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ABSTRACT

Social interaction and influence have been the subject of considerable research. Examining in great detail the factors involved in social influence has enabled social psychologists to understand better the effects of persuasion, propaganda, coercion, indoctrination, and brainwashing. Out of this research has come a widespread acceptance of the pervasiveness of the persuasion process. Source and recipient, it has been shown, are actively and jointly involved in constructing a common outcome, which can take the form of changes in belief, attitude, behavior, or some combination of these. The causal link between attitude and behavior, the effects of persuasion, and the planning of intervention studies designed to promote the development of desirable attitudes and behaviors are discussed in this paper. The theory of reasoned action (TRA) is used to present a conceptual framework for linking behavior to specific antecedent variables such as personal beliefs, attitudes, social support, and irtentions. Sections include: (1) "Social Psychological Models"; (2) "Research Methods"; (3) "Application"; and (4) "Conclusion". Over 40 references are provided. (KR)

Attitude Research in Science Education: Contemporary Models and Methods

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Introduction

Attitude has been the subject of investigation by social psychologists for decades. One reason for this interest is the belief that people make evaluative judgements about a wide variety of targets and rely on these judgements, or attitudes, in deciding among several possible courses of action in the future. The attitude-behavior link has been so intuitively appealing that for years it was assumed to need no further elaboration. After all, is not a person who likes sports cars, for example, more likely to buy one?

Social interaction and influence also have been the subject of considerable research. Examining in great detail the key factors involved in social influence has enabled social psychologists to understand better the effects of persuasion, propaganda, coercion, indoctrination, and brainwashing. Out of this research has come a widespread acceptance of the pervasiveness of the persuasion process. Source and recipient, it has been shown, are actively and jointly involved in constructing a common outcome, which can take the form of changes in belief, attitude, behavior, or some combination of these.

Social Psychological Models

The study of attitude and behavior change has commanded considerable interest of social psychologists. Until recently, however, researchers have lacked the conceptual foundation and empirical evidence needed to understand the causal link between attitude and behavior, explain the effects of persuasion, and plan intervention studies designed to promote the development of desirable attitudes and behaviors. Crucial to the development of this understanding has been the pioneering research conducted by Ajzen and Fishbein (1975), Ajzen (1985), and Petty and Cacioppo (1981).

Theory of Reasoned Action

Fishbein and Ajzen (1975) proposed the theory of reasoned action as a unifying and systematic conceptual framework that could be applied to the diverse literature on attitudes and could be used to understand a myriad of human behaviors. The theory rests on the assumptions that humans are rational, have control over their behavior, and seek out, utilize, and process

all available information about pending decisions before taking action. Behaviors of interest are single, specific actions rather than multiple acts that are best classified as behavioral categories. In contrast to single actions, behavioral categories represent inferences made from a set of behaviors, which may be relatively narrow or quite global in scope. Pursuing a career in science or engineering, for example, represents a behavioral category which might include specific behaviors such as enrolling in advanced, elective high school courses in Algebra 2, calculus, chemistry, physics; earning grades of "A" or "B" in mathematics and science courses; or entering projects in science fairs and mathematics tournaments. Observation of any one of the multitude of related single acts comprising this or any behavioral set provides an inadequate measure of a behavioral set and would be expected to be weakly associated with the behavioral category.

The theory of reasoned action presents a conceptual framework for linking behavior to specific antecedent variables — personal beliefs, attitudes, social support, and intentions. The model can be used to predict intention at any level of specificity from information on personal and normative components, provided there is correspondence between the level of specificity of predictors and criterion variables. The theoretical structure linking behavior (B), behavioral intention (BI), attitude toward the behavior (AB), subjective norm (SN), and beliefs is causal and unidirectional (Fishbein & Ajzen, 1975).

Attitude and subjective norm have antecedents. Beliefs that an individual holds about the consequences of engaging in a specific behavior, a within-subject effect or personal norm, help the person form an attitude toward engaging in the behavior. Similarly, beliefs an individual holds about social support for engaging in the behavior, a between-subject effect or social norm, serve to shape the subjective norm. Persons form anticipations about the likelihood of specific, personal consequences associated with engaging in a behavior (behavioral beliefs, b_i), weight each belief by an evaluative reaction toward the specific consequence (outcome evaluations, e_i), and combine each value-action association to form a generalized, personal judgement. This personal judgement is the belief-based antecedent of an individual's attitude

toward engaging in a specific behavior (AB). Similarly, persons judge the extent to which salient referents hold expectations about performing the behavior in question (normative beliefs, nb_k), weight each belief by the individual's willingness to comply with each referent's expectation (motivation to comply, mc_k), and combine each compliance-action association to form a generalized social judgement. This social judgement is the antecedent of the subjective norm (SN).

Personal beliefs are linked with outcome evaluations and normative beliefs with motivation to comply through the expectancy-value theorem. This formulation was first introduced by Fishbein (1963) to show how attitude toward an object is related to beliefs about the object. The expectancy-value theorem has its roots in Edwards' (1954) subjective-expected-utility (SEU) theory, which predicts that a person making a behavioral choice will select the alternative which will lead to the most favorable outcome. In the language of the expectancy-value theorem, a person's attitude toward any object is a function of the beliefs the person holds about the object and the implicit evaluative responses associated with those beliefs. The theory is summarized in following equation:

$$A_O = \Sigma_i b_i e_i$$

where A_O is the attitude toward some object, O; b_i is the belief i about O, i.e., the subjective probability that O is related to attribute "i"; e_i is the evaluation of the attribute "i".

This expectancy-value linkage is representative of the thinking process that takes place prior to decision-making. The constructs comprising the theory of reasoned action are summarized in the following equation:

$$B \sim BI = w_1 AB + w_2 SN,$$

where the antecedents of AB and SN are $\Sigma_i b_i e_i$ and $\Sigma_k (nb)_k (mc)_k$, respectively and represent expectancy-value beliefs. The factors w_1 and w_2 represent the relative contributions of attitude and subjective norm components to the formation of behavioral intention.

The exact nature of the information mapping process is idiosyncratic. Differences in the inter-subject expectancy and value assigned to specific beliefs give rise to differences in

personal attitude and subjective norm. Inter-subject differences, or external variables, may lead also to variations in the relative weights assigned to personal and subjective norms. Specific external variables mediate behavior only to the extent that they give rise to differences in the salient beliefs, belief strength, outcome evaluations, normative beliefs, motivation to comply, or the relative contributions of antecedent variables to the prediction of intentions (Ajzen & Fishbein, 1980, p. 83). Crawley and Coe (1990) have shown that among grade 8 science students, for example, the relative contributions of attitude and subjective norm components (i.e., the w's in the foregoing equation) to the prediction of intention to enroll in a science course in grade 9 vary in predictable ways, depending on students' gender, ethnicity, general ability, and science ability. Thus, similar intentions may arise as a result of quite dissimilar levels of importance assigned to the antecedent variables, attitude and subjective norm, and/or differences in underlying beliefs. Evidence for the multidimensional, multiplicative nature of expectancies and the recursive nature of the theoretical constructs comprising the theory of reasoned action have been tested and substantiated by Bagozzi (1982).

The theory of reasoned action has been found to be extremely successful in explaining volitional behaviors. Volitional behaviors are those actions that do not require skill, special abilities, opportunities, and the cooperation of others to perform; they require only that the individual possess the motivation to perform the behaviors, i.e., behavioral intention. The model variables have accounted for a multitude of diverse human behaviors of interest to social-psychologists, such as drinking, dieting, choosing a career, planning a family, voting, and consumer purchasing (Ajzen & Fishbein, 1980). In educational contexts, the theory has been used successfully to understand and predict the intentions of students in New Zealand high schools to study science (Stead, 1985), grade 8 students' intentions to enroll in a high school science course (Crawley & Coe, 1990), preservice elementary teachers intentions to teach science using hands-on activities (Koballa, 1986), girls' intentions to enroll in at least one physical science course in high school (Koballa, 1988), physical science teachers' intentions to

use investigative teaching methods (Crawley, 1990), and grade 5-8 students' intentions to smoke (Norman & Tedeschi, 1989).

Theory of Planned Behavior

The theory of reasoned action has been criticized because of its limited applicability. Most behavior, according to Liska (1984), is neither volitional nor involitional, but ranges from behavior which requires little skill and social cooperation to behavior which requires considerable skill, considerable social cooperation or both. The theory of planned behavior was proposed by Ajzen (1985) as an extension of the theory of reasoned action to account for the performance of behaviors that are not completely under the subject's control. The utility of the theory of reasoned action in explaining behavioral intention and subsequent behavior was found to be insufficient when subjects perceived that their control over behavioral performance was incomplete. When subjects did not possess the requisite personal attributes, resources, or opportunities to engage in the behavior in question the theory of reasoned action proved to be incomplete as a model for understanding and predicting behavior.

The theory of planned behavior adds a third construct to the model, perceived behavioral control, which has a direct impact on the formation of behavioral intention, independent of the contributions of attitude and subjective norm. Perceived behavioral control is "the person's belief as to how easy or difficult performance of the behavior is likely to be" (Ajzen & Madden, 1986, p. 457) and represents the extent to which the individual believes that behavioral performance is complicated by internal (inadequate information, skill, or ability) and external factors (lack of resources, opportunity, or the cooperation of others). As in the theory of reasoned action intentions occupy a central role in the prediction of behavior. Intentions "... capture the motivational factors that impact on a behavior; they are indications of how hard people are willing to try, of how much an effort they are planning to exert, in order to perform the behavior" (Ajzen, 1989, p. 250).

Perceived behavioral control (PBC) has belief-based antecedents as do attitude and subjective norm. Persons associate a limited number of controls with performance of a specific

behavior (control beliefs, cb), weight each control by the likelihood it will occur (likelihood of occurrence, lo), and combine each control-action association to form a generalized, self-efficacy judgement (Ajzen, 1988, p. 135; Ajzen & Madden, 1986, p. 462). The model variables comprising the theory of planned behavior are summarized in the following equation:

$$B \sim BI = w_1AB + w_2SN + w_3PBC,$$

where $\Sigma_i b_i e_i$, $\Sigma_k (nb)_k (mc)_k$, and $\Sigma_n (cb)_n (lo)_n$ are the expectancy-value antecedents of AB, SN, and PBC, respectively.

The theory of planned behavior has been used successfully to predict college students' attendance at class lectures and getting a grade of "A" in a course (Ajzen & Madden, 1986) and weight loss over a 6-week period among college women (Schifter & Ajzen, 1985). For situations in which perceived behavioral control does not pertain or is irrelevant, the theory of planned behavior conceptually and empirically reduces to the theory of reasoned action (Ajzen & Madden, 1986 p. 460; Ajzen, 1985). In education, the theory of planned behavior has been successfully used in studying the intentions of science teachers to use investigative teaching methods (Crawley, 1990). Simple regression analyses revealed that attitude, subjective norm, and perceived behavioral control accounted for 28% ($p = .0007$) of the variance in intentions. The explanatory power of the theory of planned behavior was not improved when a hierarchical model (independent plus interaction effects) was compared with a simple model (independent effects only). Furthermore, the increase in the variance in science teachers' intentions explained by perceived behavioral control proved not to be significant, thereby empirically reducing the theory of planned behavior to the theory of reasoned action.

Persuasion

Hovland and his colleagues (Hovland, Janis, & Kelley, 1953) at Yale University were the first researchers to systematically investigate the effectiveness of persuasive messages on attitude change. The question, who says what to whom with what effect?, served to organize their work by specifying source, message, and recipient variables that were manipulated to test their effects on attitude change. The basic assumptions that supported their work are: (a)

learning new information from a persuasive message will change beliefs, the cognitive basis of attitudes, and (b) remembering the information will assure the persistence of attitude change. In line with these assumptions, a persuasive message will be effective to the extent it is attended to, comprehended, and accepted. Although the Yale Group's work is now viewed as antiquated, it has significant historical value. Even today, the learning-theory paradigm and the research methods pioneered by Hovland continue to facilitate persuasion research.

Persuasion research in science education is a direct outgrowth of the work done by Hovland and his colleagues. Shrigley (1976; 1978) was the first to use the learning-theory paradigm to investigate science-related attitude change. He surveyed elementary teachers to identify the arguments that would best persuade them of the importance of teaching science to young American students and the characteristics of the most credible messenger. These initial efforts resulted in the development of a model for constructing science-specific persuasive messages. No fewer than a dozen science education studies have utilized Shrigley's model to design and test persuasive messages, with behaviors of interest ranging from computer usage by teachers (Weeks, 1988)to the use of either Science-A Process Approach (SAPA) or Science Curriculum Improvement Study (SCIS) to augment elementary science textbook programs (Koballa, 1986).

Unfortunately, the learning-theory paradigm of persuasion is not without its weaknesses. Fishbein and Ajzen (1980) pointed out that factors related to the message context and not the message content were the focus of most of the work, and that no attempt was made to show how attitudes were related to behavior. Others criticized the work for its failure to recognize the important role played by the message recipient in determining the effectiveness of persuasive appeals (Petty and Cacioppo, 1981). Such criticisms of this early work led to persuasion being reconceptualized as "the co-creation of a state of identification or alignment between a source and a receiver that results from the use of symbols" (Larson, 1986, p. 82).

Following a period of relative inactivity in the 1970s, persuasion research gathered momentum in the 1980s due in large part to the work of Fishbein and Ajzen. Their theories of reasoned action and planned behavior provided considerable guidance regarding how to construct

persuasive messages by specifying three conditions that must be satisfied for behavioral change to occur. First, changes in attitude, subjective norm, and perceived behavioral control will come about only when a sufficient number of the behavioral, normative, and control beliefs or their evaluations are changed. Second, changes in beliefs or evaluations will affect behavioral intention only to the extent that attitude, subjective norm, and perceived behavioral control carry a significant weight in the prediction of intention. Third, the degree to which an intention change will cause a behavioral change is determined by the correspondence between intention and behavior.

In 1984 Stutman and Newell proposed a plan for constructing persuasive messages that extended the working of Fishbein and Ajzen. Important to their plan is that specific beliefs rather than societal and cultural values are the critical elements of successful persuasive appeals. Stutman and Newell contended that values are generalized beliefs that function better in persuasive appeals directed at general attitudes or behaviors, where as specific beliefs should be used when appeals are made to specific behaviors.

Although not offering suggestions regarding how to construct persuasive messages, Petty and Cacioppo's Elaboration Likelihood Model (ELM) has contributed greatly to an understanding of how people are persuaded when messages are encountered. The ELM acknowledges the central role of the message recipient in the persuasion process and proposes that most approaches to persuasion can be placed along a continuum, anchored at one end by a central route to message processing and at the other end by a peripheral route. Careful scrutiny of the issue-relevant arguments contained in a persuasive message characterizes the central route; whereas the peripheral route emphasizes persuasion where little consideration of message arguments occurs. Important to the ELM are the notions: (a) people are motivated to hold beliefs that are seen as beneficial, and (b) considerable variability exists regarding the kind and amount of issue-relevant elaboration that people are willing to engage in to evaluate a persuasive message.

According to the ELM, a message recipient may attend to peripheral cues present in the persuasive context, or process message arguments in either an objective or biased manner.

Factors that strengthen the importance of peripheral cues tend to reduce the recipient's motivation and/or ability to process issue-relevant arguments. However, as peripheral cues become less important, issue-relevant processing is correspondingly enhanced. Greater resistance to counter-arguments and improved congruence between attitude and behavior are among the benefits associate with the increased cognitive activity that occurs with issue-relevant processing (Petty & Cacioppo, 1886).

Determining the degree to which people scrutinize issue-relevant arguments are five motivational and ability variables. The variables include: (a) personal relevance, (b) number of message sources, (c) number of persons evaluating the message arguments, (d) prior knowledge, and (e) the message recipient's need for cognition (Petty & Cacioppo, 1986). Need for cognition addresses the desire a person has to "experience an integrated and meaningful world" (Cohen, Stotland, & Wolf, 1955) and embraces behaviors that, according to Petty and Cacioppo (1986), cannot be explained as drives or instincts.

Research Methods

Experimental studies of attitude-behavior formation and change in science education draw upon the work of Fishbein and Ajzen (1980), Ajzen (1985), Petty and Cacioppo (1986), and Stutman and Newell (1984). Six steps characterize intervention studies designed to develop one or more favorable attitude-behavior outcomes among members of a target group:

1. specifying the target behavior,
2. determining the salient beliefs of the target group,
3. designing the A-B questionnaire,
4. developing the persuasive message,
5. conducting the intervention program, and
6. assessing the A-B outcomes.

Target Behavior

Identification of the specific behavior of interest in the intervention study is the crucial first step. The behavior must be a single action rather than a behavioral category. Four

distinct components characterize a specification of the behavior: (a) action (overt, observable), (b) target (object of action), (c) context (the situation in which action is to take place), and (d) time (when the behavior is to be performed). These four elements clearly communicate the endstate of the intervention program. It is the favorableness of this endstate that defines an individual's attitude toward the behavior. For example, the behavior "To enroll (action) in high school (context) Chemistry (target) next Fall (time)" contains the four behavioral elements.

Salient Beliefs

Underlying the performance of the target behavior is an assessment of the personal consequences, social support, and self-efficacy. People can hold a great number of beliefs about personal consequences, social support, and self-efficacy, but it is believed that they can attend to only a small number of them (five to nine) at any given moment (Miller, 1956). These key beliefs are said to be salient to the behavior in question. There are likely to be, therefore, only a limited number of personal consequences, important referents, and facilitating or obstructing factors that form the personal information base which people consult prior to engaging in a specific behavior.

Salient beliefs related to the target behavior are identified by means of an open-ended questionnaire (Ajzen & Fishbein, 1980, p. 262). First, a sample of respondents representative of the target population is identified. Next, the open-ended questionnaire is constructed and administered to the sample respondents. The questionnaire contains three questions for each of the three underlying determinants of personal intention to engage in the target behavior (enrolling in high school Chemistry next Fall, for example). Salient beliefs about the outcomes of engaging in the target behavior are elicited by the following questions:

1. What do you see to be the advantages of your (insert target behavior)?
2. What do you see to be the disadvantages of your (insert target behavior)?
3. Is there anything else you associate with your (insert target behavior)?

Next, salient beliefs about the social support for engaging in the target behavior are identified in a similar manner.

1. Who are the groups or people who would approve of your (insert target behavior)?
2. Who are the groups or people who would disapprove of your (insert target behavior)?
3. Are there any other groups or people who come to mind when you think about your (insert target behavior)?

Last, the salient beliefs about the factors that facilitate and obstruct engaging in the target behavior are elicited.

1. What things could happen that would make it easy for you to (insert target behavior)?
2. What things could happen that would make it difficult for you to (insert target behavior)?
3. What other things come to mind that might influence whether you (insert target behavior)?

The modal salient beliefs about the personal consequences, social support, and self-efficacy are determined next. To do this, the beliefs collected on the open-ended questionnaire are content analyzed, which involves grouping responses that refer to similar outcomes, referents, and control factors, respectively, and counting the frequency with which responses in each group within an antecedent were elicited. Each response group identifies a category, and each category designates a particular outcome, referent, or control factor. The categories within the three antecedents are arranged according to each category's frequency of response. The most frequently mentioned outcomes, referents, and control factors are selected to account for 75% (Ajzen & Fishbein, 1980, p. 70-71) or more of the responses provided for each antecedent. These beliefs constitute the modal salient beliefs and are formatted as items for the A-B questionnaire.

A-B Questionnaire

The A-B questionnaire consists of items that provide information about each of the component parts of the theory of planned behavior. In particular, items are written to assess

behavioral intention (BI), attitude toward the behavior (AB), subjective norm (SN), perceived behavioral control (PBC), behavioral beliefs (b) and outcome evaluations (e), normative beliefs (nb) and motivation to comply (mc), and control beliefs (cb) and likelihood of occurrence (lo). Each of the items provides information about a causal factor underlying the decision to engage in the target behavior.

Response scales on the A-B questionnaire consist of two types: semantic differential and 7-point, bipolar, adjectival scales. A direct measure of intention to engage in the target behavior is obtained by having respondents reply to the statement "I intend to enroll in high school Chemistry next Fall", for example, by marking the appropriate space on a 7-point, likely-unlikely scale. Steps along the continuum are anchored with the adverbs extremely, quite, slightly, neither, slightly, quite, and extremely, as follows:

I intend to enroll in high school Chemistry next Fall

likely _____ _____ _____ _____ _____ _____ _____ unlikely

extremely quite slightly neither slightly quite extremely

Attitude toward engaging in the behavior is determined by having subjects respond to the statement "My enrolling in high school Chemistry next Fall" (continuing with the chemistry enrollment example) by marking the appropriate place along 7-point adverbial scales, anchored at the endpoints by the bipolar adjective pairs good-bad, valuable-worthless, harmful-beneficial, and pleasant-unpleasant.

Subjective norm is measured using two general statements. One statement measures general social support for engaging in the target behavior, and the other, general motivation to comply with referents. The general normative belief statement for the behavior, "enrolling in chemistry", for example, is written, "Most people who are important to me think I should enroll in high school Chemistry next Fall". This statement is followed by a 7-point adverbial-response scale anchored at the endpoints by the adjectives likely-unlikely. General motivation to comply is determined, in the chemistry example, from responses provided to the statement, "I want to do what most people who are important to me think I should do about enrolling in high

school Chemistry next Fall". Again, a 7-point, likely-unlikely response scale follows the general motivation to comply statement.

Several items are used and scores on these items are combined to arrive at a direct measure of perceived behavioral control. In each of these statements controls are directly linked to performance of the target behavior. The following three statements serve to illustrate the wording of items for the behavior, "enrolling in chemistry". Each item is followed by a 7-point, likely-unlikely response scale.

1. It is mostly up to me whether or not I enroll in high school Chemistry next Fall.
2. If I wanted to I could enroll in high school Chemistry next Fall.
3. There is very little I can do to make sure that I enroll in high school Chemistry next Fall.

Seven-point, bipolar, adjectival scales are used to record responses to statements of behavioral belief, outcome evaluation, normative belief, motivation to comply, control belief, and likelihood of occurrence. Behavioral beliefs represent outcomes associated with engaging in the target behavior, both advantages and disadvantages. Each of the modal salient beliefs is linked with the target behavior and included on the A-B Questionnaire as one item. For example, a plausible disadvantage students might associate with enrolling in chemistry might be increased homework. The behavioral belief statement would read, "My enrolling in high school Chemistry next Fall will result in me having more homework." Students would indicate the extent to which they associate "more homework" with "enrolling in chemistry" by marking the appropriate space on a 7-point, likely-unlikely scale. Outcome evaluations denote the respondents' rating of each modal salient belief. For example, students evaluate "having more homework" on a 7-point, bipolar scale anchored by the adjective pair good-bad. Each outcome evaluation serves to weight the contribution of its respective behavioral belief statement to the total belief-based estimate of attitude.

Normative belief and motivation to comply statements are worded in a manner similar to behavioral beliefs and outcome evaluations. For example, "parents" might be likely sources of encouragement for students to "enroll in Chemistry." The normative belief statement for this

referent is then written, "My parents think I should enroll in high school Chemistry next Fall." Students indicate the extent to which they agree with this statement by marking the appropriate place on a 7-point scale anchored at the endpoints by the adjective pair, likely-unlikely. The motivation to comply statement is similarly listed, "I want to do what my parents want me to do about enrolling in high school Chemistry next Fall" and also is followed by the 7-point, likely-unlikely response scale. The contribution of each normative belief to the belief-based estimate of subjective norm, then is weighted by its respective motivation to comply score.

Control beliefs and likelihood of occurrence statements provide information on the extent to which respondents believe that the decision to engage in the target behavior is independent of outside influences. The target behavior, "enrolling in chemistry", serves to illustrate how control belief and likelihood of occurrence statements are worded. Participation in extra-curricular activities, for example, may serve to prevent some students from enrolling in chemistry. The control belief statement for this inhibiting factor, "Participating in extra-curricular activities prevents me from enrolling in high school Chemistry next Fall", is followed, as in previous items, by a 7-point, likely-unlikely response scale. Similarly, the likelihood of occurrence statement, "The chance that I will have extra-curricular activities next Fall is", also is followed by a 7-point, likely-unlikely response scale. Control beliefs are each weighted by the perceived likelihood of occurence and summed to arrive at a belief-based estimate of perceived behavioral control.

Persuasive Message

Fishbein and Ajzen (1981) argued that "only when the message brings about a shift in the summed products across a total set of underlying beliefs can it be expected to influence attitudes or subjective norms [or perceived controls] and, by extension, intentions and behavior" (p. 344). From this perspective, a persuasive message must include arguments and supporting evidence that addresses the personal consequences, social support, and self-efficacy associated with the behavior of interest. Thus, critical to the effectiveness of a persuasive message is the use of arguments that address salient behavioral, normative, and control beliefs; arguments that

address the outcome evaluation of behavioral beliefs, motivation to comply with referents, and the likelihood of occurrence of control beliefs; or both.

Once modal salient beliefs and referents are identified, what strategies can be employed to guide the construction of arguments supportive of the desired behavior? Stemming from the work of Stutman and Newell (1984) four recommendations may be offered:

1. Reinforce outcomes, referents, and control factors supportive of the desired behavior.
2. Downplay or discredit outcomes, referents, and control factors not supportive of the desired behavior.
3. Strengthen the association between supportive outcomes and their evaluation, between referents and motivation to comply with them, and between facilitating factors and the probability of their occurrence.
4. Disassociate negative negative outcomes from their evaluations, non-supportive referents from motivation to comply with them, and obstructing factors with the probability of their occurrence.

The first recommendation points out the importance of reinforcing the attributes that form the modal salient beliefs held by the audience in a persuasive message. Emphasized in the second recommendation is the need to downplay or discredit the attributes that are not supportive of the target behavior. When employing this strategy, discrediting attributes that reflect deep seated religious or educational prejudices should be avoided. The final two recommendation are not as straight forward as the first two and are best explained using an example. Let's say that one attribute linked by high school students to enrolling in Chemistry is that doing so will cause them to be away from friends. A message to encourage students to enroll in Chemistry might argue that "Although it is likely that taking Chemistry may cause students to be away from their friends, the course will also provide opportunities to make new friends." In this example, the focus is on disassociating the attribute of being away from friends from its negative evaluation and introducing another attribute that might be judged more favorably. Similar approaches may be used to increase compliance with referents who advocated engaging in the target behavior and

to assure recipients that factors considered likely to prevent them from engaging in the behavior are in reality extremely remote possibilities. A shortcoming of the latter two strategies is that the evaluations given certain attributes are often quite resistant to change.

It is important to recognize that these four means of affecting change are intimately tied to the expectancy-value formulation of attitude described in the theory of reasoned action. Since the belief basis for attitude is defined as the sum of the products of each outcome by the evaluation of the outcome, attitude may be affected by changing either the strength of the relationship between the attribute (i.e., the outcome) and the behavior (as in strategies 1 and 2) or by changing the evaluation of the outcome's utility (as in strategies 3 and 4). Also due to their expectancy-value origins, the belief-based estimates of subjective norm and perceived behavioral control may be changed in a similar manner.

Once the arguments are identified, evidence is gathered to support the arguments. In selecting evidence, the writings of Nisbett and his colleagues (Nisbett & Ross, 1980; Hamil, Wilson, & Nisbett, 1980) and of Zimbardo, Ebbesen, and Maslach (1976) are particularly instructive. The research suggest that persuasive messages should present all sides of a debatable issue because the audience is likely to hear the opposing view points from other sources. Further, case histories and anecdotes rather than statistical, data summaries should be utilized because these forms of evidence are more emotionally interesting and tend to increase the likelihood of issue-relevant elaboration.

A validation process is recommended before the message is used. As described by Koballa (1984), the process involves persons representative of the audience reading the message and indicating whether or not arguments and evidence that address the modal salient beliefs and referents and their corresponding evaluative responses chosen to target in the message are present and, if so, whether or not they are supportive of the desired behavior. Chi-square values are calculated for each modal salient term and its evaluative response targeted in the message to statistically verify the person's responses. The Chi-square values suggest if arguments and evidence should be revised or strengthened.

Intervention Program

The view that persuasion cannot occur unless the recipient actively participates in the process suggest that factors other the message itself should be considered in structuring a persuasive intervention. The early work of Hovland and his colleagues (Hovland, Janis, & Kelley, 1953) suggests that attention should be given to the messenger, the channel through which the message is delivered, and, most importantly, the message recipient.

Since the message source may either help to facilitate or impede the effectiveness of a persuasive message, care must be taken to identify the person or persons to whom the message will be attributed. Research on communicator characteristics overwhelmingly suggests that a source perceived by the audience as credible--both knowledgeable and trustworthy--will enhance persuasion (Hass, 1981). Descriptions of credible message communicators can be elicited using the following questions, using the chemistry enrollment example:

1. Who would be most likely to convince you to enroll in chemistry?
2. What attributes do you associate with the person(s) most likely to convince you to enroll in chemistry?

These questions are included on the open-ended questionnaire used to gather salient belief data. Responses to the questions are content analyzed as previously described to provide a best estimate of the most trustworthy purveyor or purveyors of information about engaging in the target behavior.

The channel of the communication is also an important consideration when designing an intervention. Should the message be read by the audience, delivered live, or presented via audiotape or videotape? Although results of educational studies have shown no significant difference between the effects of written, audiotaped, and vidiotaped persuasive messages (Demers, 1987; Miller, 1985), it is generally accepted that an easily comprehended message is more persuasive when presented live or via vidiotape, and that printed media is best when the message is complex (Chaiken & Eagly, 1976). Without steadfast rules to go by, the general appeal of audio-visual approaches to learning, and the need to ensure that the message is

attended to and does not change from one presentation to the next has encouraged the use of videotape, followed by audiotape, as the channels of choice. A fact sheet may be used in conjunction with the message presented via either medium to help audience members attend to the modal salient arguments proffered in the message.

Among the first to examine the effects of recipient factors in persuasion were members of Hovland's Yale group. They presented messages to audiences that were disaggregated by intelligence, self-esteem, and gender. Generally, their findings for these and other recipient factors were mixed, with limited generalizability. It was not until the unveiling of the ELM by Petty and Cacioppo that knowledge of how recipients interact with persuasive messages was significantly advanced. Recently, it has been shown that recipients engage in issue-relevant processing of the message or attend to simple cues present in the persuasion context (Petty & Cacioppo, 1986). Temporary effects may be realized when either process is utilized, but only through issue-relevant processing is persuasion likely to be enduring and resistant to counter-argument. This scenario suggests that interventions be prepared that encourage issue-relevant processing by increasing the recipient's ability to understand the message or motivation to attend to it. Administering a focusing task immediately before message exposure, where subjects are encouraged to think about either hypothetical or real life occurrence related to message arguments, as was done by Warden (1990), can effect subjects' issue-relevant processing. Further, an audience may be disaggregated on the basis of prior knowledge about or personal relevance of the target behavior, or on need for cognition, which can be measured using Petty and Cacioppo's Need for Cognition Scale. Research outside of science education has revealed that prior knowledge, personal relevance, and need for cognition are highly correlated with issue-relevant processing (Petty & Cacioppo, 1986). Unfortunately, measuring engagement in issue-relevant processing is not particularly easy. Greenwald's (1968) cognitive response protocol and one-on-one interviews in which subjects are questioned about the thoughts generated in response to the message are two ways of gathering data about the extent of issue-relevant processing.

A-B Outcomes

Response scales for all items are scored on a +3 (extremely likely) to -3 (extremely unlikely) continuum, with exception of behavior-inhibiting beliefs and motivation to comply, which is scored on a 1 to 7 scale. One item provides a direct measure of behavioral intention, and four scores are added to arrive at a direct measure of attitude toward the behavior. A direct measure of subjective norm is obtained by multiplying the score for the general statement of normative belief (+3 to -3) by the score for motivation to comply (1 to 7). A direct measure of perceived behavioral control is obtained by adding scores for the three items comprising the scale. All behavioral, normative, and control belief statements are scored from +3 (extremely likely) to -3 (extremely unlikely), with exception of statements linking performance of the behavior with disadvantages, non-supportive referents, or obstructing factors. Scores for these scales are reversed, -3 (extremely likely) to +3 (extremely unlikely). Expectancy-value measures for attitude, subjective norm, and perceived behavioral control are obtained by multiplying scores for each belief by its corresponding weighting factor and summing over all respective beliefs.

The contribution of each of the variables contained in the theory of planned behavior to the prediction of behavior can be examined once scores are computed for all subjects on each of the scales of the A-B Questionnaire. Several options are available to analyze the resulting data. The validity of the model for members of the target audience is first checked by computing the relationships among the model variables--behavior, behavioral intention, attitude toward the behavior, subjective norm, and perceived behavioral control. Regression analyses are frequently employed to test model validity, but more detailed analyses are possible through structural equation modeling (e.g., see Bagozzi, 1981, 1982).

The effects of a persuasive message are determined by examining the expectancy-value (i.e., belief-based) estimates of attitude, subjective norm, behavioral control, or combinations of these belief-based antecedents, depending upon which construct(s) the message arguments set out to change. Responses from message recipients are compared with those collected from

members of a control group who received a placebo. Experimental-control group comparisons document the impact of changed beliefs on the direct measures of attitude, subjective norm, behavioral control, or some combinations of these antecedents. Finally, antecedent variables are examined to determine their contribution to the formation of behavioral intention and subsequently behavior.

Application

Persuasive messages and a measurement instrument were developed by Crawley and Koballa (1990) and utilized in an investigation designed to determine the effect of messages developed to encourage Hispanic-American students in the Rio Grande Valley of Texas to enroll in high school chemistry. The specific question addressed in the study was: Will providing information to students and their parents/guardians that addresses students' concerns about Chemistry enrollment result in more students registering to enroll in chemistry in Fall, 1990?

The Chemistry Interest Questionnaire (CIQ) was used to collect data on students' behavioral intention, attitude, subjective norm, perceived behavioral control and the belief-based antecedents of attitude, subjective norm, and perceived behavioral control. It consisted of 50 items and required about 20 minutes to complete. Information obtained from students' responses to the Chemistry Interest Survey (CIS) was used to construct items contained on the CIQ. The CIS was a 9-item, open-ended questionnaire which sought students' beliefs about the advantages and disadvantages of enrolling in Chemistry, the persons who would or would not support their enrollment in Chemistry, and factors which served to facilitate or inhibit enrolling in Chemistry.

Messages were written for grade 10 students who were soon to decide whether to enroll in an elective Chemistry course in grade 11. One message was written for students only; a second message was written for the students and their parents/guardians. The two messages were identical in content except for the introductory paragraph which spoke to either students or parents/guardians. During their biology class students listened to an audiotape of the message recorded in English as they read printed scripts, but the message which was sent home to

parents/guardians was printed in Spanish as well as English. Both messages were attributed to Maria Garza, pseudonym for a Hispanic-American female enrolled in a graduate program in science education.

Information addressing modal salient beliefs constituted the arguments included in messages written for students and their parents/guardians. Modal salient beliefs consisted of the fewest number of items that accounted for 90% of the belief statements supplied by students who responded to the CIS. Messages contained arguments that reinforced favorable beliefs, supportive referents, and facilitative controls and either downplayed or discredited unfavorable beliefs, non-supportive referents, and inhibitive controls that students associated with registering for Chemistry in the Fall, 1990.

Realistic examples and personal anecdotes were chosen to support favorable beliefs. For the behavioral belief that "My registering to enroll in Chemistry in Fall, 1990 will increase my knowledge of chemistry" students and parents were told the story about Maria's high school friend who was hired as a summer employee by a swimming pool maintenance company because he "knew about 'pH', and he knew about pH because he had taken chemistry in high school."

Unfavorable beliefs were either discredited by giving contradictory evidence or by downplaying the belief's importance. To discredit the belief that "My speaking a first language other than English would discourage me from enrolling in Chemistry in Fall, 1990" Maria offered the following response:

> No! Several of the people in my chemistry class spoke English and Spanish, and we were able to help each other and those who had difficulty understanding some of the information we had to read from the textbook. Also, our chemistry teacher was bilingual and helped all of us a lot by explaining terms and relating them to similar words in Spanish. Knowing Spanish helps you understand some terms in chemistry.

The unfavorable belief that "My registering to enroll in Chemistry in Fall, 1990 would cause me to get low grades" was downplayed by Maria when she said:

You're worried about your grades? I know. No one wants to get bad grades. If you use good study skills and plan your time you can work it out and make good grades. My biology teacher and chemistry teacher were both very supportive and encouraged me to give chemistry a try...group work and teacher explanations really helped me learn the chemistry and prepare for the tests. If you keep up with your studies and not put off studying until the night before, you will do well on the tests.

Two classes from each of six teachers were randomly assigned to experimental and control groups. Experimental conditions included: (a) the student message only, and (b) student and parent messages. Students in the second experimental group, in addition to reading and hearing the message during class time, were instructed to take a written copy of the message home to discuss its contents with their parents/guardians, complete a brief questionnaire, and return it the next day. Following the intervention, all students in the participating classes responded to the CIQ. Data collection concluded with the registration for Fall, 1990 courses, which took place two weeks after the intervention.

Results of the statistical analyses were significant. Chemistry enrollment exceeded expectations for students receiving the "student only" message, a result not found for the "student and parent/guardian" or "control" groups.

In accordance with the theory of planned behavior, changes in enrollment were brought about by changes in students' motivation (i.e., behavioral intention). Students who received the "student only" message and students in the control group registered greater motivation to enroll in chemistry than did students who received the "student and parent/guardian" messages. However, the differences between the "student only" message and control group, though not significant, tended to favor the "student only" message groups. Changes in student motivation arise from three model variables and their antecedents: (a) personal attitude, (b) social support, (c) personal control, and (d) their underlying beliefs.

Significant differences in attitude toward enrolling in chemistry were detected among members of the "student only" message group. Several beliefs were changed as a result of

receiving a message about enrolling in chemistry. Significantly changed when compared with control group students were beliefs that "enrolling in chemistry would lead to increased learning about concepts in chemistry." Approaching significance were students' beliefs that they "would study interesting topics" and "would be helped to reach their educational goals" provided that they enrolled in chemistry. Both differences favored members of the "student only" message group.

Results of tests of differences in social support also showed significance. Members of the "student only" group reported a greater degree of support for enrolling in chemistry than did members of the "student and parent/guardian" or "control" groups. Significant differences were detected also for beliefs regarding support for enrolling in chemistry provided by three referents: (a) parents/guardians, (b) biology teacher, and (c) counselor. Counselor support was thought to be most important by students, followed by parents/guardians, and the biology teacher. All differences in perceived support for enrolling in chemistry favored the "student only" message group. A detailed description of this intervention study with Hispanic-American students has been reported by Crawley and Koballa (1991).

No significant differences in perceptions of control were detected among any of the three groups: "student only" message, "student and parent/guardian" message, and control.

What conclusions can be drawn from the study? Students facing the decision to enroll in chemistry appear to be independent minded. In reaching a decision, they rely on their perceptions of the personal consequences of taking chemistry, not on what other people want them to do. They are to some extent, however, influenced by what they perceive to be external barriers to enrolling in chemistry. Providing parents/guardians with information about enrolling in chemistry did not improve students' motivation to enroll in chemistry above chance expectations.

Conclusion

The findings of the intervention study provide support for using belief-based, persuasive messages to promote chemistry enrollment, but they also indicate that further refinements to

the message design process are required. The messages developed for the study tended to be complex and to emphasize the possible gains associated with enrolling in chemistry rather than stressing the potential losses that might be linked to not doing so. The results of choice-framing research (Kahneman & Tversky, 1984) show that people who face possible gains in a situation avoid taking risks. By contrast, faced with a possible loss in the same situation, these same people will seek risks. These findings from choice-framing research suggest that students are most likely to become risk-takers and decide to enroll in chemistry when they are confronted with information about lost educational, career, and other opportunities when chemistry is avoided. In addition, the work of Clark and Delia (1976) indicates that sophisticated persuasive arguments may be ineffective with children and adolescents because of their inability to take the perspective of others when engaging in issue-relevant elaboration. Future messages designed to persuade students to enroll in elective science courses or to engage in other science-related behaviors should utilize the results of choice-framing research and consider the developmental level of the audience when developing belief-based message arguments.

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