Cognitive Access to Negatively Arousing News: An Experimental Investigation of the Knowledge Gap

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An Experimental Investigation of the Knowledge Gap

Over the past 30 years, survey researchers have documented the existence of a knowledge gap and expressed concern that people with little education are falling behind because they do not acquire the information necessary to participate in socioeconomic spheres. This study is the first to offer (a) experimental evidence for the existence of the knowledge gap and (b) explanations for it in terms of varying levels of information processing capacities, or cognitive access. Participants from higher and lower educational backgrounds paid equal levels of attention to television news stories, but they did not display the same recognition memory for facts. Moreover, participants in the higher education group were physiologically more aroused by news than those in the lower education group. These findings do not pinpoint whether cognitive access is learned or innate, but they do suggest that the biological systems of people from higher educational backgrounds are particularly alert in processing for information processing.

The idea that people with little education have less knowledge about important social issues than people who achieve higher levels of education challenges democratic ideals of equality. A number of scholars (Beltran, 1975; Bennett, 1988; Childers & Post, 1975; Deli Carpini & Keeter, 1994; Donohue, Olien, & Tichenor, 1987; Graber, 1993; Olien, Donohue, & Tichenor, 1983) have argued that knowledge, particularly about public affairs, is a major means to empowerment. Put simply, social systems favor people who are informed, whereas the uninformed become disenfranchised, often without
being aware of it (Deli Carpini & Keeter, 1994). Although people from lower socioeconomic strata do accumulate knowledge, it is typically gossip, rumor, and folklore rather than knowledge that is socially and economically empowering (Childers & Post, 1975; Moore, 1987; Price & Zaller, 1993).

Tichenor, Donohue, and Olien (1970) first alluded to the mass media's contribution in perpetuating knowledge inequities when they formally posed the knowledge gap hypothesis:

As the infusion of mass media into a social system increases, segments of the population with higher socioeconomic status tend to acquire this information at a faster rate than lower segments, so that the gap in knowledge between these segments tends to increase rather than decrease. (pp. 159-160)

From the time of this formulation to 1997, approximately 100 studies, each examining some dimension of the knowledge gap hypothesis, have been published (for comprehensive reviews of the literature, see Gaziano, 1983, 1997; Viswanath & Finnegan, 1996). Without exception, existing research on the knowledge gap hypothesis has employed survey methodology to examine correlational and causal relationships between knowledge and such variables as education, media exposure, attention, interest and involvement in public affairs media, salience of the message to audience members, and channel use (radio, television, newspaper) of audience members. The survey approach to studying the knowledge gap certainly has utility. Yet, there is reason to argue for methodological reevaluation when a theorem such as the knowledge gap hypothesis, which focuses on individual-level information acquisition, has only been investigated through the aggregate-level survey method. To date, not a single experimental study has been conducted to examine the information processing mechanisms that might underlie variance in information gain. The study reported here attempts to fill this void by being the first to do so.

Physical Versus Cognitive Access

Whereas physical access to information has been identified as a central contingent condition in knowledge gap research (see Gaziano, 1983, 1997; Viswanath & Finnegan, 1996), the matter of cognitive access or information processing competence has virtually been ignored as a possible explanation for knowledge inequities. Although not specifically tied to the knowledge gap, the distinction between physical and cognitive access is starting to enjoy attention in information science studies of the Internet. Physical availability
of equipment through which citizens can search and locate information in a media environment is distinguished from the ability of media consumers to access and make use of online information (Kling, 1999).¹

The distinction between physical and cognitive access to mediated information, particularly television, also deserves attention as it might shed light on why this medium fails to rectify information inequities. The popular assumption that television messages are processed without much effort might account for why knowledge gap researchers have ignored issues related to cognitive access and instead investigated television news for its potential to level knowledge inequities (see Galloway, 1977; Gantz, 1978; Neuman, 1976; Shinghi & Mody, 1976; Tichenor et al., 1970; Torsvik, 1972). Investigations of television’s capacity to create a more evenly informed citizenry have generally been inconclusive. In fact, a number of knowledge gap studies have contradicted the notion that television viewing eliminates the knowledge gap (Gandy & El Waylly, 1985; Griffin, 1990; Gunter, 1987; Horstmann, 1991; McLeod & Perse, 1994; Simmons & Garda, 1982). As the information processing literature has demonstrated, viewing television news is not a simple cognitive task. The cognitive system is burdened with processing multiple audio-visual channels (voice, ambient sound, visual material) of mostly survival-related information in a living environment crowded with distraction (see Drew & Grimes, 1987; Graber, 1990; Newhagen, 1998). These findings fuel the motivation for an experimental investigation of the knowledge gap with focus on television news.

Approximately 99% of homes in the United States have at least one working television set and 70% of homes have more than one set (U.S. Bureau of the Census, 1997). These figures indicate virtual saturation, and in essence, full physical access to television. In terms of television news viewing, 64% of Americans say they rely on national and local television newscasts for information (Radio Television News Director’s Association, 1999). Knowledge gap research confirms that people on the lower socioeconomic strata tend to depend more on television than print media for information (Bogart, 1981; McLeod & Perse, 1994). Physical access or exposure to television news is central to this investigation because different levels of familiarity with television news formats might affect how people with different educational backgrounds process television news. Hence,

Research Question 1: Does exposure/physical access to television news differ by educational level?

Although the notion of cognitive access has not yet been employed in television news research, a number of studies in the information processing
tradition point to the logic of testing this concept in the context of the knowledge gap hypothesis.

The limited capacity model of information processing (Geiger & Newhagen, 1993; A. Lang, Dhillon, & Dong, 1995) proposes that television viewers do not retain all the information they are exposed to during a broadcast but instead select portions of messages for encoding and storage into long-term memory. At the same time, previously stored information needed to make sense of the current message is retrieved. These subprocesses (selection, encoding, storage, and retrieval) occur continuously and simultaneously during viewing, taxing the viewers’ information processing resources. Thus, not all audio-visual information is selected, encoded, stored, and retrieved with the same efficiency.

The allocation of processing resources, whether controlled or automatic, plays an important role in storing information. Controlled processes, as the term implies, are under the control of the viewer. Several factors may activate controlled resource allocation, including the viewers’ goals, intentions, interests, and motivations. Automatic processes, on the other hand, are triggered by characteristics of the message. Structural features (attention-grabbing video editing and camera techniques), as well as compelling message content, elicit involuntary allocation of processing resources.

The motivation to attend to a message, or controlled processing, varies greatly from viewer to viewer, whereas the basic mechanics of automatic information processing are shared by most human biological systems. Thus, differences among viewers in terms of controlled information processing are largely explainable by varying levels of interest in the message; differences among viewers in terms of automatic processing are best explained by variance in aptitude to process information efficiently. When automatic processing is activated, researchers have an opportunity to study the underlying processes of information gain without interference from motivational factors.

Among the variables used to study information processing, physiological and emotional arousal, attention, and recognition memory are the most revealing (A. Lang et al., 1995; A. Lang & Basil, 1998; Newhagen & Reeves, 1992). These three concepts constitute important catalysts of information processing and, for the purposes of this study, are treated as determinants of cognitive access and ultimately information gain.

**Arousal**

Research has established associations between arousing television messages and a number of outcomes of information processing. First, arousing television content elicits more attention than calm television messages (A. Lang
et al., 1995; A. Lang, Newhagen, & Reeves, 1996; Newhagen & Reeves, 1992, Zillmann, 1982). Second, viewers allocate more processing resources (measured using secondary-task reaction times) to arousing messages, compared to calm messages (A. Lang et al., 1995; Lang et al., 1996). Third, viewers have better recognition memory (A. Lang, Bolls, Potter, & Kawahara, 1999; A. Lang et al., 1995; A. Lang, Zhou, Schwartz, Bolls, & Potter, in press), cued recall (A. Lang, Bolls, et al., 1999), and free recall or comprehension (Gurevitch & Levy, 1986; Lang et al., 1995) for arousing messages, compared to calm messages. Thus, when messages are arousing, viewers (a) automatically pay more attention to media content, (b) automatically allocate processing resources to encoding and storage, and, as a result, (c) experience an increase in sympathetic nervous-system activation. Most importantly, these three consequences of arousing messages improve the ability of viewers to gain information from viewing television news.

Negatively arousing messages appear to have particularly powerful outcomes for information gain. Reeves, Newhagen, Maibach, Basil, and Kurz (1991) and A. Lang and colleagues (1996) report that memory is better for negative than positive messages. P. J. Lang (1985), Newell (1990), and Shoemaker (1996) explain the influence of negative messages on information processing from the perspective of evolutionary psychology: In the face of a survival threat, emotional conditions are automatically activated to enhance physical performance (attack or flight). Newhagen and Reeves (1992), Newhagen (1998), and Shoemaker (1996) argue that negatively compelling television news images resemble a nonmediated survival threat to the degree that the biological systems of viewers automatically prepare for premium performance, hence the increase in physical and emotional arousal, attention, and memory associated with negatively compelling messages (see also Basil, Schooler, & Reeves, 1991; Bradley, Greenwald, & Hamm, 1993; Bradley, Greenwald, Petry, & A. Lang, 1992; A. Lang & Friestad, 1993; Newhagen & Reeves, 1992; Reeves, A. Lang, Thorson, & Rothschild, 1989; Reeves et al., 1991).

Negatively arousing stimuli could be expected to optimize automatic information-processing operations so that the underlying mechanisms might be studied in people from different educational backgrounds. No previous research suggests that people with different educational backgrounds should experience different levels of physiological or self-reported arousal when they watch negatively compelling news. In fact, a few knowledge gap studies have indirectly suggested that the arousal response to negatively compelling messages should not differ by educational background (see Frazier, 1986; Galloway, 1977; Genova & Greenberg, 1979). Donohue, Tichenor, and Olien (1975) conclude that knowledge gaps about local news issues tend to narrow
because these issues are typically about conflict and therefore should be salient to all people, regardless of educational background. This salience assumption leads to a second research question:

*Research Question 2*: Do arousal responses to negatively arousing news stories differ by education level?

*Attention*

Weenig and Midden (1997) suggest that less-educated people pay less attention to media messages than people who are more educated. From an information processing perspective, different levels of attention are caused by differences in the allocation of processing resources on account of either motivation or information processing competency. The first possibility, that the difference lies with the motivation of viewers, is more a question about interest and behavior than pure cognitive access. In knowledge gap research, motivation emerges as one of the most prominent individual-level variables to explain information differences (see Gaziano, 1997; Viswanath & Finnegan, 1996). Motivation to attend to messages has been tested in relation to knowledge gain using variables such as viewer interest, involvement, concern, participation, and perceived message importance (see Chew & Palmer, 1994; Ettema & Kline, 1977; Ettema, Brown, & Luepker, 1983; Fredin, Monnett, & Kosicki, 1994; Genova & Greenberg, 1979; Kwak, 1999; McLeod & Perse, 1994). Ettema and Kline (1977) and Ettema and colleagues (1983) conclude that knowledge gaps exist in part because of differing levels of interest in and use for information. They dismiss information processing explanations for the knowledge gap by arguing that public affairs issues do not require highly developed processing abilities. Instead, they argue that public affairs issues are merely more important and useful to people in higher socioeconomic groups, which leads to the formation of knowledge gaps.

To assess the contribution of motivation to news information acquisition, both the information and entertainment interests of viewers were considered in this study. This leads to a third research question:

*Research Question 3*: Do evaluations of the informativeness and enjoyment of negatively arousing news stories vary by education level?

The second reason why viewers might allocate varying amounts of attention resources to news viewing involves their cognitive processing competence. To maximize the chances of measuring the information processing
mechanisms at work, rather than the motivation of viewers to attend to messages, the effect of motivation on allocation of processing resources could be controlled in the experimental setting. First, participants could be instructed to pay close attention to the messages because their memory for the content will be tested. Second, as already discussed, negatively arousing news stories trigger automatic allocation of processing resources, thereby overwhelming individual differences in motivation to attend to the news. This leads to the fourth research question:

*Research Question 4:* Does attention to negatively arousing television news stories vary by education level?

**Encoding of Information**

Viewers with higher education levels may remember more from the media because the process of reasoning is more elaborated for educated people than for the less educated (Park & Kosicki, 1995). It is generally thought that greater elaboration leads to a higher level of processing and an increase in the amount of information stored (Craik & Lockhart, 1972).

Similarly, Rogers (1976), Robinson (1967), and Chew and Palmer (1994) argue that less-educated people may have less-developed cognitive abilities to select, store, and retrieve information, suggesting that they may gain less knowledge from the same amount of information exposure than higher educated people. Stauffer, Frost, and Rybolt (1978) attribute memory differences to the possibility that people in higher and lower education groups do not obtain information from television news with the same efficiency. A possible explanation is that the educational processes that develop specific reading and writing skills may enhance the general ability to process visual and aural information (Park & Kosicki, 1995).

These authors suggest that memory is better for people with higher levels of education because their cognitive processes involved in producing memory function more efficiently. To investigate whether education impacts the efficiency of information storage, this study tests how well participants with varying levels of education fare in encoding and retrieving information. This leads to the fifth and sixth research questions:

*Research Question 5:* Does the encoding of information from negatively arousing news vary by education level?

*Research Question 6:* Does memory sensitivity vary by education level?
Method

Participants with different educational backgrounds were recruited for this study. One group had no more than a high school education, whereas the other group had at least some postgraduate education. The participants were invited to view eight broadcast news stories. During viewing, participants' heart rates and skin conductance were measured. Immediately after viewing each story, respondents rated it for enjoyment and information value and indicated their own emotional response. A verbal recognition task, testing recognition memory for information in the story narratives, was administered after participants had viewed all eight stories.

Design

This experiment used a mixed education (2) × story (8) × order (4) repeated measures design. Education and order were between-participants factors, whereas story was a within-participants factor. Education had two levels, higher and lower. The repetitious story factor comprises the eight news stories that participants viewed. The four levels of order represent the four quasi-randomized orders of the stimulus tape that were produced. Participants were randomly assigned to view one of the stimulus tape orders.

Stimulus Materials

The stimuli for this experiment consisted of nine stories. One story was used as a practice message for participants to familiarize themselves with the experimental situation. The practice story was viewed first in every experimental order. The other eight stories were used for data collection. The story topics included a drive-by shooting; a hostage situation; a tornado; a flood; conflict between abortion protesters, the police, clinic workers, and patients; a residential fire; violent clashes between KKK and Black Panther protesters; and conflict during a flag-burning rally. Each of these stories contained negatively compelling images, which are most likely to automatically command attention from viewers.

Raw video material for the stimuli was obtained from WISH-TV, the local CBS affiliate. Edited stories ranged from 90 to 120 seconds in duration. Four male newscasters, all with professional experience in broadcast news, were used for voice-over narration. Each newscaster narrated two stories. The stories were produced on an AVID nonlinear editing system.
Dependent Variables

*Media use/physical access*. Before the experiment, participants recorded on the questionnaire how often they watched local news, national newscasts, and television news magazine programs. Ratings were made using a 3-point scale: once a week, 2 to 3 times a week, or more than 4 times a week.

*Education*. Two groups of participants were used in this experiment. Participants were either in the higher education group \((n = 20)\) or in the lower education group \((n = 20)\). Participants with some graduate education were recruited from interdisciplinary academic programs at a large midwestern university. Potential participants with academic training in journalism or telecommunications were excluded from the participant pool to minimize familiarity with the stimulus material. The lower education group consisted of university employees with no more than a high school education. Participants in the lower education group included janitors, cooks, and physical plant workers.

Like the majority of investigators of the knowledge gap, we were interested in participants with different levels of education and ended up with participants who also differed in terms of social status. However, we do not view these differences in the social statuses of participants as confounding the education variable because education level is a key dimension in measuring the very complex notion of social class. In fact, knowledge gap researchers have documented a strong correlation between education and other social class variables such as income and occupation (see Gaziano, 1997). There is also a large body of literature in sociology that documents the high correlation between education and social class (e.g., see Gorman, 1998; Kinloch, 1987; Shanahan, Miech, & Elder, 1998; Yeakey & Bennett, 1990).

Arousal

Both self-reported and physiological arousal were measured in the experiment. Self-reported arousal was measured using the Self-Assessment Mannequin (SAM) (P. J. Lang, Greenwald, Bradley, & Hamm, 1993). The SAM scale is composed of three 9-point pictorial scales that measure three dimensions of emotion (arousal, valence, and dominance). For this study, we used only the arousal scale. SAM has been shown to be a valid measure of emotional response to many types of media messages, including television (Detenber & Reeves, 1996; A. Lang et al., 1995; Lombard, Reich, Grabe, Campanella, & Ditton, 2000). Lower scores on the arousal dimension of SAM reflect greater self-reported arousal \((1 = arousing, 9 = not arousing)\).
Skin conductance has been reliably employed as an indicator of sympathetic nervous system activation, signaling arousal (Cacioppo & Tassinary, 1990; Hopkins & Fletcher, 1994). Activation of the sympathetic nervous system leads to an increase in sweat gland activity, causing greater skin conductivity. Skin conductance responses were collected 20 times per second throughout the presentation of each story and for a 5-second baseline period prior to each story's onset. Each participant's skin conductance during the news stories was coded for the frequency of spontaneous skin conductance responses. A skin conductance response was defined as an increase in skin conductance level of at least 0.5 micro siemens (see Cacioppo & Tassinary, 1990). The greater the frequency of skin conductance responses, the greater the activation of the sympathetic nervous system.

**Motivation measures.** Single-item semantic differential rating scales were used to obtain participants' subjective evaluation of each news story. Between stories, participants rated how enjoyable and informative each story was on 10-point semantic differential scales (1 = low, 10 = high).

**Attention.** Participants' heart rates were used as a measure of how much attention was being paid to the news stories. Research has shown that cardiac deceleration is a physiological indicator of increased attention paid to an external stimulus (Cacioppo & Tassinary, 1990; A. Lang, 1990), including television messages (A. Lang, 1994; A. Lang, Bolls, et al., 1999; A. Lang, Zhou, et al., in press; A. Lang et al., 1996). Although the heart is under the dual control of the sympathetic and the parasympathetic nervous system, heart rate decelerates during attention due to activation of the parasympathetic nervous system (Cacioppo & Tassinary, 1990).

Heart rate data were collected throughout the presentation of each story and for a 5-second baseline period immediately prior to the onset of the story. Heart rate was averaged over 5-second intervals in the stories and transformed into change scores by subtracting the 5-second averages from heart rate during the last second of the baseline period. The length of news stories varied, but 16 to 26 heart-rate change scores were computed for each story. Analysis was performed on change scores computed during the first 40 seconds of each story. Because attention can fluctuate over the course of a message, heart rate data were analyzed over time. Thus heart rate data were analyzed using an education (2) × story (8) × order (4) × time (8) mixed repeated-measures ANOVA. The first three factors (education, story, order) are the factors described above. For the heart rate data, another factor, time (8), was included. This factor refers to the eight 5-second periods that
comprise the first 40 seconds of each message, allowing analysis of the change in heart rate over the course of the messages.

**Encoding of information.** Recognition of news story content was tested using a forced-choice recognition test. Participants were presented with 112 two-second audio clips. Half of the clips were from news stories the participants had viewed, and half were foils from stories they did not view. Seven audio clips were taken from each of the eight news stories. Clips were selected to test recall memory for information related to the five Ws and H journalistic formula (who, what, where, when, why, and how) in addition to how the local news event fit national trends. Four randomized orders of the audio recognition test were produced. Participants were instructed to indicate whether the clip was or was not from one of the news stories they viewed.

Recognition data were analyzed both in terms of accuracy (percentage of correct answers) and signal detection analysis. Signal detection analysis is based on the theory that finding a memory in the brain is similar to detecting a weak signal in the environment (see Shapiro, 1994). Two major components affect a person’s decision about whether a signal or memory event is detected. One dimension of that decision is how sensitive or good a person’s memory is, called sensitivity or (d prime). The second dimension of the decision about whether a signal/memory is detected relates to how willing a person is to guess. This dimension is called the criterion bias: how liberal or conservative a person’s decision-making strategy is.

To perform a signal detection analysis, four values are computed for each participant: (a) the percentage of hits—the percentage of items participants say they have seen before they have in fact seen it; (b) the percentage of misses—the percentage of items they say they had not seen before that they had seen; (c) the percentage of correct rejections—the percentage of items they say they had not seen before that they had not seen; and (d) the percentage of false alarms—the percentage of items they say they had seen before that they had not seen. These values are combined to compute a participant’s sensitivity (d prime) and criterion bias. The greater a participant’s sensitivity, the more accurate their memory, both in terms of hits and correct rejections. Criterion bias is determined by the number of false alarms and misses and is interpreted as how confident a participant needs to feel about having seen an item before being willing to say the item was seen before. Signal detection analysis allows researchers to attribute the percentage of correct memories to either a sensitive memory or a willingness to guess.
Procedure

Informed consent was obtained from all participants. The informed-consent form stated that the purpose of the study was to learn more about how people learn from mediated messages. It also informed participants of the placement of electrodes for the collection of physiological data. Each participant was paid $10 for partaking in the experiment.

Participants viewed the news stories sitting approximately 5 feet from a 20-inch color television. Prior to viewing the news stories, five Beckman AG/AGCL standard electrodes were attached to each participant's forearm and palm of their nondominant hand for the collection of physiological data. Directions for participating in the experiment were recorded onto the audio track of the videotapes containing the stimuli. These narrated instructions preceded the stimuli material, explained the self-report scales used in the experiment, and directed participants between stories to complete a questionnaire containing the evaluative and SAM scales. Participants first viewed a practice story about riverboat gambling. Once the participants indicated that they understood the self-report scales, they were shown the eight stimulus stories. After completing the scales for the last news story, the electrodes were removed and participants were given a recognition test. They were then debriefed and thanked for their time.

Results

Physical Access

The first research question asked whether physical access to television news differed by education level. From the items measuring how often participants watched local and national broadcasts, as well as news magazine programs, no significant differences emerged between the lower and higher education groups. Yet, the means for the lower education group (local news, $M = 2.21$, $SD = 1.03$; national news, $M = 1.84$, $SD = 0.96$; news magazine programs, $M = 1.17$, $SD = 0.69$) were higher than for the higher education group (local news, $M = 1.7$, $SD = 0.98$; national news, $M = 1.8$, $SD = 1.06$; news magazine programs, $M = 0.9$, $SD = 0.55$) across all three news genres. It is therefore unlikely that participants in the lower education group had less physical access to television or that they were less familiar with television news than the higher education group.
Table 1

Summary of Significant Results

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Education Level</th>
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<th></th>
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<td></td>
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<td>Some Graduate School</td>
<td>$F$</td>
<td>$df$</td>
<td>$p$</td>
<td>$\epsilon^2$</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
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<td>68.00%</td>
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<td>.003</td>
<td>.19</td>
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<td>3.40</td>
<td>1, 38</td>
<td>.004</td>
<td>.18</td>
</tr>
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<td>4.09</td>
<td>5.07</td>
<td>1, 37</td>
<td>.030</td>
<td>.07</td>
</tr>
</tbody>
</table>

Cognitive Access

Arousal. The second research question asked whether arousal responses to television news stories differed by education level. Arousal was measured both by viewers’ self-reported arousal ratings and the frequency of nonspecific skin conductance responses during the messages. As Table 1 shows, there was a significant main effect for education on the skin conductance data, $F(1, 30) = 6.00, p < .02, \epsilon^2 = .09$. The lower education group had fewer skin conductance responses during the collection period ($M = 1.29, SD = 2.18$), indicating lower arousal than the higher education group ($M = 2.28, SD = 2.35$).

The main effect for education on the self-report data was not significant, $F(1, 37) = 1.20, p < .28$, although the mean ratings were in the same direction as the skin conductance data, with the lower education group reporting less arousal ($M = 5.1, SD = 1.95$) than the higher education group ($M = 5.7, SD = 1.13$).

Attention. The third research question assessed the motivation of participants to attend to messages. It asked whether evaluations of the informativeness and enjoyment of negatively arousing news stories varied by education level. The main effect (see Table 1) of education on the enjoyment rating was significant, $F(1, 37) = 5.07, p < .03, \epsilon^2 = .07$, with the higher educated group reporting greater enjoyment of the stories ($M = 4.09, SD = 1.64$) than the lower educated group ($M = 2.91, SD = 1.61$). There were no significant effects for education on the informativeness scale.

The fourth research question asked whether attention to negatively arousing news stories also varied by education. Heart rate was used as a measure of attention. The greater the decrease in heart rate during viewing,
the greater the attention of the viewer. The main effect for education on the heart rate data was not significant, $F(1, 27) = 1.19, p < .28$. Although there was a significant main effect for time, $F(7, 189) = 16.46, p < .000, \varepsilon^2 = .35$, there was no interaction between time and education. Thus, both groups showed the characteristic significant decrease in heart rate indicative of attention to the stories, but there was no difference between the high- and low-education groups in the amount of attention paid to the stories.

**Encoding of information.** The fifth research question asked if there are differences in how people with higher and lower education encode information from the news. The percentage of accuracy for the two groups on the recognition test was used to address this research question. The main effect for education was significant, $F(1, 32) = 10.11, p < .003, \varepsilon^2 = .19$. The higher education group's mean accuracy was 68% ($SD = 6.00$) compared to the lower education group's mean accuracy of 62% ($SD = 7.00$).

The accuracy of recognition results is useful as an indication of memory. Yet, it assumes that recognition memory for information is either at hand or not, when many times people are not sure if they remember something (Shapiro, 1994). The final research question therefore probed more detail about how people from higher and lower educational backgrounds encode information. Signal detection analysis enables a sophisticated measure of
information encoding by revealing memory strength (d prime) and judgments related to recalling information (criterion bias). Signal detection analysis for the recognition results showed a significant main effect for education on d prime or memory sensitivity, $F(1, 38) = 9.40, p < .004, \varepsilon^2 = .18$, but no significant main effect for education on criterion bias. Higher education groups had higher sensitivity scores ($M = 1.05$, $SD = 0.32$) than the lower education group ($M = 0.69$, $SD = 0.41$).

These signal detection results suggest that participants in the higher education group had better memory for information presented during the news stories, and that this difference in memory was due to greater memory sensitivity, not to a difference in their willingness to guess. The two groups did not differ in how certain they had to feel about an item before judging whether they had seen it before. But, after a single viewing, the higher education group had successfully encoded more of the items at that level of certainty. Thus, the greater accuracy of the higher education group was due to better recognition memory for what they had seen.

Discussion

Similar to many survey research studies over the past 30 years, this experiment supports the existence of a knowledge gap: People with higher levels of education scored better on the verbal recognition tests than those with lower levels of education. Physical access to news did not seem to contribute markedly to the information processing disparities found in this study. People from lower educational backgrounds had as much daily physical access/exposure to television news as people with higher educational backgrounds. Cognitive access, or information processing proficiency, emerged as a plausible contributing factor to knowledge gaps caused by the media. Specifically, testing the operation of three information processing mechanisms (arousal, attention, and encoding of information) in people from higher and lower educational backgrounds produced some insights into the relationship between education level and information gain. Figure 2 summarizes the variables included in this study as well as a number of variables common to survey studies of the knowledge gap. The diagram presents cognitive access, which comprises information-processing aptitude, as a central explanation for how knowledge gaps emerge. Physical access and characteristics of the message and audience are illustrated as interconnected, contributing sources of variance in cognitive access and resulting knowledge inequities.

Findings related to the notion of cognitive access deserve specific consideration. Skin conductance data revealed a difference in physiological arousal during news viewing between the two education groups. In particular,
participants with more education showed greater sympathetic nervous system activation while watching news stories than those with less education. Because sympathetic activation is generally associated with increases in the allocation of resources to both encoding and storage, this increased arousal may be partially responsible for the higher education group's superior recognition of information presented in the news stories.

It remains unclear why people with more education experienced greater arousal during news viewing, but at least two possible explanations could be considered. First, the topics in the news stories might simply be more interesting and arousing to people with higher education than they were to those with lower education. This explanation is possible, but not likely. Most of the stimulus stories featured crime, disasters, and conflict, topics that can be expected to arouse participants from both education groups. Second, and
theoretically perhaps more plausible, is the explanation that those with higher education have the ability to mobilize their sympathetic nervous systems in support of cognitive tasks. Such a faculty could either be learned or innate, conscious or subconscious, but it might predispose a person to pursue higher education. The idea that people mobilize physiological resources with varying levels of efficiency to support cognitive functions deserves more research attention.

From the standpoint of evolutionary psychology, it is particularly worth noting that the biological systems of people with more education prepared them better for the surveillance of negatively compelling, and therefore potentially threatening, audiovisual information than the biological systems of people with less education. It appears that people with higher education levels display physiological characteristics that as Shoemaker (1996) notes, may have benefited watchmen in primitive societies who surveyed the environment and disseminated information to other tribe members in advance of an oncoming survival threat. Interestingly, higher educated participants also reported greater enjoyment of news stories. Perhaps this is a matter of the functional division of labor; people with better cognitive skills enjoy and excel at fulfilling the ancient surveillance role in human societies, whereas those with less-developed cognitive skills tend to contribute to society on other levels such as physical labor or hunting.

Results of the heart rate analysis provide evidence that education did not affect attention to the news stories. Participants in both education groups paid equal amounts of attention to the messages. The heart rate curve, shown in Figure 1, indicates a relatively large decrease in cardiac activity during news viewing, accounting for 35% of the variance in the heart rate data. This deceleration confirms that participants in both groups were paying close attention to the stories during viewing.

Taken together, these results suggest that attention to messages might not be a fundamental cause of information inequities. This does not mean that varying levels of controlled attention paid to information could not contribute to the knowledge gap phenomenon. Rather, when people are equally motivated to pay attention (e.g., by viewing messages that compel attention) those with more and less education pay the same, relatively high, level of attention to the messages.

Also important to note is that these findings do not bolster explanations of the knowledge gap as a result of differing levels of interest and perceived usefulness of media information. Ettema and Kline (1977), as well as Ettema and colleagues (1983), argue that televised public affairs issues are not so complicated as to necessitate highly developed information processing skills but that these issues are typically more important and useful to people in
higher socioeconomic groups. They therefore conclude that the knowledge gap exists in part because of differing levels of interest and use for information. Likewise, Donohue and colleagues (1975) conclude that knowledge gaps about local news issues tend to narrow because these issues are typically about conflict and therefore salient to people from all levels of the socioeconomic hierarchy. This study did not use public affairs or national stories as experimental stimuli. Instead, participants were shown negatively compelling local news stories that delivered survival-relevant information (crime, disaster, and combative protests) considered salient to all members of society and therefore likely to command the attention and thus the automatic allocation of processing resources of viewers (Newhagen & Reeves, 1992). Even these stimuli, with equal salience to people in the lower and higher education groups, yielded a significant knowledge gap.

The results of recognition data demonstrate three things. First, participants with more education remembered more facts from the news stories. Second, participants in both education groups used the same criteria to decide whether they recognized a test item. Third, participants with more education had more sensitive memories than less educated participants. Together, these results suggest that people with more education are qualitatively and quantitatively better at encoding information from audio-visual media than participants with less education. Signal detection analysis was instrumental in explaining why participants with higher education levels fared better in the information recognition tests. They did not outscore the lower education group because they were more willing to guess if they recognized information; rather, they remembered more because they encoded information more effectively.

The results of this investigation do not give credence to the argument that television, because it is supposedly more accessible and easier to process than newspapers, has the potential to be the great leveler of the knowledge gap (Brantgarde, 1983; Chew & Palmer, 1994; Galloway, 1977; Gantz, 1978; Kleinnijenhuis, 1991; Neuman, 1976; Tichenor et al., 1970). In this experiment, participants saw compelling television messages with universal relevance. Results reveal a significant knowledge gap in recall of that information. An important counterargument to consider is that the medium generally believed to pose relatively small challenges to the cognitive processing system might in fact require more developed cognitive skills to successfully encode information than previously believed.

On a methodological note, this study took the first experimental step in examining the knowledge gap hypothesis. The survey method, which has produced a valuable body of research on the knowledge gap phenomenon, has noteworthy limitations. Namely, respondents in survey studies often
deliberately conceal honest responses to questions due to social desirability biases or are simply not able to accurately explain or assess their own media consumption patterns (Messaris, 1977). The physiological measures used in this experiment provided relatively untainted data about people’s arousal, attention, and encoding of information associated with media exposure. On the other hand, like all experiments, the one reported here is vulnerable to the standard criticisms of the experimental method.

Experiments are more effective for testing theoretical ideas than for making population estimates. This study identified differences in the information processing mechanisms of people with different levels of education, but generalizing these findings to a large population would be inappropriate. The origin of information processing differences between people from varying educational backgrounds remains unexplained. Because it is unclear whether a viewer’s cognitive-access aptitude—especially his or her arousal to and encoding of information in a news message—is innate or learned, it is impossible to make recommendations about how people in lower education groups can become more empowered by both survival-relevant and public-affairs news. This matter takes on a certain urgency for communication research, given that the World Wide Web is predicted to replace television as the medium most burdened with the mass dissemination of information.

To date, policy makers and media researchers have been preoccupied with citizens’ physical access to information technology (Kling, 1999; National Telecommunications and Information Administration, 1998). Perhaps it is equally important to understand how obstacles to cognitive access might widen the knowledge gap that the Internet and World Wide Web seem likely to perpetuate. At the same time, the capacity to efficiently process mediated information in large volume might increasingly become the means whereby literate societies stratify power. As Tichenor and colleagues (1970) remarked when they formulated the knowledge gap hypothesis, “... more highly educated persons are at the vanguard of social and technological change, their accelerated acquisition of mediated knowledge may be socially functional” (p. 170).

Notes

1. In the case of the Internet, researchers are now considering cognitive access as a factor in usability studies that typically assess the effectiveness, efficiency, and satisfaction of online experiences. Kling (1999) reports that ordinary people consider accessing information on the Internet as “too hard,” whereas Borgman (1989) found that choice of academic major (e.g., engineering, psychology, English) plays a significant role in online information retrieval abilities.
2. The order of the evaluative measures and Self-Assessment Mannequin scales were alternated across stories.

References


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