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ABSTRACT

A study examined whether structural features of radio elicit orienting responses in attentive and inattentive listeners. Subjects (college students enrolled in one of three telecommunications courses at a major Midwest university who received course credit for participation) listened to a 12-minute radio stimulus. Results showed that inattentive and attentive listeners exhibited cardiac orienting responses to structural features of radio. The orienting responses of attentive listeners indicated verbal processing while those of inattentive listeners indicated features processing only. No effects of orienting on memory were found. (Contains four figures and 23 references.) (Author/NKA)

"What is it?"

Orienting to Structural Features of Radio Messages

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Abstract

This study asks whether structural features of radio elicit orienting responses in attentive and inattentive listeners. Subjects listened to a 12-minute radio stimulus. Results show that both inattentive and attentive listeners exhibited cardiac orienting responses to structural features of radio. The orienting responses of attentive listeners indicated verbal processing while those of inattentive listeners indicated features processing only. No effects of orienting on memory were found.

"What is it?"

Orienting to Structural Features of Radio Messages

Are there features of broadcast radio which can affect how audio messages are cognitively processed by listeners? Previous research has demonstrated that structural features of video messages can be manipulated by producers to influence audience members' cognitive processing (Anderson, 1983; Basil, 1994; Calvert, Huston, Watkins & Wright, 1982; Geiger & Reeves, 1993; Grimes, 1990; Gunter, 1987; Lang, Dhillon & Dong, 1995) but results of this work have not been extended to other media such as radio. Radio producers have acknowledged the important role structural features such as sound effects and vocal delivery play in capturing audience attention (Keith, 1990; Siegal, 1992). However, specific investigations into which structural features influence cognitive processing of radio messages have not been conducted. The goal of this study is to identify possible structural features of radio messages and examine their influence on the processing of message information.

Much of the previously mentioned research on processing of video messages has been done using limited capacity theory. Limited capacity theory proposes that audience members have a limited capacity of processing resources to be allocated to the mental tasks of encoding and storing information contained in media messages (Lang, 1996; Lang, 1990). What information gets encoded into short term memory and how well it is stored is thought to be determined by both conscious decisions to allocate attention by the individual and by structural features of media messages (Lang, 1990). Structural features of media messages can automatically call processing resources to the message by eliciting an orienting response in audience members

(Thorson & Lang, 1992). The orienting response is conceived as a response to either meaningful signal stimuli or novel stimuli in the environment (Lynn, 1966). Orienting responses result in a temporary increase in attention to the response-eliciting stimulus and can be indexed by several physiological indicators such as a decrease in heart rate and an increase in skin conductance (Lang, 1995). Under limited capacity theory, orienting response eliciting features of media messages can improve encoding of information by calling processing resources to the message (Lang, 1990). The presence of orienting response eliciting features is generally predicted to improve encoding and storage of information up to the point where the individual does not have enough processing resources available to answer the demands on their cognitive system brought on by the structural features of the message (Lang, Bolls, Kawahara, Potter & Dent, under review).

Structural features of television messages that have been shown to elicit orienting in viewers include cuts and edits (Geiger & Reeves, 1993; Lang, Geiger, Strickwerda & Sumner,1993), movement (Reeves, Thorson, Rothschild, Macdonald, Hirsch, & Goldstein, 1985) and negative video (Lang, Newhagen, & Reeves, 1996). The main challenge in extending this line of research to radio is identifying structural features analogous to these structural features in television. In the research on television, structural features appear to be defined by the degree to which they introduce new information to the viewer (Basil, 1994). Cuts and edits, as structural features of television, are distinguished from each other by the degree of new information introduced to the viewer (Thorson & Lang, 1993). It appears logical to extend this definition to radio and search for structural features of radio which clearly introduce new information into the listening environment. Such structural features could include changes from one voice to another, especially from a female voice to a male voice or vice versa. They could also include sound effects or special production effects radio stations frequently use in promotional jingles or bumpers. If the research done in television can be extended to radio, such structural features should elicit orienting responses in listeners as evidenced by a temporary slowing of heart rate and an increase in skin conductance. This leads to hypothesis one.

H1: Structural features of radio will elicit orienting responses in listeners.

Much media use occurs in low involvement conditions where audience members are not highly motivated to attend to and throughly process message information for the purpose of learning. This may be particularly true of radio which is often perceived as primarily a background media. Despite a tendency toward low involvement media use, it should be possible to increase listeners' involvement by increasing their motivation to attend to message information. If increased involvement means more mental effort is invested in processing message information, involvement should be indexed by an overall speeding up of heart rate (Lang, 1995). Thus, hypothesis two:

H2: Listeners who are more involved in the content of radio messages will put more effort into processing message information as indicated by significantly faster heart rate compared to less involved listeners.

If cognitive processing of radio messages differs by level of listener involvement then orienting responses in low versus highly involved listeners could differ as well. Lang (1996) proposed that audience members in low involvement conditions may be particularly susceptible to having their cognitive processing affected by structural features of media messages. This might lead to a prediction of greater magnitude of orienting responses in low involved audience members. However, Lang's (1996) proposition was made in the context of watching television. Differences in processing radio versus television messages (strictly auditory versus auditory and visual processing) are likely to limit the applicability of all assumptions made for research on television to radio. Instead of attempting to make a prediction concerning the magnitude of orienting response according to level of involvement, it may be more useful to first focus on differences in type of orienting response. Thorson and Lang (1992) found evidence of two different types of orienting responses. One type of response was a U-shaped cardiac response curve (CRC); that is a temporary or phasic reaction of the cardiac system marked by a decrease in heart rate followed by a recovery to a base line level. The other type of response was marked by an S-shaped CRC--a decrease in heart rate followed by an increase above a base line level, and finally a return to baseline. This S-shaped CRC has been found to be associated with the processing of verbal information (Graham, 1979, Lang, 1990).

If low and highly involved listeners are investing different amounts of mental effort, then the orienting responses of these two groups could be very different. One might expect the orienting response of low involvement listeners to resemble a U shaped curve while the orienting response of highly involved listeners would be more S shaped. This leads to hypothesis three.

H3: Listeners who are more involved in the content of radio messages will have a different type of orienting response to structural features of radio messages compared to less involved listeners.

By eliciting orienting responses, structural features of television messages affect what audience members remember (Geiger & Reeves, 1993; Lang, 1990; Reeves, Thorson & Schleuder, 1986). If orienting responses result in a temporary increase in the allocation of processing resources to the message then memory should increase for message information occurring immediately after an orienting response eliciting feature. Thus, hypothesis four:

H4: Recognition memory will be significantly better for information occurring immediately after structural features compared to information immediately before structural features.

Early research on auditory processing suggests people are able to be highly involved in one channel of auditory information while ignoring other sources of auditory information (Cherry, 1953). However, further research indicated that certain structural features of an unattended audio message would break through and be recalled by listeners (Cherry & Taylor, 1954; Deutsch, 1986). It seems that structural features of radio messages could break through to affect message memory for low involvement viewers but overall memory should be better for listeners who are highly involved in processing message content. This leads to the final hypothesis.

H5: Recognition memory will be significantly better for listeners who are more involved in radio message content compared to listeners who are less involved.

Methodology

Subjects

Subjects were college students enrolled in one of three telecommunications courses at a major Midwest university. Each subject received course credit for their participation.

Stimulus Preparation and Description

The experimental design called for the creation of audio stimuli containing elements believed to cause orienting responses in radio listeners. Most of the elements tested were structural features; that is, characteristics of the messages which were separate from the factual content. The structural features chosen for investigation were: sound effects, voice changes (the onset of a different speaker), gender voice changes (the onset of a different speaker of different gender), funny voices, commercial onsets, jingle onsets, song onsets, silence, and channel changes. Of course, the content of radio messages could also cause orienting responses in listeners. The presence of sexual content was the only such feature that was tested in this experiment.

Seven audio messages, resulting in twelve minutes in duration, were selected according to the presence of these particular structural and content features. Six of these messages were recorded off the air in a Midwest college town. Due to the difficulty of having announcers' voices overlap with the onset of broadcast songs, the seventh message was a rock and roll song recorded directly from compact disc.

Four tape orders were constructed using the seven messages. There was a desire to have the orders flow as logically as possible in order to represent the frequent experience of hearing announcers' discourse being followed by a song. For that reason, the song was the fourth element in all four tape orders, with the six broadcast messages being placed in different logical orders around it. No broadcast message appeared exclusively before or exclusively after the song. Also no two broadcast messages were adjacent to each other in more than one tape order.

The tape orders were transferred onto the audio track of a VHS videotape which had been blacked and time coded. This allowed the exact location of the features (plus or minus second) to be determined.

Experimental Procedure

There were four experimenters who conducted this study; each followed the same experimental protocol designed to obtain data on human reactions to and memory for television, computer media, and radio. The radio protocol reported in this section was always the second set of procedures subjects participated in.

Prior to the subjects' arrival, a series of safety checks was conducted on the data collection equipment to ensure the safety of the subjects. Only one subject participated in the experiment at a time. Each was greeted by the experimenter, who then explained that the purpose of the study was to gain a better understanding of how human beings react to the media, specifically television and computers. After obtaining informed consent, Beckman AG/AGCL electrodes were applied to the subject's arms and hands to measure heart rate and skin conductance.

The first set of procedures involved either watching a set of television messages or interacting with a computer monitor and keyboard. After these procedures were completed, subjects were told that the researcher needed to take about ten minutes to do some calculations on the data which had just been collected. The researcher told the subject that, in the meantime, radio messages would be played for them to listen to. Half of the subjects were instructed that they should pay attention to the radio messages, as they would later be asked questions about them. The other half of the subjects were told to sit back and relax until the second half of the experiment was ready to get underway.

After the radio messages were played, subjects participated in other portions of the protocol dealing with television and computer interactions. These acted as distractor tasks for the cued recall test on the radio messages. For these tests, subjects were given several sheets of paper. Each sheet had a simple typed cue on the top corresponding to one of the radio messages (i.e., "You heard a commercial for a restaurant"). Subjects were instructed to write down everything that they remembered about each message they were cued to. The cued recall data is not reported in this paper.

After completing another distractor task, subjects were given a recognition memory test for the radio messages. This test consisted of listening to 3-second portions of audio messages. The subjects were told that some of the portions were from messages they had heard previously, and others were not. Using a joystick held in their dominant hand, subjects were instructed to answer as soon as they knew whether or not they had heard the portion earlier in the experiment.

After the entire protocol was completed, subjects were debriefed, thanked, and dismissed.

Apparatus

Heart rate and skin conductance were collected from the subjects as they listened to the radio stimulus. The stimulus tape was played by a Panasonic videocassette recorder through the speakers of a 19-in. television placed approximately 5 feet from the subject. The videocassette recorder, experimenter, and physiological recording equipment were separated from the subject by an 8-foot wooden wall.

The lab was controlled by a 386 computer with a LabMaster AD/DA board installed. Coulbourne physiological equipment was used in the collection of data. Heart rate was measured as the milliseconds between heart beats and was analyzed as the average heart rate per second. Skin conductance data were collected as an analog signal sampling at 10 times per second. Recognition tests were given using a Sidewinder joystick. Subjects would press one button on the joystick if they had heard the audio segment before, and another one if they had not. Recognition results were coded for accuracy and response latency on a 386 computer using the Slimy Recognition/Reaction Time program.

Analyses

The heart rate data were analyzed using an 18 (Feature) X 10 (Time) X 4 (Order) X 2 (Instruction) ANOVA. The within subjects factors were Feature (with 18 levels, representing the different structural features tested) and Time (with 10 levels, representing second prior and 9 second following feature onset). The between subject factors were Order (with four levels representing the presentation orders) and Instruction (with two levels corresponding to the "Pay Attention" and the "Relax" instructions). Missing heart rate data were recoded to the mean heart rate across subjects for that second. 8 values out of 6840 were missing, resulting in 0.12% of the heart rate data being recoded to the mean.

The skin conductance analysis was done on the change scores; that is, the extent to which skin conductance levels changed after the onset of the structural features. The data were analyzed using an 18 (Feature) X 4 (Time)X 4 (Order) X 2 (Instruction) ANOVA. The within and between subjects factors for this analysis were the same as above except that the Time factor had 4 levels, representing the change scores for the 4 second following the feature onset. Due to researcher error during data collection, skin conductance data from three subjects were missing. Therefore, n=35 for the skin conductance analysis.

The recognition data were analyzed using an 18 (Feature) X 2 (Position) X 4 (Order) X 2 (Instruction) ANOVA. The within and between subjects factors for this analysis were the same as above except for the Position within subjects factor which had two levels, before and after. These levels corresponded to whether the 3-second audio portion being tested occurred before or after the structural feature.

Results

Hypothesis 1

This hypothesis predicts that structural features of radio messages will elicit orienting responses in radio listeners. The orienting response was identified by a decrease in heart rate and an increase in skin conductance for the brief period following the structural features. The main effect for time on the heart rate data was significant ($F(9,270)=5.64$ $p<.0001$, epsilon squared=.1207). The cardiac response curve (CRC) shown in Figure 1 represents the mean heart rate for the 10 second surrounding all eighteen structural features. In this Figure, the onset of the structural feature occurs at the 2 second mark. As predicted, the mean heart rate sharply decreases following the feature onset. The cubic component of the curve shown in Figure 1 is significant ($F(1,6)=11.51$ $p<.007$). Since the CRC is not a straight line, we can conclude that an involuntary phasic cardiac response occurred as a result of the structural features in the radio messages.

The main effect for time on the skin conductance change scores was also significant ($F(3,81)=2.77$, $p<.047$, epsilon squared=.0182). Figure 2 shows an increase in skin conductance for the first two seconds after the onset of an audio structural feature, after which time the skin conductance returns to pre-orienting levels.

With the significant main effect for time on both heart rate and skin conductance, Hypothesis 1 is supported.

Hypothesis 2

This hypothesis predicts that listeners who are more involved with radio messages will have significantly faster heart rates than listeners who are less involved with those messages. The main effect for instruction was not significant ($p>.05$). However, Figure 3 shows that the means are in the expected direction, with involved listeners ("Attenders") having faster heart rates than uninvolved listeners ("Relaxers").

Hypothesis 3

This hypothesis predicts that people involved in processing radio messages would have different orienting responses than those who were not involved. This prediction was supported by a significant Instruction X Time interaction ($F\ (9,270)=2.42$ $p<.01$ epsilon squared=.0347). Figure 3 shows the CRCs for the Attenders and the Relaxers. Those who were involved in the message exhibited an S-shaped CRC which had a significant cubic component ($F\ (1,6)=12.43$ $p<.006$). The CRC for the Relaxers, on the other hand, was much less pronounced and took on a U-shape. The quadratic component for this curve was significant ($F(1,7)=14.12$ $p<.003$). Since the CRCs obtained for each level of the involvement manipulation are best fitted to different curvilinear equations, Hypothesis 3 is supported.

Hypothesis 4

This hypothesis predicts that there will be significantly better recognition memory for information presented immediately after structural features compared to information presented immediately before. The main effect for position on the memory data was not significant ($p > .05$). Hypothesis 4 is not supported.

Hypothesis 5

It was also predicted that listeners who were more involved in processing radio messages would have significantly better recognition memory than those who were not involved. This prediction was tested using the Position X Instruction interaction on the recognition data. This interaction was not significant ($p>.05$). Hypothesis 5 is not supported.

Discussion

This research attempts to answer three questions. First, do certain structural features of radio messages elicit orienting responses in listeners? Second, do people who are paying attention to a radio message orient to its structural features differently than people who are not paying attention? Finally, how does orienting to radio messages affect memory for those messages? The answers to these questions have both practical and theoretical applicability, as we will attempt to show in this discussion.

Previous research has used a phasic decrease in heart rate and increase in skin conductance as indicators of orienting responses to the structural features of television messages (Lang, 1990). In the current study, the same psychophysiological phenomena were obtained in response to structural features in radio. This suggests that certain aspects of audio messages can cause brief, automatic increases of attention in listeners.

This information is of great interest to those in the radio industry who depend upon the ability of their audio creations to capture the attention of an audience. Consider, for example, a News Director for a radio station. She has daily decisions to make concerning the on-air presentation of the news product. Our results show that there are specific structural features (i.e., voice changes) she can employ to cause listeners to pay attention. Armed with this knowledge, the News Director could choose to use two different anchors to deliver each newscast or insert actualities at times when important information is being reported.

Similarly, consider a radio Program Director whose job, one could argue, is to cause listeners to pay attention to his station. Our results indicate two important things that a P.D.

might want to keep in mind. First, there are certain production elements that cause listeners to orient to audio. The judicious use and placement of such elements could increase listeners' attention to a message at strategic times (i.e., near important news information or adjacent to call letters).

Perhaps of even more interest to a Program Director are the findings obtained from those subjects not actively processing the radio messages; that is, those whose experimental condition had them simply relaxing in a room with the radio playing. Certainly, the P.D. could say that such a condition has greater external validity since it more closely replicates the way radio is used as a "background medium". Plus, our findings show that these listeners still orient to structural features in the messages. Therefore, if an orienting response occurs prior to a particularly compelling piece of content, a well-placed structural feature may able to hook a previously inattentive person into listening closely to your message!

From a theoretical standpoint, this research represents the first step towards generalizing to other media the long history of research conducted on the cognitive processing of television messages. Results showing that certain radio features cause listeners to orient suggest that future research continue to make analogies between television and radio processing. The question of "how much is too much" is of theoretical and practical interest, of course. One could argue that our results indicate that by having different announcers deliver every other word of the nightly newscasts, listeners would never be able to stop orienting to the messages. Intuitively, however, there seems to be a point of diminishing returns where listeners would habituate to the presence of structural features. In other words, the novelty would be lost due to constant repetition. Another possibility is that the overuse of structural features to capture attention becomes annoying to listeners. The optimal number of structural features is a mystery left for future research.

It is important to note that our results are consistent with previous work done in psychology and physiology. We found that radio listeners orient to structural features regardless of whether or not they are actively processing the content of the message. These findings are theoretically consistent with those of dichotic listening experiments done in basic psychology (Cherry, 1953 & Moray, 1959 in Pashler, in press) where subjects were provided with different audio messages in both ears but told to attend to only one. Results of these experiments show that certain aspects of information provided in the unattended ear cause it to "break through" and be stored in memory. Future studies should investigate how structural features facilitate this breakthrough effect, and whether the listeners' have conscious awareness of this facilitation.

Similarly, results which show different cardiac response curves depending upon whether listeners were paying attention to the content of the messages or simply relaxing in the room with the radio on, replicate previous research indicating that S-shaped cardiac response curves are indicative of processing verbal information (Graham, 1979; Lang, 1990). Meanwhile, as shown in Figure 3, the "Relaxers" in our experiment produced a U-shaped curve which is indicative of processing of the structure rather than the content of the message. This finding also seems to make sense; those not paying close attention the content of the radio messages would be more likely to experience the structural features as a change in the form of the message rather than something in the content itself. Future research should continue to investigate the different ways involvement in radio messages affects the way they are cognitively processed.

Finally, some mention should be made of the non-significant recognition results. From a practical standpoint, one could argue that the fac listeners orient to structural features is irrelevant if orienting does not improve memory for radio messages. However, it is important to remember that the statistical analyses were done on data collected for time points surrounding all 18 features believed to cause orienting. Such analyses allow for the possibility that either some of the general feature categories tested do not cause orienting, or that the features used as stimuli were poor examples of the category. While it seems that the physiological responses were large enough to overcome these possibilities, it is possible that the memory responses were not. To test this possibility, a post-hoc ANOVA was done on the memory data for the voice change structural features only. Here, there was significantly better recognition for information after voice changes ($F(1,19)=9.25$, $p < .007$, epsilon squared=.1482) than before voice changes. These results are shown in Figure 4. This significant result, when compared to the overall lack of significance in the recognition data, suggests that further analyses and research be conducted to determine exactly which structural features cause the most orienting and result in the best memory.

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Figure 1: Main effect for time

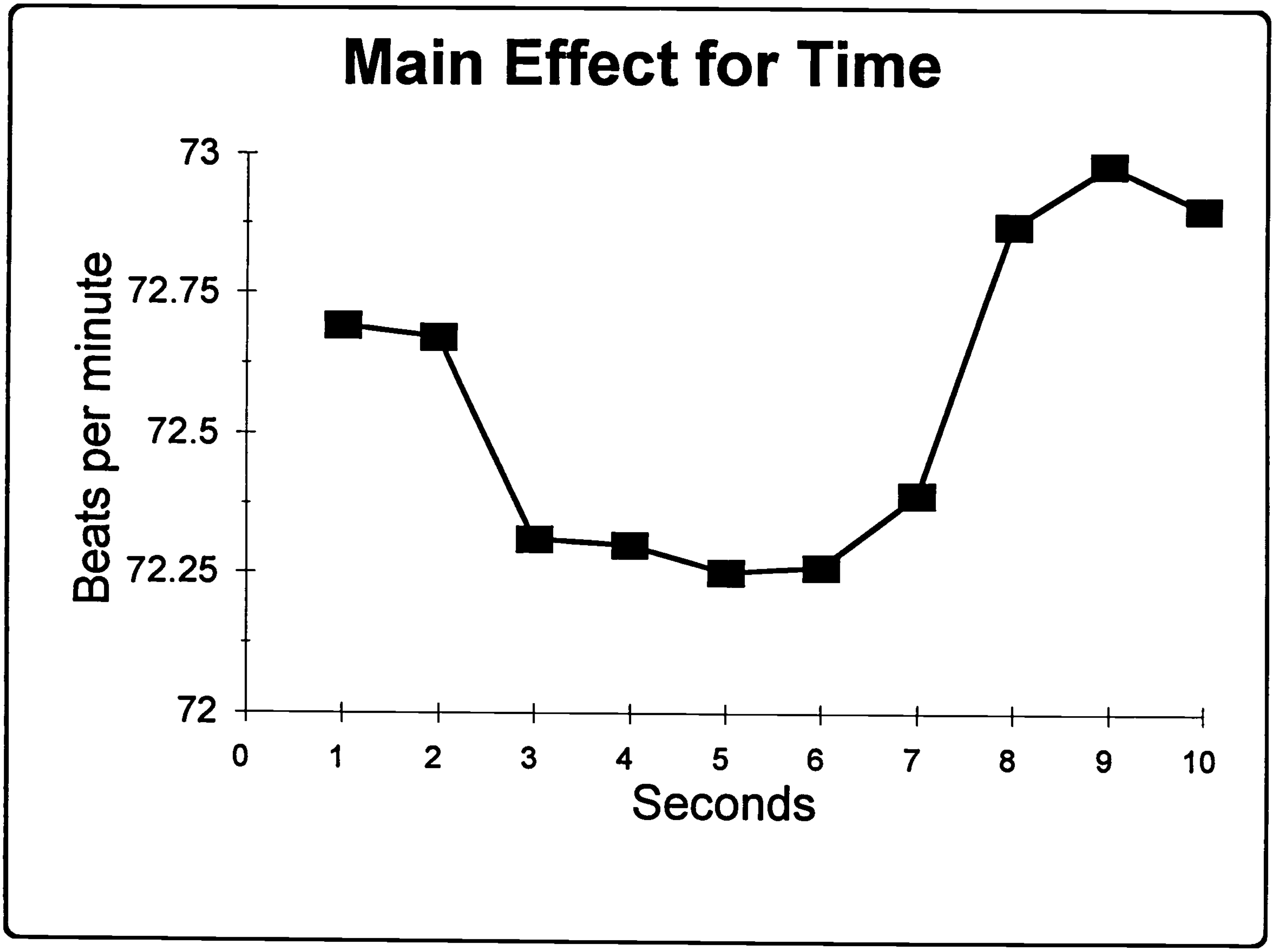

Main Effect for Time
73
72.75
72.5
72.25
72
Beats per minute
0
1
2
3
4
5
6
7
8
9
10
Seconds

Figure 2: Skin conductance by time

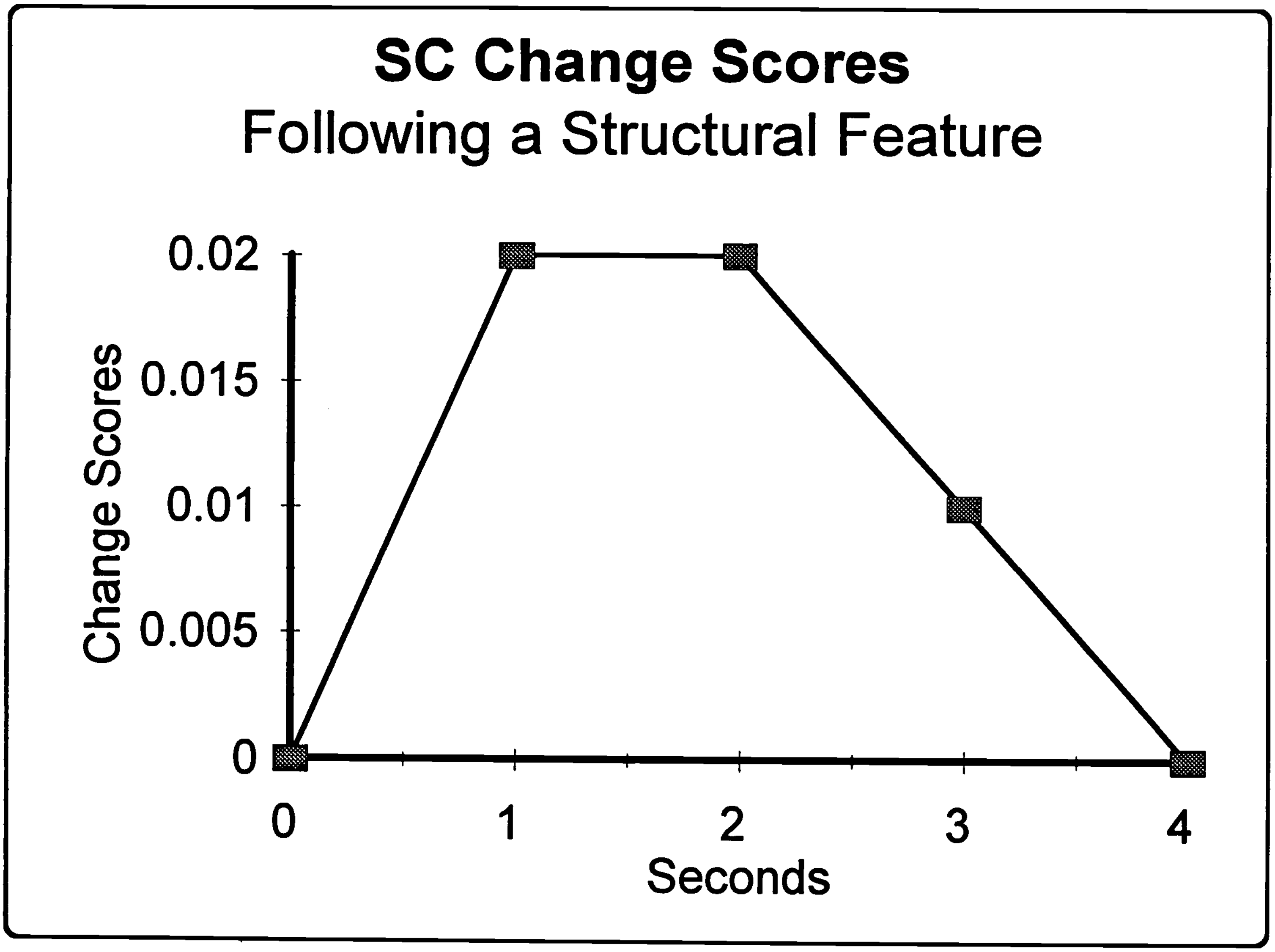

SC Change Scores
Following a Structural Feature
Change Scores
0.02
0.015
0.01
0.005
0
0
1
2
3
4
Seconds

Figure 3: Attention by time interaction

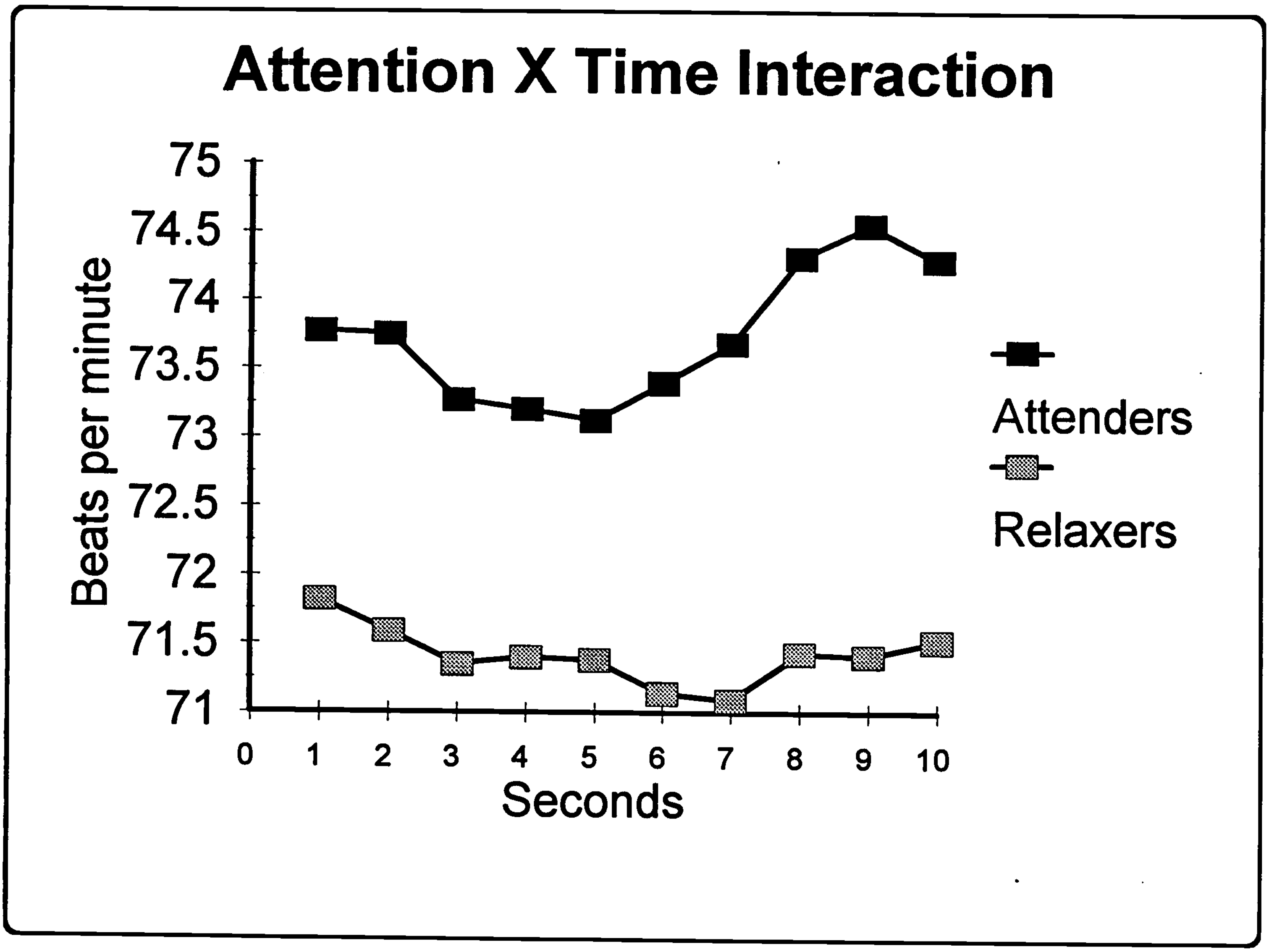
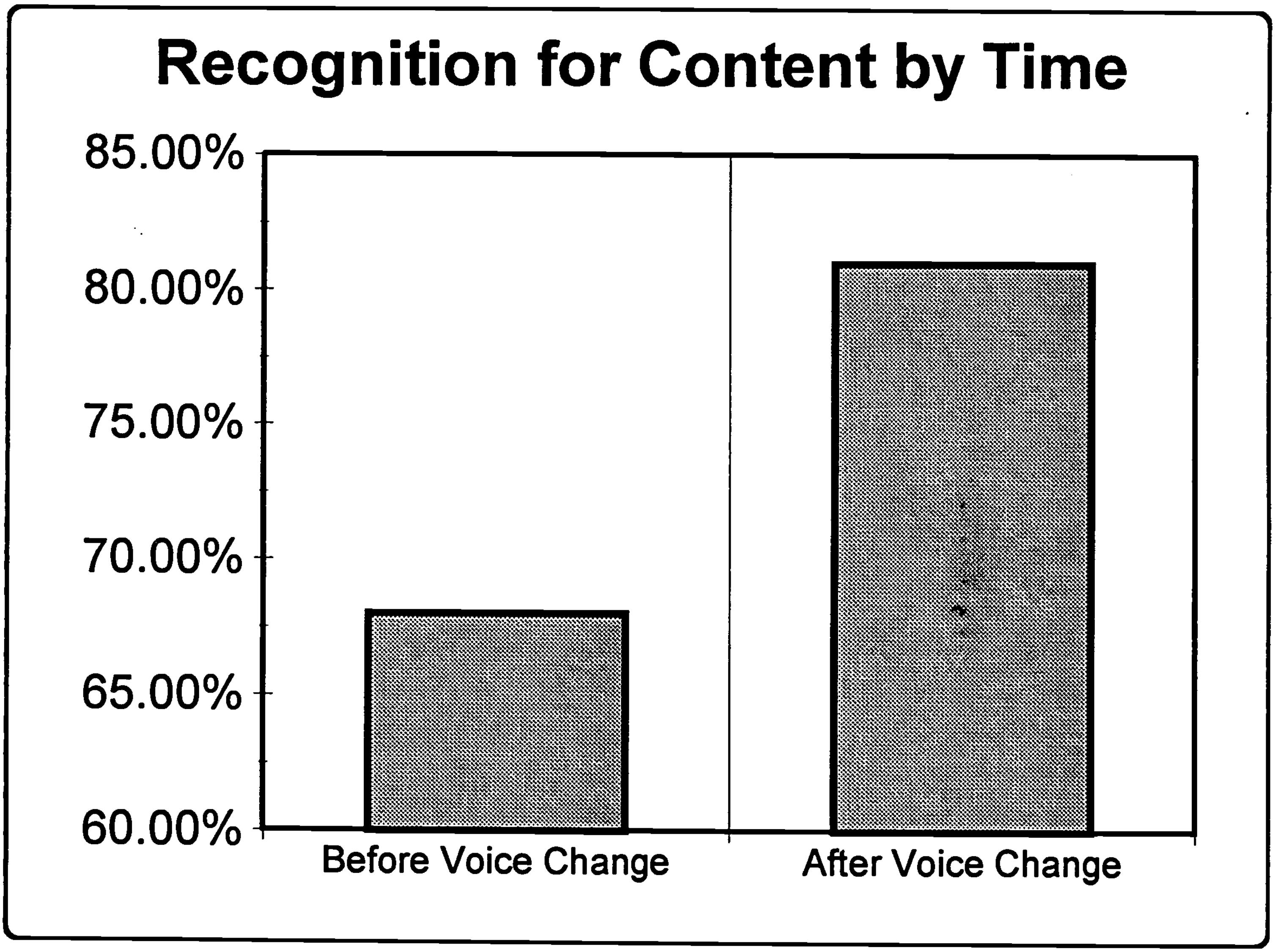

Attention X Time Interaction
Beats per minute
75
74.5
74
73.5
73
72.5
72
71.5
71
0
1
2
3
4
5
6
7
8
9
10
Seconds
Attenders
Relaxers

Figure 4: Memory before and after voice change


Recognition for Content by Time
85.00%
80.00%
75.00%
70.00%
65.00%
60.00%
Before Voice Change
After Voice Change

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