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ABSTRACT

A study was conducted in the Washington, D.C., area to test mass media effects in a community controversy. Five possible theories were hypothesized to explain the effects media have on a community: indirect and direct effects, null effects, agenda setting, reverse effects, and reverse agenda setting. During the 16-month test period of the British and French Concorde supersonic jet flights into Dulles International Airport, a noise complaint telephone number was publicized and complaint calls were coded. Also, mass media coverage of the controversy was monitored by tabulating the number of Concorde-related statements appearing in the "Washington Post," on NBC, CBS, and ABC national newscasts, and on television station WTOP, which had the highest rated local news programs. After the tabulations were analyzed, it was found that three of the theories (direct and indirect effects, agenda setting, and reverse agenda setting) received some empirical support. However, expanding from statistical tests, it can be argued that the direct/indirect effects theory best explains the data. (TJ)

TIME SERIES ANALYSIS OF ALTERNATIVE MEDIA EFFECTS THEORIES

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TIME SERIES ANALYSIS OF ALTERNATIVE MEDIA EFFECTS THEORIES

INTRODUCTION

Theory in mass communication effects can be grouped into several general categories. Each category implies a somewhat different process occurring in audiences.

The direct effects perspective assumes that mass media teach audiences behaviors and attitudes directly. This perspective includes three major theories: the hypodermic theory, the one-step flow theory, and observational learning theory.

The hypodermic theory of mass communication effects was prevalent among early researchers into the political effects of communication (see Katz, 1963, for a discussion of these early assumptions). This simple stimulus-response theory merely assumed that exposure to mass communication would affect audiences in a way consistent with media content.

The one-step flow model is an elaboration of the hypodermic theory. It introduces audience selectivity processes between the media stimulus and the audience response (cf. Troldahl, 1966; Rogers, 1973). Thus the media are not assumed to have the same effect on all audience members. The effect is presumed modified by selective exposure or attention, selective perception, and selective retention of content on the part of the audience.

Observational learning (cf. Bandura and Walters, 1963;

Liebert, Neale and Davidson, 1973) has been used primarily in the context of children's response to televised violence, but it applies to the learning of any mass medium content. In essence, it adds a number of message content attributes to the one-step flow model. It postulates that learning from media involves stages of exposure to the message, retention of its content (usually expressed as recall of behaviors exhibited by a model), and some acceptance phase which consists of inhibition or disinhibition toward the class of actions represented in the message content. Each of these stages are affected by message attributes such as status of the source, closeness to the audience member in age and sex of the source, vicarious rewards and punishments depicted in the message, etc.

The indirect effects perspective introduces the interpersonal communication process into the study of mass media effects. The major theories in this class are the two-step flow and the multi-step flow. The two-step flow (cf. Lazarsfeld, et al.,1944; Rogers, 1962) states that information from the mass media flows first to opinion leaders, who then pass on the information or opinions via interpersonal channels to others. The mass media content may be modified by its relay through these opinion leaders, but it ultimately affects large numbers of persons.

The multi-step flow (Rogers, 1973) is an elaboration of this theory to accomodate many relays of information through interpersonal channels. It thus allows a more complex communication network, and removes the mass medium message even further from its ultimate effect on an audience member.

The commonality shared by all these theories is that of a cause-effect relationship between mass media content and the effect of this content. To be sure, the effect can be greatly reduced or modified by the intervening processes of selectivity and interpersonal communication, but some effect as a result of exposure to mass communication is predicted by all the theories.

Another class of theories disputes this cause-effect conceptualization. These can be called the null-effects theories, although this may be overstating the case. Klapper (1960) proposed that mass media be considered only one of many causes of change in audience behavior and/or attitudes, and further that it was generally subordinate to other, non-mediated communication causes of such changes. Klapper's view of media effects includes most of the processes contained in the one-step flow model and the multi-step flow model, but considers the non-media processes to be dominant over the mass communication processes. A similar theory of limited effects in political communication has found some support (cf. Becker, McCombs and McLeod (1975); Blumler and McLeod (1974)). In over-simplified terms, this theory contends that, because of selectivity processes, only persons already holding similar views to those advocated in the message will be affected by the message.

A somewhat different approach to mass communication effects is provided by the agenda-setting theories. (cf. McCombs and Shaw, 1972; Cohen, 1963). This theory posits that the mass media set the public agenda for discussion, not by persuading the audience of the correctness of particular attitudes or behaviors, but by teaching them what is important and what is not.

Agenda-setting differs from the direct and indirect effects theories in predicting that the media will affect the saliency of issues perceived by the audience, rather than affecting audience behavior or attitude. Thus the amount of exposure of an audience member to messages about a topic should affect the perceived importance of the topic by the audience, and by implication, should result in behavioral action related to the topic.

There are two other classes of theory which are little considered. These can be considered mirror-image forms of the direct effects theories and the agenda setting theories. The <u>reverse effects</u> class would state that the media content responds to public opinion or behavior, and thus the causal direction is opposite of that postulated by the direct effects theories. Reverse effects are most often mentioned in discussions of whether the mass media create audience taste, or merely reflect it (<u>e.g.</u>, Bogart, 1969).

<u>Reverse agenda setting</u> would predict that the prominence of stories about a topic in the mass media is produced by the salience of the issue to the audience, <u>i.e.</u> that the public sets the agenda, and the mass media reflect this decision in their coverage. This proposition has received very little attention from mass media researchers.

<u>Determining the Correct Theory</u>

In general, it is difficult to distinguish between direct and indirect effects, while it is fairly easy to distinguish between these two classes of theory and null effects and agenda setting. Considering indirect and direct effects as a single class, the following findings should be observed in order to choose a particular paradigm.

1. Indirect and Direct Effects. Exposure to media content (advocated behavioral actions or attitudes) should predict subsequent audience behavior or attitudes. Note that the media content measure must include both an evaluation of advocated positions or behaviors and either the amount of exposure reported by audience members, or a measure of the message prominence, which should predict aggregate exposure.

2. Null Effects. Media content should not predict subsequent behaviors or attitudes.

3. Agenda Setting. The prominence of media content in a particular area should predict the salience of the issue observed in the audience, and by implication should predict the amount of, but not the direction of subsequent behaviors. The assumption here is that more salient issues are acted on more frequently, although the particular nature of the action cannot be predicted.

4. Reverse Effects. Audience behavior or attitudes should predict later media coverage. Again, both advocated behaviors and attitudes and message prominence should be predicted.

5. Reverse Agenda Setting. The salience of a topic to the audience should predict message prominences, but not the

behaviors or attitudes advocated in the messages.

Information for Theory Discrimination

The tests between theories just outlined imply that a researcher obtain the following minimum information:

1. A measure of exposure to mass media messages by the audience. This exposure measure can be either direct, as by asking media use recall questions on a questionnaire or by using a media use diary. It can also be indirectly inferred by measuring the prominence of mass media messages and making the reasonable assumption that more prominent messages reach more audience members.

2. A measure of mass media content which taps the content attribute central to the effect being tested. For example, if community attitudes on a topic were being studied, this might be a positive-negative evaluative dimension. For information gain studies, it might be number of factual statements presented. This analysis will be called assertions analysis for the remainder of this paper.

3. A measure of audience attitude or behavior. Typical studies might use attitude shift on particular issues, knowledge knowledge gain, shifts in frequency of advocated behaviors, etc.

4. A measure of the salience or importance of a topic perceived by the audience. Again, this may be directly assessed by questioning audience members or inferred by observing audience behavior.

5. All the above measures must be taken over time, at as many time points as possible, as the time order of variables is necessary to discriminate between some theories, e.g., direct effects and reverse effects.

METHOD

The research described in the remainder of this paper involves a test of mass media effects in a community controversy. The five requirements just outlined were operationalized and used in an attempt to discriminate which general class of media effects theory was the best description of reality, at least for the community and topic studied.

The Problem

In May, 1976 the British and French national airlines were given permission to begin a 16 month test period of Concorde supersonic transport flights into Dulles International Airport in Washington, D.C. Concurrent with this test period, the Federal Aviation Administration conducted noise and pollution monitoring of Concorde operations. As part of this monitoring, a noise complaint telephone number was publicized. Calls to this number were coded into type of complaint categories, and the number of calls received each day were tabulated. Monitoring of mass media coverage of the controversy was also initiated at this time. The research reported here draws from these two data bases.

The Media Measures

In the Washington area, the Washington Post and evening news broadcasts on WTOP, a local television station, were monitored. WTOP had the highest rated local news programs in May, 1976 when monitoring began. Concorde related statements on NBC, CBS and ABC national network newscasts were also tabulated. Data for the first 253 days of the trial period, from May 24, 1976 to January 31, 1977 are used in this analysis. All media with the exception of WTOP were recorded on a daily basis. WTOP newscasts were monitored in four separate three week periods at approximately equal intervals, giving data for 91 of the 253 days.

Prominence Coding. This measure was constructed to fulfill the need for a measure of probable exposure to the story being coded (for direct effects tests) and as a measure of the importance assigned the story by news organizations (for agenda setting tests).

Two operational formulae for prominence were developed, one for television news stories and one for print media stories. The formula for television prominence is:

$$TVPROM=((TPT-TNS)/TPT)+(DS/150)+(.5*TSG/DS)+(TFV/DS)$$

Where TPT is total news program time in seconds
TNS is time from beginning of newscast to start of story in seconds
DS is the duration of the Concorde story in seconds
TSG is the time of appearance of stills and graphics during the story in seconds
TFV is the time of appearance of film and videotape during the story in seconds

Stories nearer the beginning or lead position of the newscast score higher in prominence, as do longer stories, stories which use still graphic aids, and stories which use film or videotape.

The 150 divider for the duration of story term represents an arbitrary estimate for the duration in seconds of an average news story. Actual average for Concorde stories was about 120 seconds. The .5 weight for stills and graphics is an arbitrary weight reflecting the lesser visual impact of still presentations, as compared to film or videotape.

The formula for print prominence is:

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PRPROM=.1*SW*((CW*CI)+(2*G))*EXP(-((PG-1)+(NS-1))/10)
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Where SW is a Section Weight (for newspapers, the front section is given a weight of 1.5, other sections 1.0
CW is the column width used for the story in inches
CI is the length of the story in column inches
G is the area of graphics, cartoons, and headlines, in square inches
PG is the page number
NS is the number of sections in the particular issue of the newspaper from which the story was obtained

This formula represents a number of common sense decisions about the nature of a prominent story in the print medium, i.e.:

1. A story in the front section of a newspaper is more prominent than a story in later sections.

2. The more text, as measured by the square area devoted to the text (column inches times column width), the more prominent is the story.

3. The more square area devoted to graphics, the more prominent the story. The graphics serve as an attention-

getting device, and so serve to make the story more prominent to the reader. An arbitrary weight of 2 is assigned graphics, reflecting the assumption that they are more important, per square area, than is story text.

4. The further back in a section the story appears, the less prominent it is in a newspaper.

5. The more sections a newspaper has, the less prominent is any story appearing near the front of any single section. For example, a story appearing near the front of a section in a newspaper with three sections is more prominent to a reader than the same story appearing near the front of a section of a newspaper which has seven sections.

6. The prominence of any story decreases more rapidly as it goes from the front page of a section to the second page, slightly less rapidly as it goes from the second to the third, less yet from third to fourth, <u>etc</u>. This is the reason for the exponential (natural logarithm based) decay term in the prominence formula.

7. The front page of a section in a newspaper with a small number of sections is a more prominent position than is the front page of a section in a newspaper with a large number of sections, as there is less competition for attention by front page stories in a newspaper with fewer sections. The adjustment for the number of sections in a newspaper in the exponential decay term reflects this assumption.

The constants in the equation are scale factors to make the range of the print prominence scores comparable to those for television, so that the two can be summed in an overall prominence index.

Both prominence measures were tested for face validity by coding the first month's Concorde stories with the operational definitions, and comparing the ranking of story prominence to prior subjective rankings of story prominence made by two persons. When split into high, medium, and low prominence categories, the operational measures gave virtually the same results as the subjective rankings.

Assertions Analysis. Assertions are defined as a simple declaration of fact or opinion. Any sentence spoken or printed may contain many assertions, if it is grammatically complex, or it might contain no assertions relevant to the topic being coded.

Assertions in each Concorde story were coded into one of 38 content categories. Full descriptions of these categories and their development can be found in Watt (1977). Intercoder reliability tests gave a 92% agreement between redundant coders of 20 stories on the number of assertions in each story, thus validating the ability of coders to recognize the basic unit of analysis.

Each assertion was also coded as being either positive, negative, or neutral toward the Concorde. These terms were not defined, but left to the interpretation of the coder. Mean agreement by coders of the same material on positive assertions was 92%, on neutral assertions was 88%, and on negative assertions was 89%. It was concluded that coders could agree reasonably well on positive, negative and neutral assertions when they were classified into the content categories.

Only seven of the categories which were related to Concorde noise were used in this study, as the audience effect measurement of interest was noise complaints. The seven categories were:

1. Noise physiological effects
2. Noise measurement by FAA
3. Noise measurement by other groups
4. Noise measurement, general
5. Subjective reactions to noise
6. Concorde noise compared to other planes
7. Other mentions of Concorde noise

Strength-Direction Index. In order to test the direct/indirect effects model and the reverse effects model, it is necessary to combine the prominence of a story with its assertions score to create an index of potential effects. A highly negative, but non-prominent story might be expected to have less effect than a mildly negative, but highly prominent story. The formula for the index used is:

STRDIR=(NPOS-NNEG)*PROM

Where NPOS is the number of positive assertions in the category for the story
NNEG is the number of negative assertions in the category for the story
PROM is the prominence score for the story

The strength-direction index for a single story is computed by summing the strength-direction values for each of the seven assertions categories used.

Each story in the monitored media which mentioned the Concorde was coded by at least three different coders. The assertions value for each evaluation level of each content category was determined by computing the mean for all coders of the same story. Over the 253 day period, 76 Concorde stories were located and coded; 49 were print stories and 27 appeared on television.

The Audience Measure

The measure of audience behavior used in the tests of the models was the number of complaints received each day by the FAA noise complaint telephone service. This measure is the audience response in tests of direct/indirect theories, and the causal agent in reverse effects tests. The measure also is taken to represent perceived salience of the noise issue in the audience, by assuming that more complaints represent a higher salience condition. This implied salience can then be used in tests of agenda setting and reverse agenda setting models.

Time Series Analysis

As was outlined previously in the discussion of the requirements of theory discrimination, both the media measurements and the audience measurements were taken over a number of time periods (253 daily time points). A time series analysis utilizing autocorrelations and cross correlations was carried out to provide significance tests for observed relationships. (See Krull and Husson, 1977, for a discussion of time series analysis.)

Autocorrelations. An autocorrelation is the correlation of a variable with itself at different time intervals. It is thus a measure of consistency over time of a particular variable. A variable which increased and decreased slowly over long periods (for example, seven days of increase, followed by seven days of decrease) would show high autocorrelations for adjacent days, as the level of the variable on any given day would be predictive of the level the next day.

Autocorrelations can be computed for differing time intervals, in order to determine how long this predictive ability persists. In the above example, the autocorrelations for a one-day lag (the ability of today's value to predict tomorrow's) would be high, the autocorrelation of a twoday lag somewhat lower, etc., until the autocorrelation reached non-significance, probably somewhere around seven days. This would indicate that one could predict future values of the variable for about six days, given the current value. This interval represents the consistency window of the variable.

Autocorrelations are not directly used to test the alternative models, but they are indicative of the reasonableness of postulated cause-effect relationships. It is reasonable to expect that a cause and its effect have similar consistency windows, i.e. a cause which persists for two days should be linked to an effect which persists for a similar time. It is possible for a cause to produce a longer lasting effect (e.g. brief exposure to a poison may produce long-lasting effects), but it is not plausible for the reverse to occur (e.g. the effects of a poison to wear off before exposure to the poison is terminated.)

The computational formula (see Fuller, 1976) for autocorrelation is:

$$RAUTO=(1/(N-L+1))*\sum_{i=1}^{n-j+1}((A_i-MEAN)*A_{i+j-1}-MEAN))\ /\ VAR$$

Where N is the number of time points
L is the time lag interval (from 1 to some maximum)
MEAN is the arithmetic mean of the variable taken over all time points
VAR is the variance of the variable taken over all time points
SIGMA is the standard summation function

Cross-Correlations. Cross-correlation of two time series variables is similar to simple Pearsonian correlation. The major difference is that the values for one variable are correlated with the values for the other variable a fixed number of time intervals away. For example, the values of an X variable will be paired with values of a Y variable one time interval away, to produce one cross-correlation, then recomputed with X and Y two time intervals away to produce another, etc. The results can be interpreted as the ability of current values of X to predict subsequent values of Y at differing lengths of time in the future. Cross-correlations with a zero time interval difference are simple Pearson correlations, computed with values of the same two variables at a number of time points.

Cross-correlations can be used to infer causal direction. If X significantly predicts values of Y at later time intervals, and Y does not predict X at later times, one would infer that at least the temporal sequence implied in the statement "X causes Y" was satisfied, if not the other requirements of causality.

The time interval between the X and later values of Y for the highest cross-correlation provides information about the length of time required for the possible cause to produce the effect. If one observed increasingly larger cross-correlations as one computed time intervals of 1, 2, and 3, then observed decreasing cross-correlations with larger time intervals, one would conclude that three time intervals was the point at which the effect was strongest.

This ability to test causal sequence and to estimate effect time makes cross-correlations ideal for contrasting models in which the causal direction is in question, such as between direct effects and reverse effects theories. The computational formula for the cross-correlation at each time interval (X at time) t correlated with Y at t+L is:

$$XCORR = \frac{(1/(N-L+1)) * \sum_{i=1}^{n-j+1} (Y_i - MEAN_Y) * (X_{i+L-1} - MEAN_X)}{SD_X * SD_Y}$$

Where) N is the number of observations in the X and Y time series
- L is the time interval between) X and the) Y value being correlated
- X and Y are the time series being correlated
- $MEAN_X$ and $MEAN_Y$ are the means of all the values of X and Y respectively for the entire series
- SD_X and SD_Y are the standard deviations of the same values
- SIGMA() is the standard summation function

RESULTS AND CONCLUSIONS

Table I contains the results of the autocorrelations analysis for the three variables of interest. As it shows, story prominence is reasonably stable over a two-day period; about 16% of the variance in tomorrow's prominence can be predicted by today's prominence. After a one-day period, however, current prominence of Concorde stories could predict subsequent story prominence at no better than chance levels.

The strength-direction index which included story prominence as well as an evaluative direction assigned to noise assertions was also fairly stable over a single day period only, but only 8% of the variance of the next day's index was explained by current values.

Noise complaints were somewhat more stable, with current numbers of complaints predicting the number of complaints for two days at better than chance levels. A little more than 4% of the variance in both day's complaints was explained.

All variables are seen to have similar consistency windows from the autocorrelation analysis. No causal information is provided by this analysis, as the similar autocorrelations indicate that any variable could reasonably be the cause of any other. The cross-correlation analysis must be used to determine temporal sequences.

The tests between an agenda setting effect and a reverse agenda setting effect are found in the cross-correlations summarized in Table II. As that table indicates, only the zero-lag, or normal Pearsonian correlation between prominence and noise complaints is significant. This would indicate that agenda setting, if it is taking place at all, takes place in the same day as the media stories which produce it. Since the time lag of zero cannot establish temporal sequence, reverse agenda setting cannot be ruled out, if it also takes place very rapidly.

Both these suppositions are not very plausible. If prominent stories changed the salience of issues and this increase in salience lead to the behavioral action of complaining, then one would expect the effect to persist longer than 24 hours. It is here that the value of a time-series technique such as cross-correlation becomes evident. If one simply correlated story prominence with complaints, with no time lagging, one would conclude that story prominence and complaints were related, and thus an agenda setting effect was likely. The addition of a cause-effect time estimate makes this conclusion much less acceptable.

Table III summarizes the cross-correlations which contrast the reverse effects and the direct/indirect effects models. As this table clearly indicates, there is no support for the reverse effects or mirror model. None of the correlations are above chance levels when complaints predict the strength-direction (prominence combined with evaluation) index.

On the other hand, the strength-direction index predicts the number of complaints one day later at better than chance levels. The amount of variance explained (about 2%) is small, but it is unlikely that the relationship is due to chance. Further, the negative sign for the cross-correlation indicates that the more negative the index, the higher the number of complaints. Thus we have evidence that prominent stories having a preponderance of noise related assertions negative to the Concorde are followed a day later by an increase in complaints about Concorde noise. Interestingly, there is no significant relationship between the strength-direction index and complaints in the same day.

DISCUSSION

Within the limitations of this study (and these will be discussed below), we have received empirical support for three general theories: direct/indirect effects, agenda setting and reverse agenda setting. All other media effects theories were rejected, as they gave predictions counter to observed data.

We can expand from the statistical tests somewhat and argue that agenda setting and reverse agenda setting, while not ruled out by the data, are not convincing models of the data. The results indicate that these processes occur immediately and their effects disappear before 24 hours have elapsed. Thus the only agenda setting effect consistent with the data would have to be translated into behavior immediately, or changes in audience salience level reflected in behavior would have to be reported upon by the media in the same day in which they take place. Neither explanation is convincing.

Direct/indirect effects seems the better model to impose on this set of data. The effect is seen to follow the cause by a day, consistent with the fact that most of the media exposure to Concorde stories by the audience probably took place in the afternoon or early evening, and that reaction to this exposure would thus quite likely occur the next day. It might be further argued that direct effects is a better explanation than indirect effects, simply because the effect is observed so soon after exposure. The interpersonal communication necessary in indirect effects would have little time to take place. But indirect effects cannot be ruled out.

However, this study has limitations which certainly rule out its presentation as the definitive word on mass media effects theories. For example, agenda setting may have received little support because of unmeasured media coverage before the beginning of the project. If the salience of the Concorde trial period has already been set in the minds of the audience, further stories might have little effect. In other words, perhaps audience salience with respect to the Concorde had already reached a ceiling.

It can be further argued that noise complaints are not the best operationalization of audience salience possible. But from a public policy making viewpoint, it can also be argued that salience which does not lead to behavior is not terribly critical.

There is also a possibility of a 'third-variable' problem in the conclusions presented. For example, media coverage was highest in the Spring of 1976 and tapered off in the fall and winter. It could be that more complaints were telephoned in during the spring and summer because people were outside during these seasons and were responding to actual outside noise levels. When the weather cooled, and coincidently, so did the news coverage, the complaints may have decreased as people went inside. This would give the same pattern of results as was observed, but the necessary connection between the presumed cause (media coverage) and the effect (noise complaints) would be missing.

A last limitation of the study is in the small amount of variance in noise complaints explained by the media indices. This is not totally unexpected, as there are many non-media variables ignored in this study which might account for differences in the number of telephoned complaints. The actual noise level of the Concorde comes immediately to mind as a relevant variable ignored in this analysis, as does the outside temperature for the reasons explained above.

Another factor contributing to the small amount of variance explained might be the sampling of WTOP stories. Unlike the other media outlets which were continuously monitored, the local television station output was sampled. Thus stories which might have produced change in the audience could have been missed.

Clearly variables such as these should be included in analyses attempting to explain as much of the variance as possible in noise complaints. But ignoring them does not remove the non-chance findings attributable to media observed in these analyses.

TABLE I

AUTOCORRELATIONS OF STORY PROMINENCE, STORY STRENGTH-DIRECTION INDEX, AND NOISE COMPLAINTS

TIME LAG	PROMINENCE	STR-DIR INDEX	COMPLAINTS
0	1.00	1.00	1.00
1	.39***	.27***	.22***
2	.09	-.09	.23***
3	.06	.03	-.07
4	.02	-.03	-.08

*** indicates $p < .01$
** indicates $p < .02$
* indicates $p < .05$

TABLE II

CROSS-CORRELATIONS BETWEEN STORY PROMINENCE AND NOISE COMPLAINTS

TIME LAG (DAYS)	COMPLAINTS PREDICT PROMINENCE	PROMINENCE PREDICTS COMPLAINTS
0	.15***	.15***
1	.01	.07
2	.01	.00
3	-.03	-.02
4	.06	-.01
5	.00	.01

*** indicates p < .01
** indicates p < .02
* indicates p < .05

TABLE III

CROSS-CORRELATIONS BETWEEN STORY STRENGTH-DIRECTION INDEX AND NOISE COMPLAINTS

TIME LAG (DAYS)	COMPLAINTS PREDICT STR-DIR INDEX	STR-DIR INDEX PREDICTS COMPLAINTS
0	-.04	-.04
1	.04	-.14**
2	.05	-.08
3	-.07	-.02
4	-.01	-.01

*** indicates p < .01
** indicates p < .02
* indicates p < .05

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