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The effect of causal verbs on knowledge creation and behavior

by

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An abstract of
A thesis submitted to the Faculty of Emory College of Arts and Sciences
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Abstract

The effect of causal verbs on knowledge creation and behavior

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The purpose of this study was to investigate the relationship between knowledge and everyday behaviors. The study focused on people's knowledge of global warming and their recycling behavior. In Experiment 1, I found that people's knowledge of global warming, as measured by their use of specific causal verbs in a concept map, correlated positively with their ratings on a recycling behavior survey. In Experiment 2, I found that having people create concept maps with specific verbs preserved recycling behavior a week after test, whereas having people create concept maps with general verbs actually led to declines in recycling behavior a week after test. Implications for people's health practices are discussed.

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Abstract

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Intuitively, knowledge seems to play an important role in the decisions people make and the actions that follow from those decisions. There are many examples of this connection in everyday life: people choose not to smoke because of the health consequences, drivers choose not to text while driving because it can lead to accidents, people choose to exercise because they know that it will help keep them healthy. This study examines the connection between what people know and how this knowledge may affect their behaviors.

To examine the relationship between knowledge and behavior, I will focus on the relationship between what people know about global warming and their recycling behavior. I assume that most people have at least some understanding of the relationship between recycling, global warming and the environment. One of the main hypotheses of this research is that people's overall level of knowledge about these relationships will correlate positively with their real world behaviors and, in particular, the frequency to which they recycle. It is expected that everyone knows that recycling is important for the environment, and that resources are limited. Most people have a general idea about why they should recycle and what happens to the materials that they choose to recycle. However, the everyday citizen may choose to represent this knowledge in a relatively superficial manner. A second main hypothesis of this research is that by encouraging people to think more deeply about these relationships, there will be consequences for their behavior. In particular, when students are encouraged to elaborate on what they know about global warming, they will be more likely to recycle.

In forming these hypotheses, I do not intend to imply that knowledge of a topic—even deep knowledge of a topic—guarantees a particular kind of behavior. Many people smoke that are aware of the health consequences of their actions, but justify their actions with

a variety of other reasons. Many people text and drive despite their knowledge about the dangers of the action. It is sometimes the case that action is not taken unless both knowledge and an emotional connection are involved in the decision. Nevertheless, it is expected that if we measure students' knowledge of a topic, I expect that I will find that their knowledge is likely to predict their behavior. Further, encouraging people to think more deeply about what they already know may change how they behave.

Background

Work in epidemiology indicates a connection between knowledge and behavior. For example, a number of studies have documented the effect of antismoking advertisements targeted to adolescents on the number of teenagers that partake in the behavior. In Pechmann et al. (2000), it was found that teenagers with more knowledge about the long-term effects of smoking were less likely to pick up the habit. Pechmann et al. identified the seven most common types of antismoking advertising messages. Seven distinct message types were created: disease and death, cosmetics, endangers family, smokers' negative life circumstances, refusal skills role model, marketing tactics, and selling disease and death (Pechmann et al., 2000). The three types of messages that were found to be most effective in lowering the rate of adolescent smoking were under the categories of "endangers family", "smokers' negative life circumstances" and "refusal skills role model". The "endangers family" category stresses that smokers can hurt their families through their second-hand smoking as well as with the possibility of their early death. The "smokers' negative life circumstances" category associated smoking with poor qualities and standards of living to imply an unhealthy non-desirable lifestyle. Finally, the "refusal skills role model" category portrayed popular and happy people resisting the pressure to smoke and living healthy

lifestyles. From an overall perspective, the most effective advertisements combined the use of emotional appeals as well as knowledge about the harmful effects of smoking on them and the people they love around them. The evidence from this study reveals that knowledge and emotional factors impact decisions about behaviors. This knowledge has the potential to affect attitudes as well.

However, these epidemiological studies are not completely convincing. For the most part, the studies show only correlational research. Most of the studies are limited in the likelihood of a successful replication due to the limited populations covered in the research. Additionally, most of the epidemiological research that has been done in this area has been done through indirect research. For example, the research done by Pechmann and fellow researchers used only focus groups and were not very effective in measuring the realistic effects of antismoking advertisements. These studies have looked at behavior and attitude change based on knowledge in very controlled environments in which the subjects knew what was being measured. However, despite the limitations in current research, the basic intuition about knowledge and behavior remains. The goal of this research is to further examine this notion.

To look at this connection, the domain being observed is different from most studies previously done in the field. More specifically, this study will examine behaviors associated with environmentally friendly behaviors with an emphasis on the importance of recycling. This research is based on the common knowledge that global warming is associated with environmental issues and therefore is related to the environmentally friendly behavior of recycling. Based on the intuition discussed previously, it seems as though the more one knows about global warming, the more one would recycle. To investigate this possibility, we

need to be able to both measure knowledge as well as create knowledge by encouraging people to elaborate on what they already know. One approach that has been used for both of these purposes is to use concept maps.

Concept Maps.

Concept maps are graphical representations that consist of nodes representing concepts, and labeled links representing relations (Novak, 1977). Novak's idea for concept mapping was based on a theory of learning proposed by Ausubel (1963). The theory states that learning is based on the superordinate properties, as well as the ability to combine knowledge and represent knowledge while receiving new information. A primary learning process called subsumption can be applied here. In this process, new material is brought in and integrated into relevant ideas in the existing cognitive structure (Ausubel, 1963). Novak (1977) found that a simple way for people and children to relate and associate pieces of knowledge is by creating concept maps.

Concept maps can be used to measure knowledge and used as a knowledge visualization tool (Canas et al, 2005.). According to Canas et al. (2005), when concepts and linking words are carefully chosen, these maps are powerful tools for observing nuances of meaning. Additionally, everyone's concept maps are different and represent different aspects of a person's knowledge, as everyone's knowledge is essentially different. Concept maps are effective because they provide a space for personal expression within an environment that is created for specific knowledge recitation. When subjects report their knowledge using a concept map, it is more difficult for researchers to code, however it provides a fairly unlimited amount of freedom for subjects to produce their knowledge about certain topics.

Concept maps can also be used to create knowledge (Canas & Novak, 2008). Learners who are working to create good concept maps are engaged in a creative process, which eventually leads to the creation of knowledge. Novak argued that new knowledge creation is "nothing more than a relatively high level of meaningful learning accomplished by individuals who have a well organized knowledge structure in a particular area of knowledge and also a strong emotional commitment to persist in finding new meanings" (Canas & Novak, p 10). The created knowledge however, can be used to understand what subjects know about an issue as well as their new understandings of the topic that is the main idea of the concept map. Using the different relations allows the subject to create connections that can either be specific or not, and this allows researchers to judge the strength of the connections that are created.

In this study, participants were asked to create concept maps. In Experiment 1, I used these maps to measure their knowledge about global warming, while in Experiment 2, I used the maps as a means to encourage people to form new knowledge. In both experiments, I focused on people's causal mental models of global warming by limiting the range of possible relations between nodes to various types of causal relations. The types of relations examined are discussed in the next section.

Expression of Causation

As discussed in Wolff, Klettke, Ventura, and Song (2005), there are a number of ways in which causal relations can be described in English and other languages. One common way of describing causal relationships is with *affect* verbs like *affect* and *influence*, as when we say *Forest fires affect biodiversity* or *Age influences cancer spread in mice*.

Affect verbs are compatible with the notion of causation specified in the verb *cause*, but they are also compatible with notions of causation, specifically those specified in the verbs *prevent* and *enable*. Sentences containing affect verbs can often be paraphrased with a relatively wide range of verbs. For example, the sentence *Forest fires affect biodiversity* can be paraphrased with a sentence containing a cause verb (*Forest fires cause biodiversity*), prevent verb (*Forest fires prevent biodiversity*) or an enable verb (*Forest fires enable biodiversity*).

As discussed in Wolff et al. (2005), another way to describe causal relations are with *link* verbs, which include verbs like *link*, *leads to*, and *depends on.* These verbs are more specific than affect verbs in that they often can be paraphrased with the verbs *cause* or *enable*, but not *prevent*. For example, the sentence *America's intelligence failures led to September 11*, is compatible with either a cause or enable interpretation, but not a prevent interpretation (*America's intelligence failures caused/enabled September 11*; **America's intelligence failures prevented September 11*). While these verbs are more specific than affect verbs, they are still relatively ambiguous, since they are compatible with both cause and enable interpretations.

In the following discussion and experiments, I will distinguish two classes of causal verbs, general and specific. General causal verbs are those that are potentially ambiguous between *cause*, *prevent*, and *enable* type verbs. Specific verbs will be those verbs that distinguish between the notions of cause, prevent, and enable, including the verbs, *cause, force, prevent, block, enable*, and *allow*. According to Wolff et al. (2005), the key difference between these two classes of causal verbs has to do with the notions of result and tendency. Affect verbs, for example, specify that something happens to the cause in a causal

relationship, but they do not specify the nature of what happens (whether something starts to happen, or stops from happening) or whether the cause had a tendency for the resulting outcome (a distinction needed to differentiate the notions of cause and enable). Affect and link verbs fall into the class of general causal verbs because they do not specify the components of meaning that distinguish the notions specified in the verbs cause, prevent, and enable. Cause, prevent, and enable verbs are specific verbs because they do specify these distinctions.

Predictions

The distinction between general and specific verbs offers us a way in which to evaluate people's level of knowledge about global warming. In a task in which people are asked to create a concept map about global warming, people with relatively little knowledge of global warming should tend to construct concept maps with a greater proportion of general causal verbs than those with a relatively high level of knowledge of global warming. Moreover, those with a relatively high level of knowledge of global warming should tend to use more specific causal verbs than those with a relatively low level of knowledge of global warming. These predictions were tested in the following experiment.

Experiment 1

In the first experiment, subjects were asked to complete the recycling measure survey and then create a concept map around the topic of global warming. The recycling measure survey was developed by Ojala (2008). It asks questions about how often participants recycle, their feelings and attitudes about recycling, as well as their knowledge about global warming. Participants constructed their concept maps using a program developed in the

Cognitive and Linguistics Systems Lab called CausePlot. The main prediction was that people's use of specific causal verbs in their concept maps would correlate positively with their level of knowledge reported on the recycling measure survey.

Participants. Participants in the first experiment were undergraduate students attending Emory University. All students in the study were enrolled in an introductory psychology class in the university. As a class requirement, students had to participate in several studies in the Psychology Department, and the current study was listed with all the running studies on a website where students could sign up for an available time slot. There were 60 participants in this experiment. A total of 24% were male and 76% were female. Participants ranged from freshmen to seniors with an age range of approximately 18 to 23. Of the 60 students who participated in this experiment, 29 were freshmen (48%), 15 were sophomores (25%), 13 were juniors (21.6%), 3 were seniors (0.05%) and 1 person did not specify a year in school. A majority of subjects, 80% (40, 1 did not specify) lived in on-campus housing where recycling facilities are located in their residences.

Materials. Participants completed the recycling measure survey from Ojala (2008). The survey contained four sections as well as an identification section (see Appendix A). The first section of the survey asks subjects how often they recycle newspapers, glass, hard plastic, soft plastic, metal and paper. The answers are given on a Likert scale in which students choose how often they recycle each item (1-Almost never, 5- Almost always). The second section asks subjects to indicate where their nearest recycling facility is located and offers 6 possible answers: in my house (dorm), in my block, in my neighborhood, in a nearby neighborhood, in a distance neighborhood, and unsure. The third section requires subjects to indicate how often they consider recycling to be associated with certain positive and negative

adjectives. The answers are again given on a Likert scale (0- Not at all, 5- Extremely). The fourth section asks subjects to indicate how much they worry about certain issues on a societal and global scale. The answers are given on a Likert scale (1- Not at all, 5- Very much). In the final section, participants provided information about their year in school, gender, and whether the subject lives on or off campus. If the student lives on campus they were asked to provide the name of the dorm they live in.

Procedure. The experiment took place in the Cognitive and Linguistic Systems Laboratory at Emory University during the Fall 2009 semester. There were two main phases to the experiment. In the first, participants were given the recycling behavior survey. After completing the survey, subjects were introduced to the CausePlot program for constructing concept maps. To become familiar with how to create concept maps, participants first practiced making a concept map about the topic of 'Catching the Flu'. After completing the practice map, subjects were asked to create a concept map with the topic 'Global Warming' and were told this was the actual trial. Each time a participant formed a link between two concepts, the program prompted them with a list of causal relations to choose from. Roughly half of the causal relations were general causal relations, namely, *influences, leads to, is linked to*, and *depends on*. The remaining causal relations were specific relations, namely, *causes, enables, allows,* and *prevents*. The order of the causal relations in the list of relations was randomized differently each time the participant created a link. Subjects were told to notify the experimenter when they had completed their map. The average time subjects spent creating the maps was 15 minutes.

Results and Discussion

Three of the concepts maps produced by participants are shown in Appendix B. As predicted, I observed a relationship between the number of specific verbs used to create the concept maps, and the people's recycling behavior. Specifically, I found that the number of specific causal verbs used ($M = 3.12$, $SD = 3.28$) correlated positively with participants' ratings of how often they recycled paper, newspaper and soft plastic during the past week, $r = .31$, $p = .018$.

In this study I measured knowledge in terms of the specificity of the causal verbs people used to connect concepts in their concept map. There are, of course, other ways in which level knowledge could have been measured. For example, we might expect that level of knowledge would be indicated by the mean number of nodes or links used in the concept map. As it turned out, the average number of nodes ($M = 11.03$, $SD = 5.51$) and links ($M = 11.57$, $SD = 6.8$) did not correlate with recycling behavior, $r = .219$, $p = .096$, $r = .218$, $p = .097$. Nor did we observe a relationship between the average number of nodes and links and people's attitudes about recycling behavior with both positive and negative emotions, $r = .023$, $p = .862$, $r = .119$, $p = .363$; $r = 115$, $p = .381$, $r = .059$, $p = .652$. Indeed, the only association observed between people's concepts maps and the recycling survey was between specificity of the verbs and recycling behavior, as described above.

Experiment 2

In Experiment 1, I observed a positive correlation between level of specificity of the verb used and recycling behavior. The results suggest a way in which it might be possible to affect behavior. If knowledge determines behavior, then changing knowledge should change

behavior. The current experiment investigated this possibility with respect to people's knowledge of global warming and their recycling behavior. Participants were once again asked to create concept maps. However, in this experiment, half of the participants were instructed to create a concept map using specific causal verbs while the remaining participants were instructed to create a concept map based on general causal verbs. I predicted that instructing people to use specific causal verbs, would lead people to think more deeply about their knowledge of global warming, leading them to form connections between previously unconnected knowledge. Given these new connections, I predicted that people instructed to use specific causal verbs would change people's recycling behavior, such that their recycling behavior should increase during the week after creating the concept map. Conversely, I predicted that for those people who were instructed to use general causal verbs, their recycling behavior would not change during the week after creating the concept map. These predictions were tested in the following experiment.

Methods

Participants. Participants in this experiment were undergraduates attending Emory University. These participants responded to an advertisement placed on the university-wide online community for a paid psychology study. There were 43 participants in this experiment. A total of 40% were male and 60% were female. Participants ranged from freshmen to seniors with an age range of approximately 18 to 23. Of the 43 students who participated in the study, 20 were freshmen (47%), 7 were sophomores (16%), 8 were juniors (18%), 6 were seniors (14%), and 2 were graduate students (5%). A majority of subjects, 77% lived in on-campus housing where recycling facilities are located in their residences.

Procedure. This experiment is similar to the first experiment with only a few additional elements. When asked to create the concept map around the topic 'Global Warming', instead of being able to use all of the linking verbs provided, subjects were placed in one of two conditions based on the strength of the verbs. Students in the "specific" condition were instructed to only use the verbs *cause, force, allow, enable, prevent*, and *block*. Students in the general condition were instructed to use one of the more general causal relations, specifically *affect, influence, linked to, leads to*, and *depends on*. After the subjects completed their concept maps they were given their payment of ten dollars, and were asked to write their e-mail addresses on a form separate from their survey as to keep their names separate from their responses. Their e-mail address was then used to contact the subjects a week later and ask them to again fill out the recycling survey.

Design. The experiment had one between subjects factor, verb specificity (specific vs. general) and one within subjects factor, time point (before vs. after), for when they completed the recycling survey.

Results and Discussion

I predicted that when people were instructed to use the specific causal verbs, that they would show more recycling behavior after a week because they would create more specific knowledge about global warming. The results provided partial support for this prediction. The results were analyzed using a mixed-factor ANOVA in which verb specificity was a between subjects factor and time point was a within subjects factor. This analysis indicated an effect of time point, specifically, that the overall level of recycling behavior was higher before people created the concepts than one week later, $F(1, 12) = 8.0$, $p = .030$. It should be

noted that the direction of this difference is opposite to what we predicted, though, as described below, the result is still potentially compatible with a weaker version of my original predictions. ANOVA provided no evidence for an overall effect of verb specificity, $F(1,5) = .229$, $p = .649$, nor of an interaction between verb specificity and time point, $F(1, 5) = 1.778$, $p = .231$.

While the ANOVA did not provide evidence for an interaction between time point and verb specificity, planned comparison provided support for the view that the verb types had consequences for people's recycling behavior. The mean recycling behavior ratings for the different conditions are shown in Table 1.

Table 1. Mean ratings of recycling behavior for specific and general verbs, before and after test, with associated standard deviations and standard errors of the mean.

Verb type	Time point	Mean	N	Standard deviation	Standard Error Mean
Specific	Before	10.143	7	3.579	1.353
	After	9.571	7	3.645	1.378
General	Before	11.571	7	1.718	0.649
	After	9.857	7	2.41	0.911

In the specific condition, there was no evidence that recycling behavior differed before and after the construction of the concept map, $t(12) = .934$, $p = .386$. However, in the general condition, recycling behavior after the construction of the causal maps was significantly lower than before the construction of the causal map, $t(12) = 3.032$, $p = .023$. The results are

consistent with the possibility that there was an overall bias towards less recycling after construction of the concept map, possibly due to the experiment being conducted towards the end of the semester when students have less time. The results in the general verb condition provided evidence for such a bias. In the specific condition, however, there was no evidence for a change in recycling behavior, consistent with the possibility that use of the specific verbs helped prevent a drop in recycling behavior. The results are consistent, then, with the idea that use of specific language can help promote recycling behavior.

While not predicted, it is interesting to note that several other effects were associated with verb specificity. As shown in Table 2, participants in the specific verb condition produced concepts maps with significantly more nodes, $t(12) = 2.107$, $p = .05$, but not more links, $t(12) = 1.196$, $p = .255$, than participants in the general verb condition. The results are consistent with the idea that instructing people to use more specific verbs encourages them to consider more units of knowledge than that they would normally consider. Example concept maps from the specific and general conditions are provided in Appendix C.

Table 2. Mean number of nodes and links with associated standard deviations (SDs).

Experiment 2 Connections

Condition	Mean Number of Nodes	Mean Number of Links
Specific	14.14 (3.34)	15.14 (3.18)
General	10.43 (3.26)	13.00 (3.51)

General Discussion

The purpose of this study was to examine the basic intuition of the connection between knowledge and behavior. It seems as if the more knowledge one has about a topic, the more one would take appropriate actions to help the situation. In this study, the more one knows about global warming and its implications for the environment, the more one will recycle. This concept was examined with a recycling behavior and attitude study and the creation of concept maps focused on the topic of global warming. Subjects in the first experiment were asked to complete the recycling survey and then create a concept map on the computer. Subjects in the second experiment were asked to do the same tasks, however, the concept-mapping task was divided into two conditions. In the first condition, subjects were only allowed to use the general causal verbs and in the second condition subjects were only allowed to use the specific causal verbs. In the first experiment, subjects were simply expected to reproduce their knowledge about recycling using the concept map. In the second experiment, subjects in the heavy condition were expected to create knowledge using the more specific linking verbs. It was predicted that the subjects who were instructed to create knowledge about global warming would perform more recycling behaviors in the following week. The subjects in the second experiment were e-mailed a follow-up survey one week after coming into the lab to measure recycling behaviors and attitudes.

Associating knowledge with behavior has been a popular relationship often examined in the public health arena. Research has been done on such issues including teen pregnancy, smoking, and texting while driving. One of the more popular issues in which an association between knowledge and behavior can be seen is adolescent smoking prevention. More recent examples include the Truth campaign. Many case studies have been examined and shown

evidence for a reduction in teenage smoking rates as a response to certain kinds of knowledge being dispersed in these advertisements.

Studies by Pechmann (2000) have shown that anti-smoking advertisements have an impact on the number of teenagers that pick up the habit. In case studies in which teenagers were asked what types of knowledge have the biggest effect on whether or not they choose to smoke, the most common types of knowledge were "endangers family", "smokers' negative life circumstances" and "refusal skills role model." (Pechmann, 2000). These studies, however, show only correlational evidence and are based mostly on case studies rather than experimental evidence. This study examines the connection of knowledge and behavior through an even more linguistic and cognitive approach, examining causal connections and specific word choice in the creation of knowledge.

The first experiment provides further evidence for Wolff et al's (2005) conclusions about the specificity of causal verbs. This implies that people do in fact separate causal words intrinsically into categories based on specificity of the verb. The verbs that infer direction, such as "causes," "enables," "prevents," and "allows" are used more specific than those that simply link two concepts such as "linked to" and "leads to." The more specific verbs were listed as group 3 in the study and were found to be positively correlated with the frequency of recycling behaviors with paper, newspaper and soft plastic.

The correlation found between the amount of paper, newspaper and soft plastic recycled with the amount of causal verbs from the most specific group signifies that those with the strongest understanding of global warming recycled the most. The survey asked for how often subjects recycled a variety of materials, however, paper, newspaper and soft

plastic are among the most commonly recycled items. These materials are often commonly used in the university setting. Newspapers are provided for free to students in bins placed in many locations around campus. Paper is used very frequently for assignments, tests, flyers and countless other tasks. Soft plastics are used in most drink bottles and other containers used to keep many foods that college students purchase.

The second experiment was done to determine if by forcing subjects to create knowledge using the more specific causal verbs, their behavior would be affected. Two conditions were created to examine this hypothesis, the specific causal verbs and the general causal verbs were separated and subjects were randomly placed into one of the two conditions. Unexpectedly, in both conditions the frequency of recycling behaviors decreased between the preliminary and secondary surveys. However, there was an effect of the intervention and despite the decline in recycling behaviors, there was a significant decline in the general condition and not in the condition with the specific causal verbs. Therefore, while creating knowledge did not directly increase the frequency of recycling behaviors, it seemed to keep recycling behaviors from declining as in the other condition in which no significant knowledge connection was created. This downward bias was only realized in the general condition, such that using specific linking verbs made knowledge more resilient to the effect of time.

This study was intended to provide evidence for the theory and basic intuition that knowledge influences behavior. Evidence was found for the use of specific causal verbs to increase knowledge to sustain behaviors. The reason for the decline in the frequency of recycling behaviors can be attributed most likely to the busy lifestyles of college students. College students, while presented with many opportunities to carry out recycling behaviors,

often do not feel they have the time or the need to recycle as often as they could. This argument can especially be made for students in the general condition, as they may not have made the close connections that were made in the specific condition and therefore saw a weak connection between global warming and recycling and felt no need to recycle more often.

After examining the number of nodes and causal connections in both experiments and both conditions, participants in the specific condition appeared to create more nodes and draw more connections. This is an interesting finding because it appears that using the more specific causal verbs creates a more integrated knowledge. In the specific condition, there seems to be a greater connectivity of knowledge. These findings can also support evidence for the resilience of knowledge created with specific causal verbs.

It is interesting to note additionally, that after running correlations with attitudes about recycling and recycling behaviors, no significant correlation was found. This points to the uniqueness of knowledge and knowledge creation as relates to behavior. More research will need to be done on this topic, however, there is something to be said for the reaction of knowledge to behavior and no reaction to attitudes and behavior.

One of the major limitations in the study relates to the population being examined. This population is only a small subset of people that perform pro-environmental behaviors. Further, when subjects were asked to complete the survey and the question asking where their nearest recycling station was located, a majority of subjects lived on campus and so were only able to provide the answer “in my dorm” or “I don’t know”. This greatly limited

the population sampled, and may have effected the results as we do not know the knowledge base and recycling behavior of the larger population.

Another limitation was the slow sampling process during the second experiment. During this session, it was much harder to recruit participants and we therefore offered a monetary incentive in turn for participation in the study. This may have skewed the data because the value of the incentive changed from credit for an introductory psychology class to money. Additionally, the type of people participating in the study changed from only those enrolled in introductory psychology classes to the entire Emory University undergraduate population.

The response rate for the survey emailed to the participants in the second experiment was very low. This is most likely due to the nature of college students to be too busy and often delete emails that they were not expecting or not familiar with. Also, the busy lifestyles of students often prevent them from participating in extraneous work that is to little or no benefit to them. The students had already received their incentive after participating in the original study, and no longer had a specific reason to complete and return the follow-up survey. This is a common occurrence when undergraduate populations are sampled and can sometimes be avoided by only providing incentives after the entire experiment has been completed but in this case it was not feasible.

Despite the limitations, however, the results of the study show promising implications for the future. With the knowledge of what kinds of causal verbs can be used to create knowledge, successful advertisements and campaigns can be created in the public health arena and others that will successfully modify behavior. This study shows a new effect of

language on thought and the implication for behavior in the real world. With new knowledge about the strength of causal verbs, more studies can be done to determine the strength of other linguistic terms and even emotional terms that may be used to affect many different kinds of behavior.

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Appendix A: Recycling Behavior Measure (Ojala 2008)

Year in school:						**Subject Number**
On/off campus:		**If on campus, which dorm?**				
Gender:						

In the past week, you recycled:	**1- Almost never**	**2- Seldom**	**3- Sometimes**	**4- Often**	**5- Almost always**
Newspapers					
Glass					
Hard plastic					
Soft plastic					
Metal					
Paper					

	In my house(dorm)	**In my block**	**In my neighborhood**	**In a nearby neighborhood**	**In a distant neighborhood**	**I don't know**
Please, indicate where your nearest recycling facility is located:						

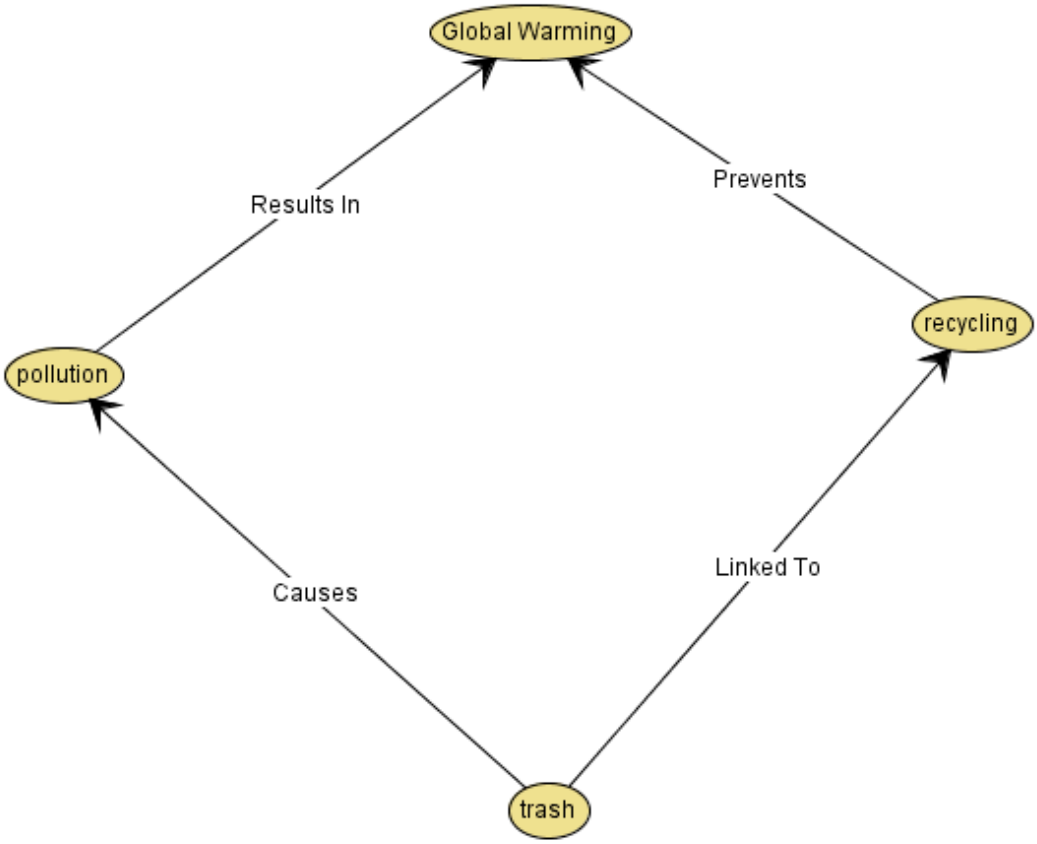
Indicate to what extent you consider recycling to be:	**0- Not at all**	**1**	**2**	**3**	**4**	**5**	**6- To a large extent**
A meaningful phenomenon							

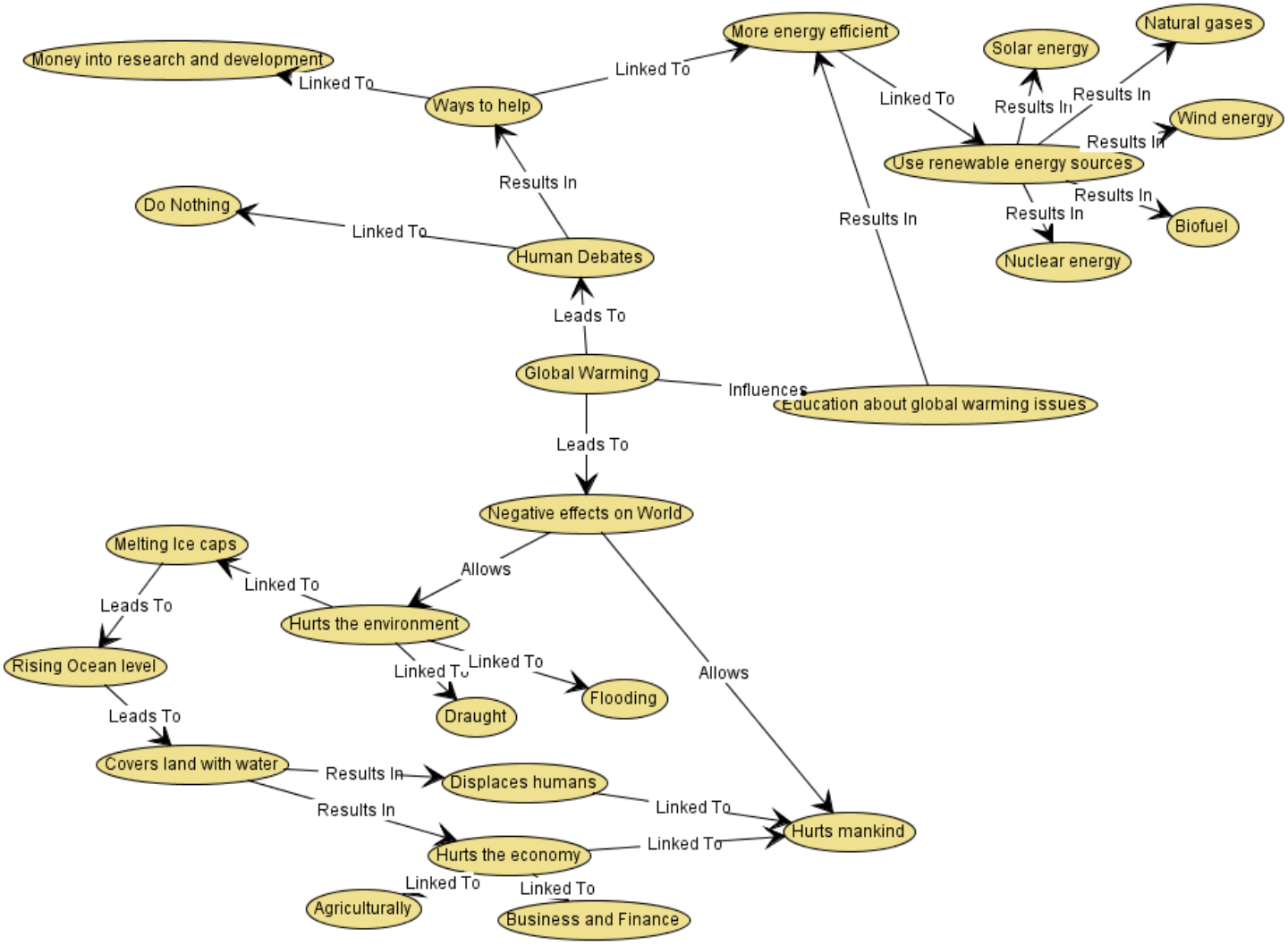
An important phenomenon							
A pleasant phenomenon							
Worth the time it takes							
Related to positive emotions							
A meaningless phenomenon							
An unimportant phenomenon							
An unpleasant phenomenon							
A total waste of time							
Related to negative emotions							

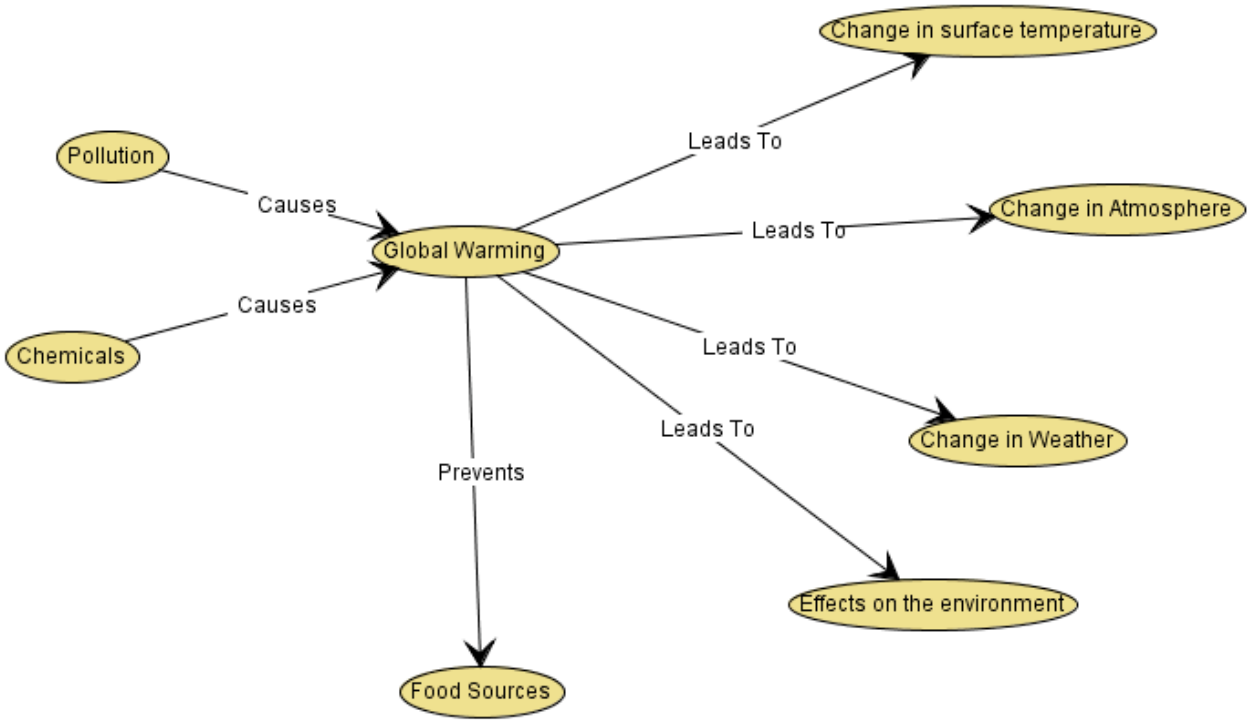
How much do you worry about the following on a societal and global scale?	**1- Not at all**	**2- A little**	**3- Fairly little**	**4- Fairly much**	**5- A lot**	**6- Very much**
Air pollution						
Extinction of animal species and plants						
Future climate change						
Hazardoes chemicals in food						
That environmental pollutants are						

increasing						
Depletion of the ozone layer						
That the Earth's natural resources will run out						
The handling of waste in society						
Destruction of the rainforest						
Energy consumption in society						
When thinking about the environmental problems present in the world today, to what degree do you feel hope?						
When thinking about the environmental problems of the world today, to what degree do you feel joy in being able to contribute to their solution?						

Appendix B: Concept maps produced in Experiment 1

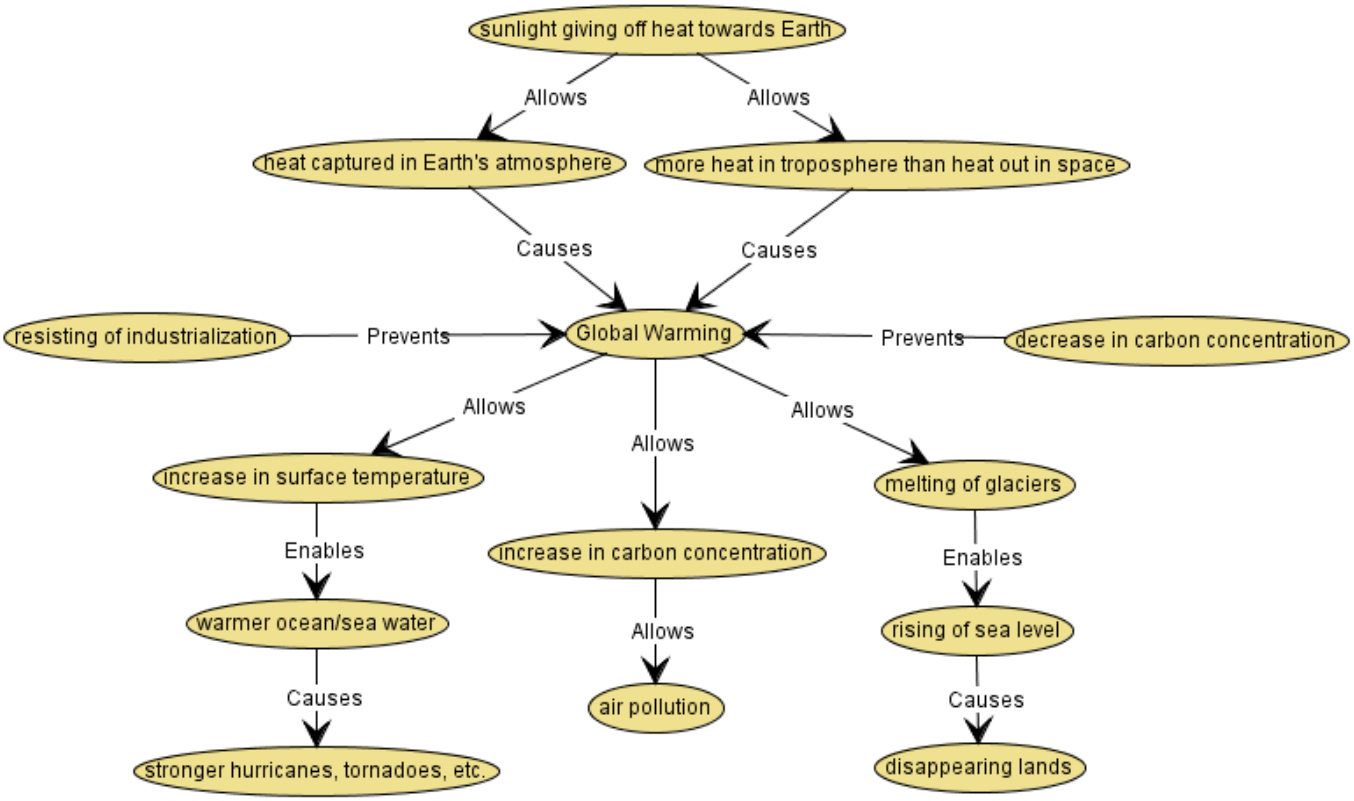



Money into research and development
Linked To
Ways to help
Linked To
More energy efficient
Linked To
Natural gases
Solar energy
Results In
Results In
Wind energy
Results In
Use renewable energy sources
Results In
Biofuel
Results In
Nuclear energy
Results In
Do Nothing
Linked To
Human Debates
Results In
Leads To
Global Warming
Influences
Education about global warming issues
Leads To
Negative effects on World
Allows
Allows
Melting Ice caps
Linked To
Leads To
Hurts the environment
Linked To
Linked To
Rising Ocean level
Flooding
Draught
Leads To
Covers land with water
Results In
Displaces humans
Linked To
Results In
Hurts mankind
Hurts the economy
Linked To
Linked To
Linked To
Agriculturally
Business and Finance


Change in surface temperature
Pollution
Leads To
Causes
Change in Atmosphere
Global Warming
Leads To
Causes
Chemicals
Leads To
Change in Weather
Leads To
Prevents
Effects on the environment
Food Sources

Appendix C: Concept maps produced in Experiment 2

Concept map produced in the condition in which participants were limited to using specific verbs.



Concept map produced in the condition in which participants were limited to using general verbs.