

# Environmental Impacts of Holiday Gift Giving of Books and Movies

Benjamin Shaffer

*DePaul University*, [bshaffe1@mail.depaul.edu](mailto:bshaffe1@mail.depaul.edu)

Follow this and additional works at: <http://via.library.depaul.edu/depaul-disc>



Part of the [Other Environmental Sciences Commons](#)

## Acknowledgements

Thanks to the Undergraduate Student Research Program and the DePaul University Environmental Science Department for funding this project.

---

## Recommended Citation

Shaffer, Benjamin () "Environmental Impacts of Holiday Gift Giving of Books and Movies," *DePaul Discoveries*: Vol. 6 : Iss. 1 , Article 3. Available at: <http://via.library.depaul.edu/depaul-disc/vol6/iss1/3>

This Article is brought to you for free and open access by the College of Science and Health at Via Sapientiae. It has been accepted for inclusion in DePaul Discoveries by an authorized editor of Via Sapientiae. For more information, please contact [mbernal2@depaul.edu](mailto:mbernal2@depaul.edu), [wsulliv6@depaul.edu](mailto:wsulliv6@depaul.edu), [c.mcclure@depaul.edu](mailto:c.mcclure@depaul.edu).

# Environmental Impacts of Holiday Gift Giving of Books and Movies

Benjamin Shaffer

Department of Environmental Science and Studies

Christie Klimas, PhD; Faculty Advisor

Department of Environmental Science and Studies

**ABSTRACT** This project examines the relationship between gift giving deadweight loss (when the cost of a gift exceeds its value to the recipient) or welfare gain (when the value of a gift to a recipient exceeds the cost of a gift) and the environmental impact of gifts. Surveys of American adults were used to determine the economic welfare losses or gains created by holiday gift giving, comparing gifts of traditional (paper) books and DVD or Blu-ray format movies. Both products showed overall welfare gains as gifts, with books averaging a larger welfare gain than movies. An ANOVA was done to determine the effect of the relationship between the giver and receiver on the amount of welfare gain or loss. This showed no significant difference based on relationship for books, but for movies significant others had a stronger welfare gain, and the category “other” showed a significantly different welfare loss. The second phase of this study uses life cycle assessment, a process used to evaluate the environmental impact of a product, to compare the global warming impacts of books and movie discs. Preliminary results are presented here for books. Initial results indicate higher global warming impacts for hardcover books than paperbacks, due largely to the additional inputs required during book production. In the future, life cycle assessment of movie discs and analysis of the relationship between welfare gain or loss and the global warming potential impact will be done to determine which type of gift has the lower impact in terms of global warming potential, compared to the welfare gain to the recipient.

## INTRODUCTION

Gift giving can involve either economic deadweight loss, when the amount spent for a gift exceeds what the recipient would pay, or welfare gain, if the value of the gift to the recipient exceeds the price paid for the gift. This deadweight loss or welfare gain value varies with

different kinds of gifts and different relationships between givers and recipients. Waldfogel (1993) has found that holiday gifts are often associated with deadweight loss because they are unwanted or valued less than their purchase price. However, some gifts are desired by the recipient and are

valued at least as much as the amount of money spent on the gift (Kaplan and Ruffle, 2009), and sometimes valued more than the purchase price. This kind of welfare gain is most likely for thoughtful gifts, such as those purchased by someone who knows the recipient well (Waldfogel, 2009). When gifts involve deadweight loss, this represents an unnecessary environmental impact, such as greenhouse gas emissions released in the process of manufacturing the gift. On the other hand, welfare gain leads to a greater value compared to the environmental impact from that gift. Quantifying this economic deadweight loss or welfare gain for different kinds of gifts and better understanding the environmental impacts of the gift itself may allow those purchasing gifts to decide to buy items that carry a lower amount of environmental deadweight and make more environmentally conscious gift giving decisions. In order to better understand the economic deadweight loss or welfare gain of gifts, this project compares two potential gift items, books and DVD/Blu-ray movies. These gifts were selected because they are similar in cost and both serve as entertainment for the recipient. A survey was used to evaluate the value of these gifts to recipients in order to ascertain if there is a deadweight loss or a welfare gain for these gifts.

In the next phase of this study, books and movies were evaluated using a life cycle assessment for their environmental impacts in several areas. Life cycle assessment is used to evaluate the environmental impact of a product from the extraction of raw materials through its end of life, such as recycling or being sent to a landfill. This type of assessment quantifies environmental impacts, such as greenhouse gas emissions and particulate pollution, which occur from the manufacture, transportation, and use of items. This phase of this study examines these environmental impacts from books, and future work will be done to examine movie discs so that their impacts can be compared.

## **METHODS**

### **SURVEY**

A survey was performed through Qualtrics in which participants were asked questions about gifts that they received during the 2015 holiday

season. Qualtrics recruited a pool of participants representative of the United States population, and acquired responses from 483 males, 517 females, 626 Caucasians, 132 African Americans, 53 Asian Americans, 171 Hispanics, and 18 from other ethnicities. Household income questions showed responses of 130 respondents in households earning under \$15,000, 117 between \$15,000-\$25,000, 107 between \$25,000-\$35,000, 136 between \$35,000-\$50,000, 175 between \$50,000-\$75,000, 117 between \$75,000-\$100,000, 125 between \$100,000-\$150,000, 50 between \$150,000-\$200,000, and 45 over \$200,000. The survey began on April 19th 2016, and finished on May 5<sup>th</sup> 2016. Qualtrics participants were compensated for their participation with no more than \$5.

Participants were asked if they received a physical book and if they received a DVD or Blu-ray movie as a gift. Those who did receive these gifts were asked further questions about the gifts, similar to those questions asked in the original study on gift-giving deadweight loss by Waldfogel (1993), although we did not ask survey respondents to exclude sentimental value associated with gifts. These questions included the amount they believed the gifts cost and how much they would have spent to buy those same items. They were also asked about their relationship to the person who gave the gift, and if they read the book or watched the movie they received.

All answers from a person's survey response were removed if they gave clearly nonsense or vulgar responses, did not complete the survey, indicated their location as outside of the United States, or if no dollar amount was given for the estimated amount spent to buy the gift. Recipient values that were positive and qualitative, such as "priceless," as well as amounts that indicated a welfare gain of greater than 200% were changed to be 200% of the original purchase price in order to reflect a more realistic value.

There were 906 valid responses to the questions about books and 709 valid responses to questions about movies. These were analyzed for gift price vs. estimated value to the recipient using a regression analysis in the statistical software program R version 3.2.5. We log-transformed the

data to reduce skew and meet the normality assumptions of the regression. We regressed the log of the value to the recipient on the log of the price of the gifts.

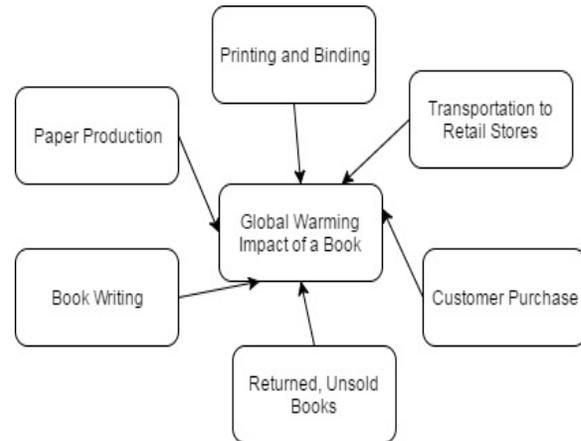
Relationship categories were determined based on the survey participants own descriptions of their relationships, and sorted into categories as partners, immediate family, extended family, friends, and others. The impact of the relationship between the gift giver and recipient was analyzed using ANOVA in R to see if the relationship between price and value was significantly different between relationship categories of gift givers, such as if people valued gifts more when given by a romantic partner rather than a friend.

### LIFE CYCLE ASSESSMENT

The functional unit considered for these life cycle assessments is an individual book or an individual movie disc, with its case and enclosed materials. A functional unit is the product or service being considered in a life cycle assessment, to which inputs of materials and processes, and outputs of CO<sub>2</sub> are related. A single book or movie was used as the functional unit because the gifts considered in the survey were gifts of a single book or a single movie. The time period considered for these gifts was one year. These life cycle assessments are “cradle to use” which means that it they include the processes of production, transportation, and purchase of the gifts. Disposal was not considered because few gifts were expected to be disposed of within the one year time frame.

The life cycle assessment for books has been completed, and the next step of this study will be a life cycle assessment for movie discs, using similar techniques. The processes that were taken into account for this life cycle assessment are shown in Figure 1. Inputs and outputs (emissions) from all steps in the production, transportation, and sale of the books that follow were converted into kg CO<sub>2</sub> equivalents, either using the program OpenLCA, or manually converting emissions to global warming potential using TRACI 2.1. OpenLCA is an open source software package that aids life cycle assessment. It allows users to build a model of the life cycle being assessed, adding modules from databases of information

about the impacts of portions of a process, such as growing a crop or different kinds of transportation. EcoInvent 3.3 is the database used in this study. TRACI 2.1 is an impact assessment tool and data source provided by the U.S Environmental Protection Agency and uses Microsoft Excel as its platform.



**Figure 1.** The different stages in book creation and transportation considered for calculating the global warming potential impact.

The mass used for a book was based on the average mass of the most common books people reported receiving in the survey. “Harry Potter” and “The Hunger Games” were listed frequently, but without specifying which books in the series people received, so all books in both series were included. I found at least one paperback copy of all books, and in situations where more than one paperback version was available I measured the masses of all versions. The Bible was the most frequently given book, therefore three different paperback, and three different hardcover Bibles were included. When a hardcover copy of the books could be found I included those, and measured the height, width, depth, and thickness of the cover. To determine the cover mass one hardcover book was taken apart and its cover weighed to determine the mass per cm<sup>2</sup>.

I considered the process of writing a book by interviewing three book authors regarding their writing process. I asked each author about the hours spent writing a book, as well as what technology was used for their writing. Much of the writing took place using laptop computers. As author Ania Bula said: “I mostly used my laptop

and wrote a significant portion of it working in coffee shops.” The authors reported an average of 348 hours spent on researching, writing, and editing per book (A. Bula, F. Zamapripa, L. Harrington, pers. comm., January 2017) though these hours were spread out over time periods from as short as a few weeks to as long as three years. These hours of use of a laptop computer were considered for the global warming potential of the book writing. Data for the impacts of laptop computer operation came from data in EcoInvent 3.3 in OpenLCA. Data specifically referred to impacts from 68% active work on a laptop with a 0.2Mbit/s internet connection.

The materials and processes for book production were analyzed using data from EcoInvent 3.3 in OpenLCA. This analysis included the production of uncoated wood-free paper, waste, and offset printing of hardcover and paperback books, as well as core board cover production for hardcovers (Borggen et al., 2011).

Transportation of paper from the paper mill to the printing location was by long-haul diesel truck, using a distance of 805 km (Matthews et al., 2001, Matthews et al., 2002). The data for the impact of this shipping came from the National Renewable Energy Laboratory (2012). Emissions were based on transporting one metric ton of material one kilometer. These impacts (ex. methane) were converted into common units of kg CO<sub>2</sub> equivalents to determine global warming potential using conversions in TRACI 2.1. Impacts were normalized based on mass of the book and packaging and total kilometers traveled.

Transportation of books occurred three times, from the book printer to a national warehouse, from the national warehouse to a regional warehouse, and from a regional warehouse to a retail store. The distance used for each of these was also 805 km. Based on an interview with a publishing company employee, it was determined that most books are transported on long-haul diesel trucks (Tedrick, 2016).

Unsold, returned books are sent back to publishers at a rate of 35% (Matthews et al., 2001, Matthews et al., 2002) and for this transportation 805 km on a long-haul truck was also used. Returned books may be resold, recycled, or

landfilled, but we did not include impacts from “final disposal” of returns in this study.

A round trip distance of 47 km was used to account for the customer picking up a book from a retail store based on the numbers used by Byrnjolfsson and Smith (2000) and also taking into account the decrease in the number of physical bookstores since 2000. According to the US Census the number of book stores in the United States has decreased from 10,860 in 2002 to 7,176 in 2012. This distance was divided in half to account for the likelihood that a customer purchases approximately two books in one trip, resulting in a total round trip distance of 23.5 km in a personal car.

## RESULTS

### SURVEY

Recipients of both books and movies experienced a significant overall welfare gain, with mean results shown in Table 2. Percent welfare gain is found by dividing the value to the recipient by the amount spent by the gift giver and is included as well as the dollar amount increase in order to limit bias due to different overall costs between the two gift options. Regression results, shown in Table 1, indicated that the value to the recipients was proportional to the cost of the gifts for both books and movies ( $p > 0.001$ ):

For books:

$$(1) \log(\text{value}_i) = 0.274 + 0.814 \log(\text{price}_i) \\ (0.040) \quad (0.032)$$

For movies:

$$(2) \log(\text{value}_i) = 0.056 + 0.948 \log(\text{price}_i) \\ (0.038) \quad (0.030)$$

Standard error values are in parentheses.

**Table 1.** Coefficients and standard errors for book and movie equations used to calculate welfare gain or loss. Standard error values are in parentheses.

	<b>a</b>	<b>b</b>
<b>Books</b>	0.274 (0.040)	0.814 (0.032)
<b>Movies</b>	0.056 (0.038)	0.948 (0.030)

**Table 2.** Mean welfare gain for both books and movies.

	Mean Welfare Increase (Dollars)	Mean Welfare Increase (Percent)
<b>Books</b>	\$6.29	25.82%
<b>Movies</b>	\$3.10	13.03%

The impact of the relationship between the gift giver and recipient was analyzed using ANOVA to see if the relationship categories had different results. For books, the relationship category had no significant impact on the welfare gain experienced ( $p=0.060$ ). However, for movies, partners were associated with significantly higher welfare gains than other relationship categories ( $p=0.037$ ). The relationship category of “other” was associated with a significantly lower value to the recipient ( $p=0.0029$ ), and was the only category with a welfare loss for movies.

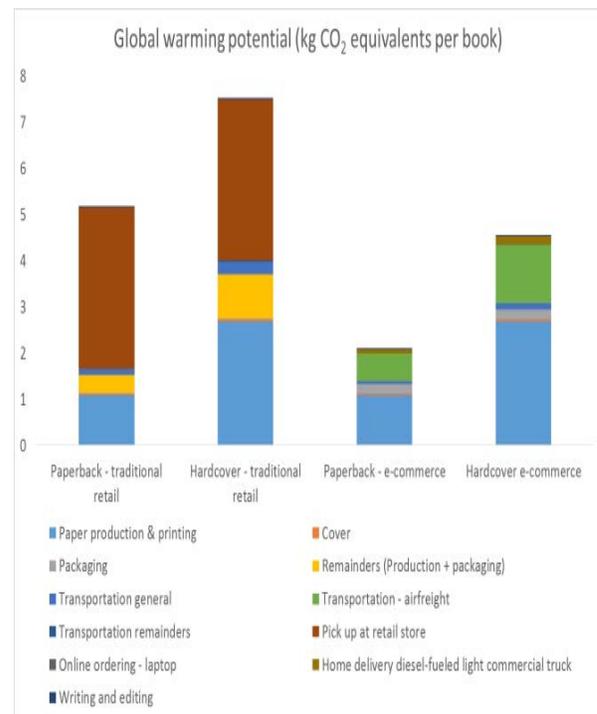
#### LIFE CYCLE ASSESSMENT

The measurements for the books considered were used to obtain the masses of paperback and hardcover books for this study. The mean mass of a paperback book was 472 g, the mean mass of a hardcover book was 1008 g, and the mean mass of the cover of a hardcover book was 28.9 g. The raw data for the measurements of these books is given in appendix 2.

All processes were analyzed for global warming potential in terms of carbon dioxide equivalents. These processes, shown in Tables 3 and 4, were added together to find the total global warming impact of a paperback book and the hardcover book for traditional retail stores and e-commerce (books purchased from online outlets).

The printing of the books and the use of a personal vehicle to purchase books at a retail store contributed the largest amount of global

warming potential to the impact of the books. Figure 2 shows the total impacts broken down by process.



**Figure 2.** Total CO<sub>2</sub> equivalent impacts of both paperback and hardcover books, in traditional and e-commerce retail, broken down by contributing processes.

The total global warming potential associated with hardcover books was higher than for paperback books, and this difference was largely due to the higher weight of the books (with a mean mass more than twice that of paperbacks) and the therefore increased impact from offset printing. Paper production impacts (for the interior book pages) were included in offset printing.

**Table 3.** Global warming impact of the writing and manufacturing portion of the life cycle assessment of paperback and hardcover books.

<b>Process</b>	<b>Global Warming Potential (kg CO<sub>2</sub> equivalent) Paperback</b>	<b>Global Warming Potential (kg CO<sub>2</sub> equivalent) Hardcover</b>
Writing and editing	0.033	0.033
Offset Printing (including paper production)	1.097	2.690
Offset Printing Remainders	0.384	0.942
Coated Paper Production	0.230	N/A
Coated paper remainders	0.008	N/A
Core board production	N/A	0.046
Core board remainders	N/A	0.016
<b>Total</b>	<b>1.752</b>	<b>3.727</b>

**Table 4.** Global warming impact of the retail and delivery processes included in the life cycle assessment of paperback and hardcover books in traditional retail and e-commerce.

<b>Process</b>	<b>Global Warming Potential (kg CO<sub>2</sub> equivalent) Paperback Traditional Retail</b>	<b>Global Warming Potential (kg CO<sub>2</sub> equivalent) Hardcover Traditional Retail</b>	<b>Global Warming Potential (kg CO<sub>2</sub> equivalent) Paperback E-Commerce</b>	<b>Global Warming Potential (kg CO<sub>2</sub> equivalent) Hardcover E-Commerce</b>
Transportation Long-haul Truck	0.128	0.277	0.064	0.139
Transportation Personal Car	3.498	3.498	N/A	N/A
Transportation of Remainders Long- haul Truck	0.011	0.024	N/A	N/A
Corrugated Boxes	0.012	0.012	0.209	0.209
Online Ordering	N/A	N/A	0.006	0.006
Air Freight Shipping	N/A	N/A	0.587	1.270
Home Delivery Light Truck	N/A	N/A	0.082	0.171
<b>Total</b>	<b>3.649</b>	<b>3.811</b>	<b>0.948</b>	<b>1.798</b>

## DISCUSSION

Based on the work of Waldfogel (1993, 2009), a deadweight loss from gift giving was the anticipated outcome from the survey performed. However, a welfare gain was found instead, showing that recipients experienced positive outcomes from these specific gifts, and there was no unnecessary money spent nor did these gifts

contribute any environmental harm related to poor gift giving choices.

There are several factors that may have contributed to this result. Many recipients did not ignore the sentimental value of the gifts they received. Thirteen percent of those who received books and 9% of those who received movies

valued their gifts at twice the purchase price or higher, or described the value of the gift as “priceless” or a similar description, which indicates that this value is much higher than the actual financial value the person places on the book. Walfogel (1993) asks participants in his work to ignore sentimental value of gifts, but more recently other researchers (Yang and Galak, 2015) have found that they can measure this aspect of gift value. This may have lead participants to rate the value of the gifts higher than they would have otherwise. Another factor may be related to the gifts selected for comparison in this study. Specific books and movies can both be selected to match the interests of the recipient, so that specific titles that the recipient can be expected to enjoy will be purchased often as gifts. This survey showed that gift givers were generally good at selecting specific books and movies that recipients valued highly. In about half of the survey results participants said they had specifically asked for the title they received which increases the likelihood of a welfare gain.

The observation that the survey found an overall welfare gain instead of a deadweight loss did change the way in which the environmental impacts of these gifts were considered. If deadweight loss had been found, the global warming impacts of the gifts would have been modified to reflect the degree of deadweight loss. For example, if a gift lost 25% of its value when given then 25% of the greenhouse gas impact would be considered to be deadweight environmental impact. Instead, the results of the survey show that the gift giving process does not change the degree of global warming potential as it relates to the gifts value.

The life cycle assessment found that the process of paper and printing were major contributors to the greenhouse gas emissions from the production and sale of books, while the actual writing and editing process contributed little. A better estimate of the number of hours spent writing and editing a book would be preferable, as the estimates given by those interviewed for this study seem too small to be accurate. A sensitivity analysis showed that multiplying the number of hours by 8, from 348 hours to 2784

hours, would only increase the impact of a paperback book by 4%. Additionally, unlike other inputs into the book making process, writing and editing impacts are not increased when a larger number of books are sold. For this study a conservative estimate of 500 copies sold was used, but the types of books most commonly given as gifts in the survey far more books were actually sold. A sensitivity analysis shows that if 50000 copies of a paperback book are sold, the global warming potential due to writing and editing a book decreases by only 0.6%. This shows that the contribution from this part of the book production was minimal and a larger number of hours spent would not significantly change the overall impact.

Driving to and from bookstores was a significant factor that caused the impact from books purchased through e-commerce to be lower than those purchased from traditional retail stores. This is consistent with the findings of Matthews, et al. (2002) and Borggren et al. (2011). Consumers can mitigate this impact by using a less impactful transportation option such as public transportation or walking to a bookstore when possible. The greater mass of hardcover books accounted for the difference in global warming potential between hardcover and paperback books. Consumers can also make less impactful decisions by choosing paperback instead of hardcover books as gifts.

While the life cycle assessment for DVD and Blu-ray discs has not yet been completed, it is expected that the process of movie production will contribute a greater portion of global warming potential than the writing of a book could. Some other processes, such as the global warming impact of buying a movie from a retail store, are expected to be essentially the same.

Overall, this study has found that books and movies are both likely to be highly valued gifts to recipients. The life cycle assessment of movie discs will need to be completed to compare the global warming potential of these two gift options, but I predict that the impact of this item may be higher due to the higher greenhouse gas emissions associated with film production compared to the low impact of book writing and editing.

## REFERENCES

- Bare, J. (2011) TRACI 2.0: The tool for the reduction and assessment of chemical and other environmental impacts 2.0. *Clean Technologies and Environmental Policy*, 13(5), 687-696.
- Borggren, C., Moberg, A., & Finnveden, G. (2011) Books from an environmental perspective-part 1: environmental impacts of paper books sold in traditional and internet bookshops. *International Journal of Life Cycle Assessment*, 16, 138-147.
- Brynjolfsson, E., & Smith, M. D. (2000) Frictionless commerce? A comparison of internet and conventional retailers. *Management Science*, 46, 563-585.
- Ciroth, A. (2007) ICT for environment in life cycle applications openLCA A new open source software for life cycle assessment. *Int J Life Cycle Assess The International Journal of Life Cycle Assessment* 12(4), 209-210
- Kaplan, T. R., & Ruffle, B. J. (2009) In search of welfare-improving gifts. *European Economic Review*, 53, 445.
- Matthews, H. S., Hendrickson, C. T., & Soh, D. L. (2001) Environmental and economic effects of e-commerce : A case study of book publishing and retail logistics. *Transportation research record.*, 6-12.
- Matthews, H. S., Williams, E., Tagami, T., & Hendrickson, C. T. (2002) Energy implications of online book retailing in the United States and Japan. *Environmental Impact Assessment Review*, 22, 493-507.
- National Renewable Energy Laboratory (2012) U.S. Life Cycle Inventory Database.
- R Development Core Team. (2016). R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Austria
- Shehabi, A., Walker, B., & Masanet, E. (2014). The energy and greenhouse-gas implications of internet video streaming in the United States. *Environmental Research Letters*,9(5), 054007.
- Tedrick, Jim. (2016, May 6). [Personal Communication].
- U.S. Census Bureau. (2002). *Retail trade: Subject series – Estab and firm size: Sales size of establishments for the United States: 2002. 2002 Economic Census of the United States* [Data file]. Retrieved from <https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk>
- U.S. Census Bureau. (2012). *Retail Trade: Subject Series – Estab and Firm Size: Sales Size of Establishments for the United States: 2012. 2012 Economic Census of the United States* [Data file]. Retrieved from <https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk>
- Waldfoegel, J. (1993). The deadweight loss of Christmas. *An American Economic Review*,83(5), 1328-1336. Retrieved February 21, 2015.

Waldfogel, J. (2009). *Scroogenomics: Why you shouldn't buy presents for the holidays*. Princeton: Princeton University Press.

Wernet, G., Bauer, C., Steubing, B., Reinhard, J., Moreno-Ruiz, E., & Weidema, B. (2016). The ecoinvent database version 3 (part I): Overview and methodology. *The International Journal of Life Cycle Assessment*, [online] 21(9), 1218–1230.

Yang, Y., & Galak, J. (2015) Sentimental value and its influence on hedonic adaptation. *Journal of personality and social psychology*, 109, 767-90.

### **ACKNOWLEDGEMENTS**

Thanks to the Undergraduate Student Research Program and the DePaul University Environmental Science and Studies Department for funding this project.