicated the end of the system processing time (e.g., "Thank you for waiting"). Both prompts were spoken by a female and recorded using Sound Forge 4.5d[1] (16 bit, 44,100 Hz), then edited to include the auditory stimuli and SRT durations.

Procedure. The study used a diagram-balanced Greco-Latin design to prevent participants from hearing the same tones and SRT durations sequentially.

Each participant read a brief description of the task (prospective paradigm) and four questions eliciting time estimates and ratings of perceived anxiety, stress, and impatience on three bipolar 7-point rating scales (see Appendix A for participant instructions and data collection questions). Each participant received verbal clarification and additional explanation as needed. They listened to a prompt/auditory stimulus combination played over an Andrea[2] CTI ANC-200 handset attached to an IBM Thinkpad[3] computer, which simulated actual listening conditions in a telephony/speech recognition application. Participants then completed the four questionnaire items (shown in Appendix A). Participants repeated this procedure for the remaining audio stimuli and SRT durations.

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[1] Sound Forge is a trademark of Sonic Foundry, Inc.
[2] Andrea is a trademark of Andrea Electronics.
[3] Thinkpad is a registered trademark of International Business Machines.

Results

A repeated measures ANOVA indicated a significant main effect of time ($F(3,36)=91.24$, $MSe=12.88$, $p<0.0001$), rate of auditory stimuli ($F(3,36)=13.85$, $MSe=13.84$, $p<0.0001$), and measure ($F(3,36)=45.13$, $MSe=94.93$, $p<0.0001$). The main effect of gender ($F(1,12)=0.47$, $MSe=56.81$, $p=0.51$) and age ($F(1,12)=0.19$, $MSe=56.81$, $p=0.67$) were not significant. Significant interactions included measure-gender ($F(3,36)=2.84$, $MSe=94.93$, $p=0.05$), time-measure ($F(9,108)=54.66$, $MSe=10.62$, $p<0.0001$), time-rate-measure ($F(27,324)=1.82$, $MSe=1.95$, $p=0.009$), and the five-way interaction among all independent variables ($F(27,324)=2.06$, $MSe=1.95$, $p=0.002$).

The significant effect of measure indicated that the 4 questionnaire items (subjective time estimate, ratings of perceived anxiety, stress, and impatience) tapped into different dimensions of measurement, as expected. Therefore, we analyzed subjective time estimate data and negative affective ratings separately.

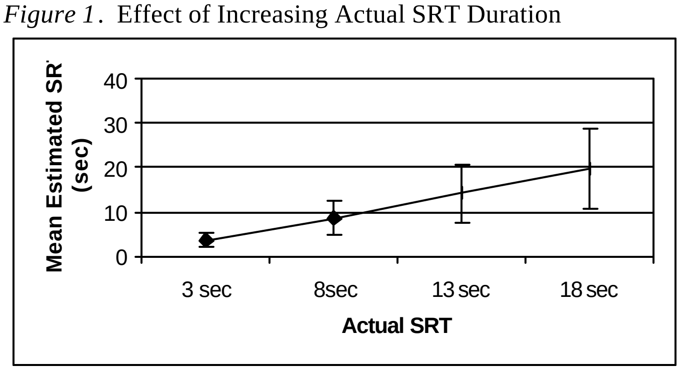
Subjective Time Estimation. Table 1 presents the mean subjective time estimates for each SRT. As shown, participants estimated longer SRTs when the actual duration was longer, with the shortest mean estimate for the 3 second SRT and longest mean estimate for the 18 second SRT. Participants showed increasing variability in their time estimates as the SRT became longer.

Table 1. Time Estimation Descriptive Statistics

Actual Length of SRT	Mean Subjective Estimate of SRT (sec)	Standard Deviation (sec)	Range (sec)	Mode (sec)
3 seconds	3.75	1.78	1-12 (11)	3
8 seconds	8.67	3.65	4-20 (16)	8
13 seconds	14.20	6.49	5-45 (40)	15
18 seconds	19.84	9.11	7-55 (48)	15

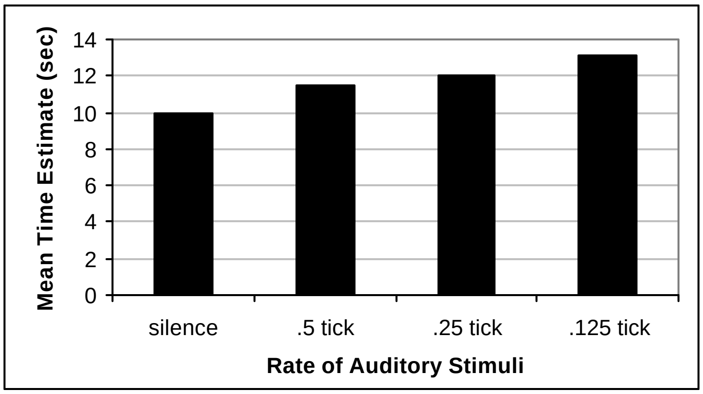
Tukey tests revealed statistically significant differences among all four mean SRT estimates ($d_T=3.45$, $alpha_{FW}=0.05$). The results indicated that participants increased their estimate of SRT as the actual SRT duration increased (see Figure 1).

Figure 1. Effect of Increasing Actual SRT Duration



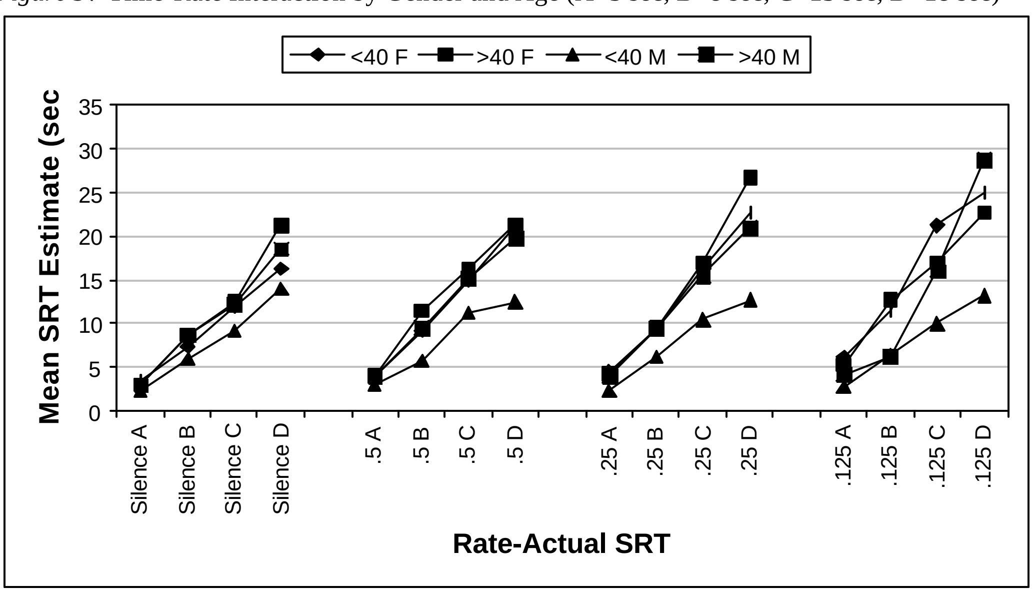
Although the more sensitive ANOVA test indicated a main effect of ticking rate, Tukey tests did not find these mean differences to be statistically significant (d_T=3.58). Figure 2 shows the mean estimated SRT for each rate (mean actual SRT=10.5 sec). Participants most accurately estimated the actual SRT in the silence condition. With ticking stimuli, they increasingly overestimated the SRT as the ticking rate increased.

Figure 2. Main Effect of Rate of Auditory Stimuli (mean actual SRT=10.5 sec)



Analysis of the time estimate data also indicated a significant 4-way interaction (time-rate-age-gender), shown in Figure 3. Females and males over 40 years similarly estimated SRTs, regardless of the auditory stimulus. However, males under 40 years underestimated the SRTs in all conditions, except when the actual duration of the SRT was 3 seconds. Tukey tests confirmed this result: males under 40 years significantly underestimated SRTs over 3 seconds for all rates of ticking tones in comparison to other gender-age groups (d_T=3.58), although a notable exception occurred at 8 seconds with the 0.5 and 0.125 ticking rates. More variability among gender-age groups occurred with the 0.125 ticking rate as well. All group means were significantly different when the actual SRT was 13 seconds or 18 seconds.

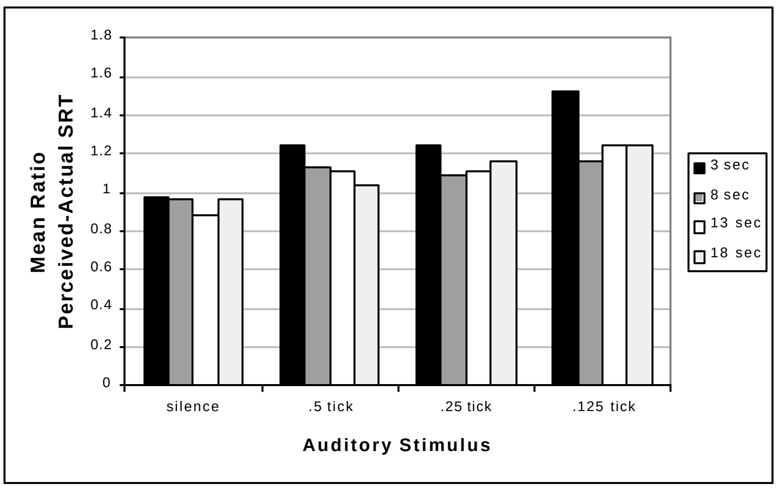
Figure 3. Time-Rate Interaction by Gender and Age (A=3 sec, B=8 sec, C=13 sec, D=18 sec)



Ratio Analysis: We also analyzed the time estimation data in the form of ratios. This procedure allowed more direct comparison of the difference between perceived and actual SRT. A ratio less than 1.00 indicates an underestimate of the actual SRT and a ratio greater than 1.00 indicates an overestimate of the actual SRT. As shown in Figure 4, for all actual SRT durations, participants underestimated their wait during silence. Participants greatly overestimated their wait for all 3 second SRTs with the ticking stimuli. Finally, 0.5 second ticking caused participants to progressively underestimate their wait as SRT increased; however, the two fastest rates of ticking caused them to increasingly overestimate the actual SRT.

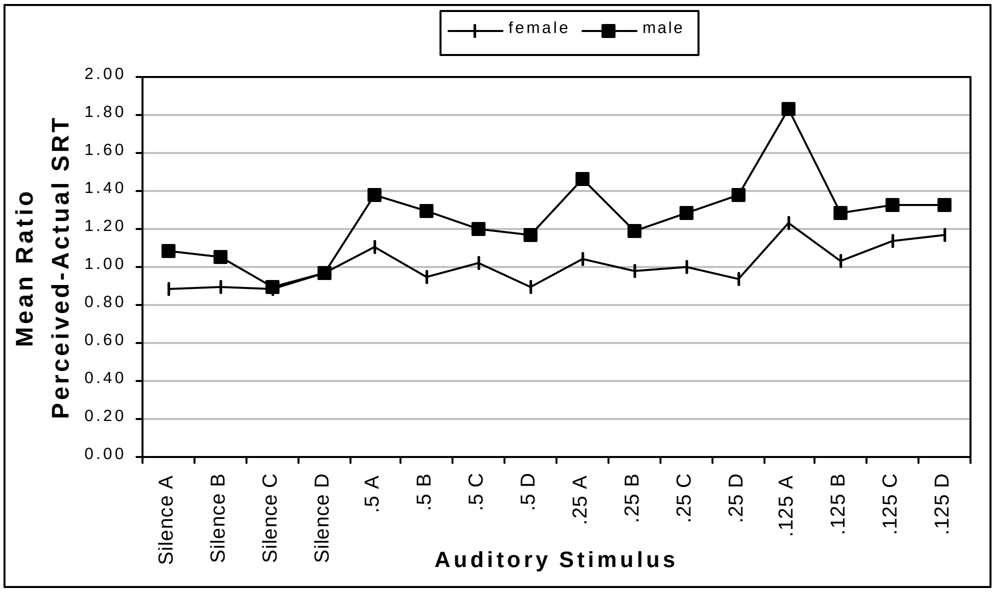
A mixed model ANOVA resulted in similar significant effects as revealed by analysis of the raw data. There was a significant main effect of time ($F(3,36)=3.78$, $MSe=0.11$, $p=0.02$) and rate ($F(3,36)=5.41$, $MSe=0.234$, $p=0.008$), as well as a significant 3-way interaction for time-rate-gender ($F(9,108)=2.11$, $MSe=0.05$, $p=0.04$). All other main effects and interactions failed to be significant.

Figure 4. Ratio of Perceived-Actual SRT



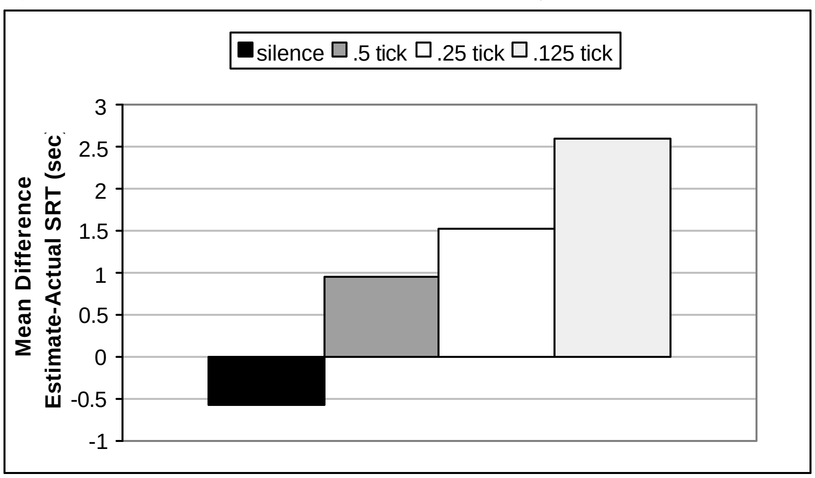
The 3-way interaction is shown in Figure 5. Although this result may have little practical importance, it is notable that males typically overestimated the SRT, while females were more accurate in their estimates in all conditions. Tukey tests indicated statistically significant differences between male and female estimates in the 0.25 tick-3 sec SRT, 0.25 tick-18 sec SRT, and 0.125 tick-3 sec SRT conditions ($d_T=0.40$).

Figure 5. Time-Rate Interaction by Gender (A=3 sec, B=8 sec, C=13 sec, D=18 sec)



<u>*Difference Analysis*.</u> Another analytical approach was to use difference scores (perceived SRT minus actual SRT). In this case, a positive value indicates an overestimate of the SRT and a negative value indicates an underestimate. Figure 6 shows the difference scores for each rate of auditory stimuli.

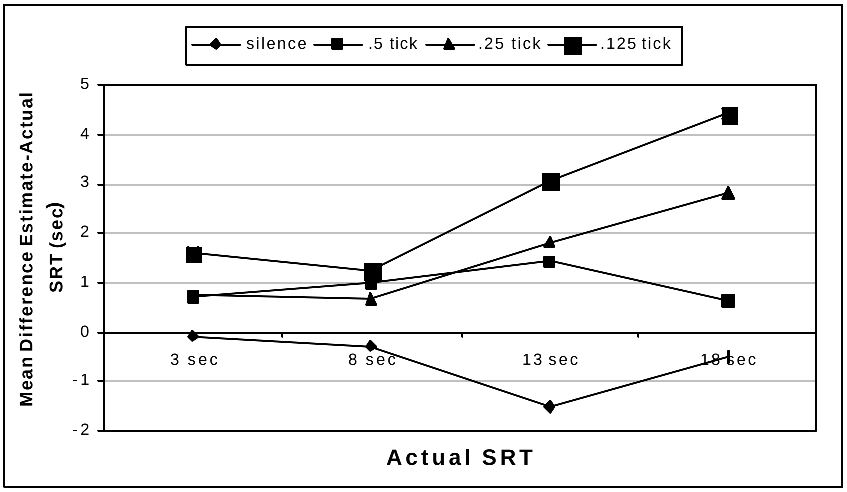
Figure 6. SRT Difference Scores for Four Auditory Stimuli (Perceived-Actual)



As illustrated by Figure 6, participants underestimated only in the silence condition. However, as the rate of ticking increased, they tended to increasingly overestimate the SRT.

A mixed model ANOVA on the difference scores indicated a unique result as compared with the analyses on the raw and ratio data. The main effect of actual SRT time was <u>not</u> significant ($F(3,36)=0.47$, $MSe=39.78$, $p=0.71$). The rate main effect of ticking rate continued to be significant ($F(3,36)=4.58$, $MSe=24.42$, $p=0.008$). Interestingly, a significant interaction between time and ticking rate occurred in this analysis ($F(9,108)=1.97$, $MSe=6.85$, $p=0.05$). As previously found in the raw data, a significant 4-way interaction (time-rate-gender-age) also occurred in this analysis ($F(9,108)=2.51$, $MSe=6.45$, $p=0.012$).

Figure 7. SRT Difference Scores Time-Rate Interaction



The time-rate interaction (Figure 7) indicated consistent underestimation of the SRT during silence but overestimation when a ticking tone occurred. As the rate of ticking increased, participants increasingly overestimated the SRT. However, with a 0.5 msec ticking rate, the amount of overestimation decreased for the 18 second SRT. Tukey tests ($d_T=3.24$) revealed four statistically significant mean differences: silence-0.25 tick (13 sec), silence-0.125 tick (13 sec), silence-0.125 tick (18 sec), and 0.5 tick-0.125 tick (18 sec). Other mean differences were not significant.

Negative Affective Ratings. A mixed model ANOVA demonstrated a main effect of time ($F=27.69$, $MSe=3.02$, $p<0.0001$), rate ($F=11.94$, $MSe=9.55$, $p<0.0001$), and affective rating ($F=5.07$, $MSe=2.21$, $p=0.015$). A significant interaction occurred between time and affective rating ($F=11.54$, $MSe=0.41$, $p<0.0001$). No other main effects or interactions were significant.

The main effects indicate that participants' perceived negative affect (a combined rating consisting of anxiety, stress, and impatience) increased as the SRT duration increased and as the rate of auditory stimuli increased. Figure 8 shows the increase in negative affect for each SRT duration. Figure 9 shows the increase in negative affect with increased rate of auditory stimuli. Although both figures show observed differences between means, they were not statistically significant.

Figure 8. Main Effect of SRT Duration on Negative Affect

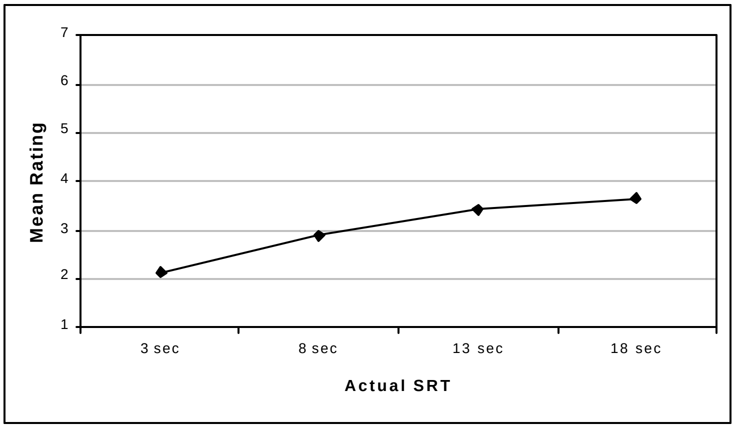


Figure 9. Main Effect of Auditory Stimuli Rate on Negative Affect

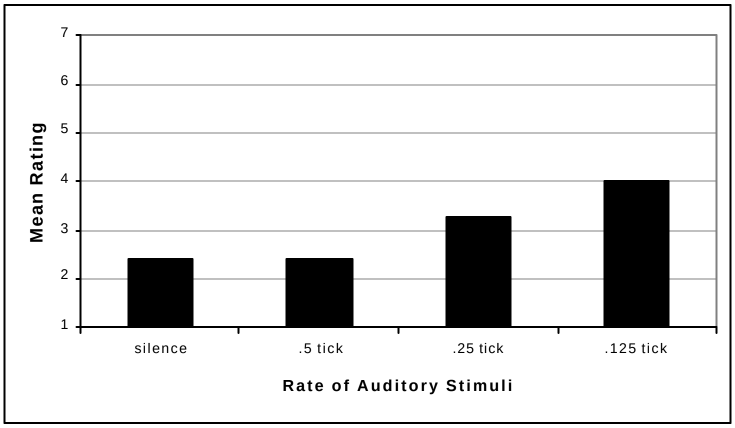


Figure 10 illustrates the perceived anxiety, stress, and impatience ratings for each SRT. Perceived anxiety, stress, and impatience all increased with increasing length of SRT. Accordingly, Tukey tests indicated significant mean differences between the following mean pairs (d_T=0.89) of affective ratings:

> Anxiety: 3 sec-13 sec, 3 sec-18 sec;
> Stress: 3 sec-13 sec, 3 sec-18sec; and
> Impatience: 3 sec-13 sec, 3 sec-18 sec, 8 sec-13 sec, and 8 sec-18 sec.

During the 18 second SRT, impatience was also significantly greater than perceived stress and anxiety (see Figure 10). All other pairwise comparisons among these means were not statistically significant.

Perceived anxiety, stress, and impatience for each of the auditory stimuli appear in Figure 11. The ratings increased as the rate of the auditory stimuli increased. Although observable increases occurred, the ANOVA indicated these mean differences were not statistically significant ($F(6,72)=1.32$, $MSe=0.33$, $p=0.26$).

Figure 10. Affective Ratings for Actual SRT Durations

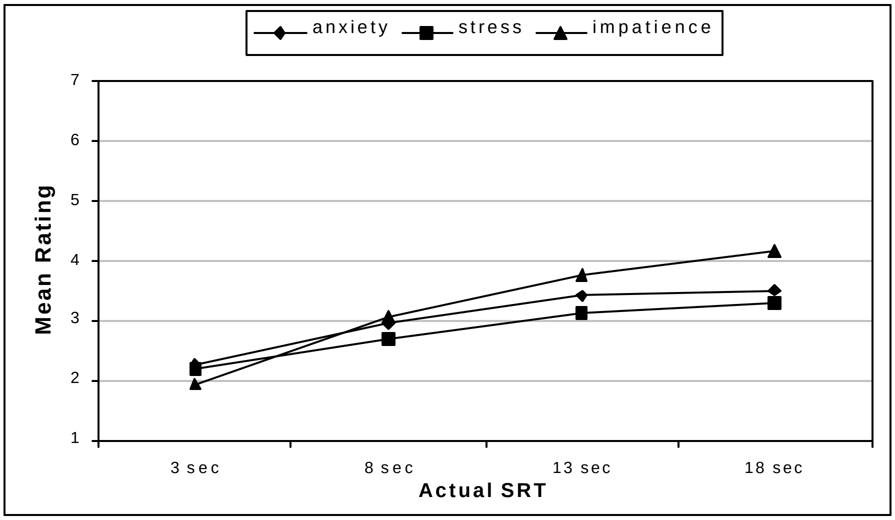
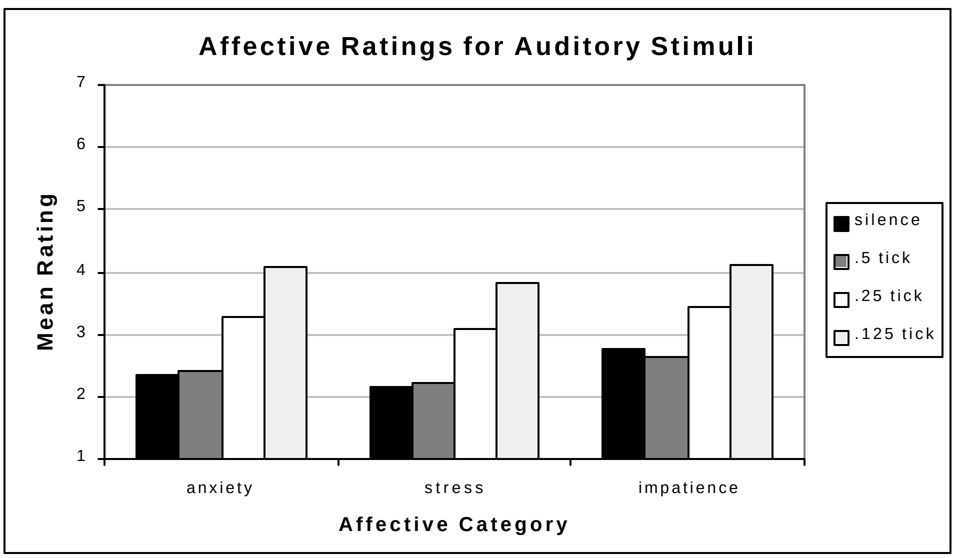


Figure 11. Affective Ratings for Auditory Stimuli



Discussion

This study investigated the effect of SRT duration and rate of change of a system processing tone (ticking rate) on participants' subjective time estimates and perceived affect. In general, the results indicated that as SRT duration increased, participants perceived a longer waiting period, especially when the system provided a system processing tone. Increasing the rate of change of the system processing tone (ticking) caused participants to overestimate the SRT, especially with longer SRTs. As both the SRT and ticking rate increased, participants' ratings of perceived anxiety, stress, and impatience also increased. The results confirmed our initial hypotheses that more rapid processing tones would increase both subjective SRT estimates and perceived negative affect.

The results offer several implications for interface design. First, it is vital to limit SRTs as much as possible, because individuals rated themselves as more anxious, stressed, and impatient with SRTs that last as little as 3 to 18 seconds. This result was consistent with the results of previous studies that have shown that SRT itself can negatively impact users' emotional and physiological states (Guynes, 1988; Komatsubhara, Yokomizo, Yamamoto, & Noro, 1985; Kuhmann, Boucsein, Schaefer, & Alexander, 1987; Schleifer & Amick, 1989) and that anxiety associated with SRTs is transitory state anxiety (Eisler & Eisler, 1994; Guynes, 1988).

Second, it is important to carefully choose a system processing (waiting) tone based on user perception and acceptance. Although the inclusion of a waiting tone may have important design implications (Balentine & Morgan, 1999), designers must recognize that a poor choice of tone may cause users to overestimate the SRT and substantially elevate their negative affect. In this study, several participants explicitly stated that they would be "irritated" or "have hung up by now" with the longer SRTs. Physical signs of anxiety, including finger or foot tapping, muscular tension in the neck and shoulders, eye rolling, whole-body movements, and forced exhalation, were also clearly apparent in some participants during data collection. Such negative physical and emotional outcomes are likely to adversely affect users' perception of the interface as a whole.

This study's results indicated that if an interface uses a ticking tone (as suggested by Balentine & Morgan, 1999), the rate of ticking should not exceed 0.5 msec. A 0.5 msec ticking rate did result in overestimation of SRT; however, users' perceived negative affect with this tone was similar to their affective ratings when silence occurred during the waiting period. Any auditory cue used during SRT should have a relatively slow rate or change or tempo to minimize user overestimation of SRT and negative affect.

Interface designers should evaluate any proposed auditory processing tone with a variety of SRT durations. The finding of interaction effects indicated that a tone may have different effects with short and long SRTs.

A fascinating additional (and unexpected) finding of this study indicated both gender and age differences in the perception of time. While primarily of theoretical value, the present results indicated that males under 40 years tended to underestimate SRT when systems provide a system processing tone. The analysis also suggested that females in general tended to be more accurate in their subjective estimates of time. The results of Eisler and Eisler (1994) also suggested the presence of gender-age group differences. They found that males tended to shorten time interval reproductions as compared with females and older participants tended to lengthen time interval reproductions. For interface designers, these findings suggest that any usability testing involving duration should include participants with a range of characteristics (not simply young males), to insure that results generalize to a broad population.

This study also points to several further directions for research. Because all participants were employees of IBM, replications should include external participants to increase the generalizability of results. It would make sense to explore user preferences for different system processing tones, as well as whether altering the rate of other types of tones affects users' subjective time estimates. Future studies should examine a broader range of SRT durations to determine how participants' subjective time estimates change between each of the SRT durations used in this study or with longer SRTs (3, 8, 13, and 18 seconds).

Finally, future studies should explore if slower rates of ticking (e.g., 1 sec/tick, 2 sec/tick) result in time estimates that are less than the true SRT, as suggested by previous findings that a slow external tempo results in underestimates of actual duration (Zackay, Nitzan, & Glicksohn, 1983). This experiment is important because one goal of this line of research is to discover techniques for reducing the subjective duration of SRT.

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Appendix A. Instructions to Participants

You will hear a recorded voice, followed by a waiting period and then another recorded voice. During the waiting period, you will hear a variety of sounds or silence.

After hearing the recording, please estimate the length of the waiting period (in seconds). Then please complete the rating forms.

1. How long was the waiting period (IN SECONDS)? ___________________________

2. How anxious did you feel during the waiting period?

1	2	3	4	5	6	7
Not at all Anxious						Extremely Anxious

3. How stressed did you feel during the waiting period?

1	2	3	4	5	6	7
Not at all Stressed						Extremely Stressed

4. How impatient did you feel during the waiting period?

1	2	3	4	5	6	7
Not at all Impatient						Extremely Impatient

Appendix B. Raw Data

Participant Characteristics

Participant	Gender	Age	Education	Experience	Hearing
1	F	under40	collgrad	E	N
2	F	under40	collgrad	E	N
3	F	under40	somecoll	E	N
4	F	under40	adv	E	N
5	F	over40	collgrad	E	N
6	F	over40	adv	E	N
7	F	over40	collgrad	E	N
8	F	over40	somecoll	NE	N
9	M	under40	collgrad	E	N
10	M	under40	adv	E	N
11	M	under40	adv	E	N
12	M	under40	adv	E	N
13	M	over40	collgrad	E	N
14	M	over40	collgrad	E	N
15	M	over40	somecoll	NE	N
16	M	over40	collgrad	E	N

Experience refers to experience with speech recognition/telephony applications (E=experience, NE=not experienced)

Time Estimation Data

Participant	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	40	3	8	20	15	5	25	20	12	12	15	5	10	4	20	8
2	25	2	7	14	11	3.7	16	13	13	6	12	4	7	4.6	16	11
3	8	2	7	8	5	2	7	7	5	4	7	1	4	2	8	4
4	20	4	5	20	15	4	18	16	14	10	15	4	7.7	5	18	9
5	15	2	7	20	15	4	12	14	10	8	9	3	8	3	13	6
6	30	3	20	30	20	2	20	30	15	10	20	3	8	5	30	10
7	15	3	6	13	12	3	14	9	11	6	13	3	6	3	16	6
8	15	2	6	15	13	3	17	10	11	7	13	2	6	3	14	7
9	20	5	10	15	15	5	20	15	10	10	15	5	8	5	20	8
10	10	2	10	10	10	2	15	10	10	5	10	2	5	5	15	5
11	55	5	20	30	26	6	37	45	18	15	27	7	11	12	41	16
12	15	2	6	10	9	3	12	15	10	8	13	4	6	3	15	8
13	15	2	6	15	10	2	12	8	8	8	8	3	5	4	15	5
14	26	3	10	15	25	7	35	15	12	12	25	6	7	4	32	16
15	30	3	5	20	20	3	20	15	10	10	20	3	10	3	30	10
16	20	4	15	25	10	5	18	15	15	8	15	5	15	8	30	15

Key to Auditory Stimuli Codes: A=19 sec .125 tick, B=3 sec silence, C=8 sec .125 tick, D=19 sec silence, E=13 sec .5 tick, F=3 sec .5 tick, G=19 sec .5 tick, H=13 sec .125 tick, I=13 sec silence, J=8 sec .25 tick, K=13 sec .25 tick, L=3 sec .25 tick, M=8 sec silence, N=3 sec .125 tick, O=19 sec .25 tick, P=8 sec .5 tick

PERCEIVED ANXIETY RATINGS

Participant	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	2	1	4	2	2	1	2	3	1	2	3	1	1	2	3	1
2	3	1	5	2	2	3	3	6	2	3	4	5	1	5	4	3
3	5	2	5	6	4	3	5	5	5	4	5	3	5	5	5	4
4	7	1	6	4	5	1	6	7	4	5	6	2	4	3	7	5
5	5	1	5	2	2	2	2	5	4	4	4	4	2	6	3	3
6	5	1	3	4	3	1	3	5	2	1	2	1	2	5	2	1
7	4	1	5	2	3	1	3	6	1	5	4	2	2	4	3	2
8	6	3	6	5	3	2	2	3	5	4	5	4	4	4	3	2
9	6	3	6	6	3	1	2	5	2	2	6	6	4	5	5	2
10	3	1	3	2	2	1	2	3	2	3	3	1	1	2	2	1
11	3	1	2	1	2	1	2	4	3	2	3	1	1	3	3	1
12	7	1	7	1	3	1	2	7	2	5	6	5	1	7	5	2
13	5	2	4	3	3	1	2	5	4	3	2	2	2	4	4	2
14	2	1	1	2	2	1	3	2	2	1	2	1	1	1	2	1
15	3	1	1	4	5	2	3	1	2	2	4	1	3	1	6	6
16	3	1	3	4	2	3	3	2	2	2	2	1	2	1	4	2

Perceived Stress Ratings

Participant	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	2	1	3	2	2	1	2	2	1	2	2	1	1	2	2	1
2	5	1	4	2	2	2	2	6	1	2	3	5	1	6	5	2
3	4	2	3	5	4	3	4	5	5	4	5	4	4	5	4	4
4	7	1	7	2	4	1	6	7	4	5	6	2	4	3	7	5
5	4	1	4	3	2	2	2	5	2	3	3	3	2	3	3	3
6	3	1	3	4	3	1	3	3	2	2	2	1	1	3	2	1
7	5	1	6	2	2	2	5	6	2	5	4	3	1	5	4	2
8	5	3	6	5	2	2	1	2	3	3	5	4	3	4	2	2
9	6	3	6	6	3	1	2	5	2	2	6	6	4	6	5	2
10	1	1	1	1	1	1	1	2	1	2	2	1	1	1	1	1
11	3	1	2	1	2	1	2	4	3	2	2	1	1	3	3	1
12	7	1	7	1	3	1	2	7	2	5	6	5	1	7	5	2
13	6	2	4	3	3	1	3	5	4	3	2	2	2	4	3	2
14	2	1	1	2	2	1	3	2	2	1	2	1	1	1	2	1
15	2	1	1	3	4	2	3	2	3	2	4	1	3	1	6	5
16	2	1	2	4	2	1	3	2	2	2	2	1	2	1	2	1

Perceived Impatience Ratings

Participant	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	3	1	4	2	2	1	2	3	1	2	3	1	1	2	3	1
2	7	1	4	2	3	1	4	6	3	2	5	4	2	2	4	3
3	5	1	3	6	5	2	5	5	5	4	5	1	5	2	6	4
4	7	1	7	3	4	1	6	7	4	5	6	2	4	3	7	5
5	7	1	6	5	4	2	4	6	4	4	4	3	3	6	4	3
6	5	1	3	4	3	1	3	5	2	1	2	1	2	1	2	1
7	7	1	6	3	3	2	5	6	2	5	4	3	1	4	4	2
8	6	3	6	5	2	2	2	2	5	4	5	4	4	3	3	2
9	6	3	6	6	3	1	2	5	2	2	6	6	4	6	5	2
10	2	1	2	2	2	1	2	3	2	3	3	1	2	1	3	1
11	3	1	2	1	2	1	2	4	3	2	2	1	1	3	3	1
12	7	1	7	3	4	1	3	7	5	5	6	2	1	7	6	1
13	7	3	5	7	7	1	6	6	6	5	5	3	5	4	7	5
14	3	1	1	2	2	1	4	2	3	1	3	1	3	1	4	1
15	2	1	1	3	5	1	5	1	2	2	5	1	4	2	6	5
16	3	1	3	5	2	1	3	2	2	2	2	1	2	1	3	1