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Effect of Picture Size on Natural Category Learning and Metacognition

Carlee M. DeYoung[10]

Metacognitive judgments are crucial sources of information for students during self regulated learning. This is because these judgments are used by students to make decisions about what strategies to use during study, how long to study, and what to study. Previous research (Kornell & Bjork, 2008) has found that, compared to massing, interleaving exemplars from multiple categories leads to superior category learning. However, a majority of participants believed massing to be more beneficial for learning than interleaving. An increased sense of perceptual fluency created by massing of same category exemplars was speculated to be the cause of this metacognitive illusion. Recent research on fluency found that learners think words in a large font are easier to remember because of an increased fluency (Rhodes & Castel, 2008). The proposed study would investigate how manipulating fluency by varying picture size would affect natural category learning and participants' metacognitive assessments of their own learning using pictures of tropical fish.

Keywords: category learning, fluency, judgments of learning (JOLs), metacognition, metacognitive illusions

Recent research has shown that perceived fluency influences the judgments people make about their memory for recently learned information. These finding are relevant and have important implications for education, specifically self-regulated learning. These implications are due to the influence metacognitive judgments have over important decisions students make about study strategy use and study time allocation for multiple subjects. These factors serve crucial roles in the overall success of students during self-regulated learning inside and outside

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classroom settings. Therefore, any research that attempts to further the current understanding of the effects of fluency on metacognition and memory would be valued.

Due to the importance of fluency as a cue for metacognitive judgments, perceptual fluency has been studied under a wide array of manipulations. Rhodes and Castel (2008) manipulated fluency, via font size, for to-be-remembered words during study. Rhodes and Castel (2008) were interested to see if judgments of learning (i.e., JOLs) would be sensitive to the manipulation of font size, even though they cited in their work that previous research by Begg et al. (1989) and Mazzoni and Nelson (1995) indicated that word size was not a salient predictor for memory performance. In their experiment, participants were presented with words for study in two different font sizes, a large, more perceptually fluent 48-point font size or a smaller, less perceptually fluent 18-point font size. After the presentation of each word, participants made a metacognitive judgment rating their confidence for later recall of the word. Rhodes and Castel (2008) found that while font size did not have any significant effect on memory performance, it did affect the confidence judgments such that, words presented in 18-point font received confidence ratings significantly lower than those presented in 48-point font.

Rhodes and Castel (2008) conducted another experiment in which they decided to include item relatedness as an additional source of variance among items. This was done to see if doing so would eliminate the effect of fluency on JOLs. Therefore showing that the effect of fluency on

JOLs is only present in situations where variance in fluency is the only available cue. In this experiment they were interested to see if fluency was a more important cue for JOLs or if item relatedness would trump fluency, thus leading to more accurate JOLs even when fluency during study is low. Rhodes and Castel (2008) participants still gave significantly lower confidence judgments for items with low fluency even when item relatedness was available as a cue. This suggested that fluency might affect metacognitive judgments in more complex real world situations where fluency is not the only available cue.

More recently, Yue, Castel, and Bjork (2013) investigated the effects of presenting words in a disfluent (e.g., not fluent), blurred font. Using a procedure similar to that used by Rhodes and Castel (2008), participants were presented with words for study in a disfluent, blurred font or normal font. After each word was presented, participants rated their confidence for later recall of the word. This process was completed for 4 wordlists each containing 26 words. Yue et al. (2013) found that words with non-blurred font were remembered only marginally more than words presented in the more disfluent, blurred format. These results contrast the results found by Rhodes and Castel (2008) who found no significant effect on memory performance when words were presented in a smaller, less fluent font. Additionally, Yue et al. (2013) found that participant JOLs for disfluent words became more accurate with each additional wordlist. This suggested that participants were appropriately adjusting their JOLs for disfluent words as they progressed through the four wordlists.

Similarly, research by Magreehan, Serra, Schwartz, and Narciss (2015) also investigated how perceptual fluency affects people's JOLs. In one of their experiments, they manipulated perceptual fluency in un-related and related word pairs. In each pair one of the presented words was disfluent (32-point, italicized font) and the other fluent (56-point, boldfaced font). JOLs for disfluent and fluent items did not differ significantly (Magreehan et al., 2015). However, when JOLs for related and unrelated word pairs were compared the difference was significant, such that, JOLs for related word pairs were higher than those for unrelated pairs. These results suggested that during this experiment participants did not use perceptual fluency as a cue for their JOLs, but instead used item relatedness (Magreehan et al., 2015). It is important to note that these results contrast those found by Rhodes and Castel (2008) in their investigation of fluency. This inconsistency among similar manipulations indicates that more research needs to be conducted investigating cue utilization during the formation of JOLs.

Ariel, Dunlosky and Toppino (2014) recently conducted a study investigating the educational implications of low perceived fluency during learning. In this study, participants studied synonym word pairs from the Graduate Record Examination (GRE). Eye tracking software and apparatus were used to track the amount of time participants fixated on individual words in each pair. Each word pair was shown for 1 s. After each word pair participants made the decision to either mass, space, or end their study of that word pair by selecting one of three options: study now, study later, or done (Ariel et al., 2014). Results showed that when participants did not fixate on the entire pair during initial study they chose massing (e.g., study now) most often. Thus, when participants' perception of the entire pair was degraded or the pair was only partially encoded they chose to mass study more frequently (Ariel et al., 2014).

The effect of participants' knowledge about massed and spaced study on their JOLs was investigated by Logan, Castel, Haber, and Viehman (2012). These researchers thought that providing participants with knowledge about the effectiveness of spacing and massing would increase the accuracy of their JOLs. In one of their experiments participants studied three wordlists, in which words were either massed or spaced. In massed presentation words appeared for study, and then immediately reappeared for an additional study period (Logan et al., 2012). Words that were spaced were presented after a lag of three word presentations (Logan et al., 2012). JOLs were provided after each item during study. After the learning phase for each list, participants then tried to recall as many words as possible. Participants graded their own recall sheets, which provided them with feedback. Participants then received a sheet with all of the words from the list divided up according to which condition they were presented in (e.g., massed or spaced) (Logan et al., 2012). Participants then tallied up the number of words they correctly recalled for each condition. This procedure was repeated for two more lists to see if participants would update their JOLs after receiving feedback. Logan et al. (2012) found that providing participants with feedback led to small, significant increases in the accuracy of JOLs for spaced items across the three lists.

While many experiments have investigated the effects of fluency on JOLs and memory performance, very few have investigated the effects of fluency during category or concept learning. Most of the category learning literature thus far has focused on effects of different study schedules. Most notably, Kornell and Bjork (2008) studied the effects of different study conditions on participants' learning of various artists' painting styles. Paintings from 12 artists were presented under either massed or spaced conditions. During massed study, paintings by one artist were presented consecutively, and in spaced study paintings by various artists were interleaved, such that, no two paintings by the same artist were ever presented successively. To test participants' learning, new, unstudied paintings from each of the 12 artists were presented for categorization during the test phase of the study. Participants also completed a posttest survey indicating whether they believed massing or spacing to be more beneficial for their learning. Kornell and Bjork's (2008) results showed that spacing paintings during study led to better test performance than massing. However, posttest survey results indicated that a majority of participants believed massing to be more beneficial then spacing. Kornell and Bjork (2008) speculated that an increased sense of fluency during massed study might be cause of their posttest survey results.

In a similar investigation, Wahlheim, Dunlosky, and Jacoby (2011) replicated the work of Kornell and Bjork (2008) by having participants learn different categories of bird species. The procedure was identical with the addition of JOLs collected at item- and category-levels during study. Wahlheim et al. (2011) found JOLs made at the item- and category-level were sensitive to the benefit of spacing. However, retrospective evaluations collected in the posttest survey did not indicate any sensitivity to the benefits of spacing, similar to previous research (Kornell & Bjork, 2008).

Recent category learning literature has questioned the use of the term “spacing” in previous studies (cf. Kornell & Bjork, 2008; Wahlheim et al., 2011). Studies by Kang and Pashler (2012) and Zulkiply and Burt (2013) investigated the cause of spacing benefits during learning. Both studies were conducted to test whether the temporal aspect of spacing benefitted memory, or if it was the interleaving of exemplars that was causing the effect (Kang & Pashler, 2012; Zulkiply & Burt, 2013). Both studies replicated the procedure from Kornell and Bjork (2008) with the addition of a between participant manipulation of temporal spacing. Both Kang and Pashler (2012) and Zulkiply and Burt (2013) found that the “interleaving” of exemplars from different categories caused the benefit of “spacing.” Therefore Kang and Pashler (2012) and

Zulkiply and Burt (2013) advised that future mentions of studies, such as, Kornell and Bjork (2008) and Wahlheim et al. (2011) should use the term “interleaving” in place of “spacing” because it is more representative of the actual cause of the reported effect.

As previously mentioned, very little literature can be found in which the effects of fluency during category learning have been assessed. Only one known study has researched this topic. This study, conducted by Oppenheimer and Frank (2008), tested whether the perceived fluency of words would affect category judgments. In this experiment participants were presented with a target category (e.g., mammal) and a set of exemplars. Participants then ranked how well each exemplar “fit” the target category using a 1 - 9 scale (Oppenheimer & Frank, 2008). In the low-fluency condition, the target category as well as exemplars were listed in small, hard to read font. In the control condition these items were presented in standard 12-point Times New Roman font. Oppenheimer and Frank (2008) found that when exemplars were presented in the low-fluency format participants ranked exemplars as worse category members than when they were presented in the more fluent control format. This suggested that fluency is used as a cue when participants are ranking the relatedness of items (Oppenheimer & Frank, 2008).

The present proposal aims to investigate the effects of perceived fluency on performance and metacognitive judgments during category learning for non-word material. The proposed research aims to answer the following: Does picture size have any effect on performance or judgments during a category-learning task using tropical fish species?

Proposed Method

Participants

The participants for the proposed study will be recruited from a Midwestern University using an online recruiting and scheduling program. A sample of at least 60 undergraduate participants will be achieved. Participants will receive adequate compensation upon completion of the study.

Materials

The materials for the proposed study are comprised of pictures of 120 different tropical fish species. All pictured fish belong to 1 of 12 fish families (see Appendix A for sample pictures and family names) with 10 different fish species pictured from each. Diverse and uncommon species from each family were selected to create samples of fish that would be challenging, yet still possible to categorize. Pictures were collected from online sources (e.g., Wikipedia's list of marine aquarium fish species), and most appear to have been taken by professional or amateur wildlife photographers. Inclusion criteria for each picture included, high-resolution image quality, no watermark, full side view of fish, and only one fish per picture. Additionally, all picture backgrounds will be removed using professional photo editing software and pictures will be cropped as closely as possible to fish to ensure uniformity among pictures.

One of the variables manipulated in this proposed experiment is picture size. Of the 10 pictures from each fish family, 6 pictures will be used for study (72 total), and 4 will be reserved for testing (48 total). During the study portion of the experiment, pictures from half of the 12 fish families (36 total) will be presented in a large picture format (5 *in* height) and the other half (36 total) will be presented in a small picture format (1.25 *in* height). During the test all pictures will be presented in a midsize format (2.75 *in* height). A visual explanation of the picture resizing procedures used can be found in Appendix B.

Experimental Design

The procedure of the proposed study was adopted from Kornell and Bjork (2008). However, this procedure has been modified so that fluency (small and large picture size) will be manipulated in addition to study condition (massed and interleaved). Therefore the proposed experiment will use a 2 (study condition: interleaved and massed) × 2 (picture size: small and large) factorial design. For a table breakdown of the proposed procedure see Appendix C.

Procedure

Prior to beginning the experiment participants will read and sign an informed consent document (see Appendix D for informed consent). Additionally, any questions participants may have will be answered by the experimenter during this time. Next, participants will begin the experiment by reading a page of general experiment instructions presented by the experimenter. These instructions will explain the general nature of both the study and test portions of the experiment (see Appendix E for instructions). The experimenter will then request that the participant verbally reiterate what the experiment entails to ensure that participants have a clear understanding of procedural expectations.

Next, participants will view and study a total of 72 pictures of fish over the course of 12 study blocks, each containing 6 pictures. Six study blocks will be massed (M) and 6 will be interleaved (I). In massed blocks participants will view all 6 species from a given family consecutively. In interleaved blocks 1 picture from each of the 6 fish families designated for interleaved presentation will be shown (see Appendix C for table breakdown of each block). The study blocks will be presented in the following order M,I,I,M,M,I,I,M,M,I,I,M. The specific order in which the massed blocks and interleaved blocks are presented will be counterbalanced.

After the study phase of the experiment the participant will be prompted to make a metacognitive judgment for each studied fish family (see Appendix F judgment prompts). Participants will then complete a test in which they will be asked to categorize the remaining 32 fish pictures by selecting the correct family name from the full list of families for each picture (see Appendix G for sample test item). Then participants will be informed of the differences between massing and interleaving and asked to make a retrospective judgment indicating if they found massing or interleaving to be more beneficial during the study (see Appendix H for retrospective judgment survey). Finally, participants will be debriefed and given an information sheet (see Appendix I for information sheet).

Projected Results and Discussion

The purpose of this study is to replicate previous work by Kornell and Bjork (2008), but also to see how fluency will affect participants later test performance, and their metacognitive judgments. Since no results have been collected I can only speculate what I may find. I believe that I will find a trend in the metacognitive judgments similar to those found in previous research. Fish families presented during massed study in the large format would have the highest fluency and therefore best judgments of confidence, and small-interleaved fish families would receive the lowest judgments of confidence.

Additionally, I predict that when performance on the categorization test for small and large fish families are compared, I will find results different from previous research. I predict that I will find that participants perform better when pictures are small. This is because the diagnostic feature for each fish family is not the finer details, but instead more broad features like body shape. By making the pictures smaller it makes less important details such as color pattern less accessible increasing the possibility that participants will focus on the more diagnostic feature of body shape. If this is found it will be a novel contribution to the category learning literature.

However, since these results would be dependent on the material, all have broader defining features future research should conduct the same experiment with categories where finer details are more diagnostic of category membership than more broad ones.

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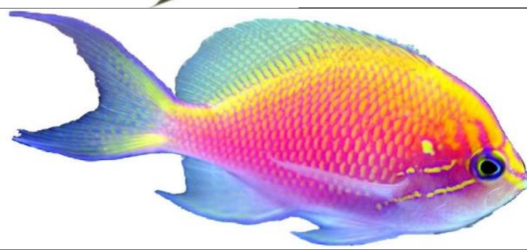
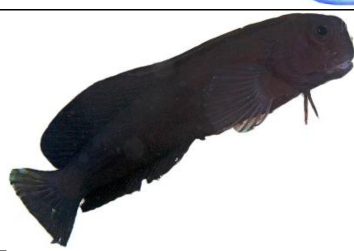
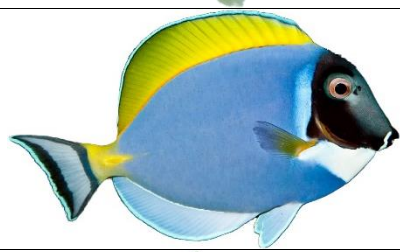
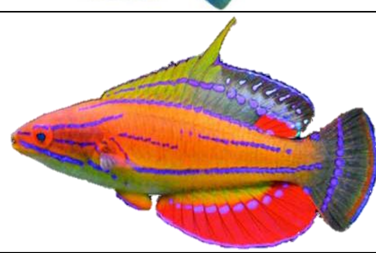
Appendix A

This table contains a sample item for each fish family.

Family Name	Sample Exemplar
Angelfish	
Anthias	
Blenny	
Butterfly	
Cardinal	
Chromis	

Appendix A continued

Family Name	Sample Exemplar
Damsel	
Groupers	
Goby	
Tang	
Trigger	
Wrasse	

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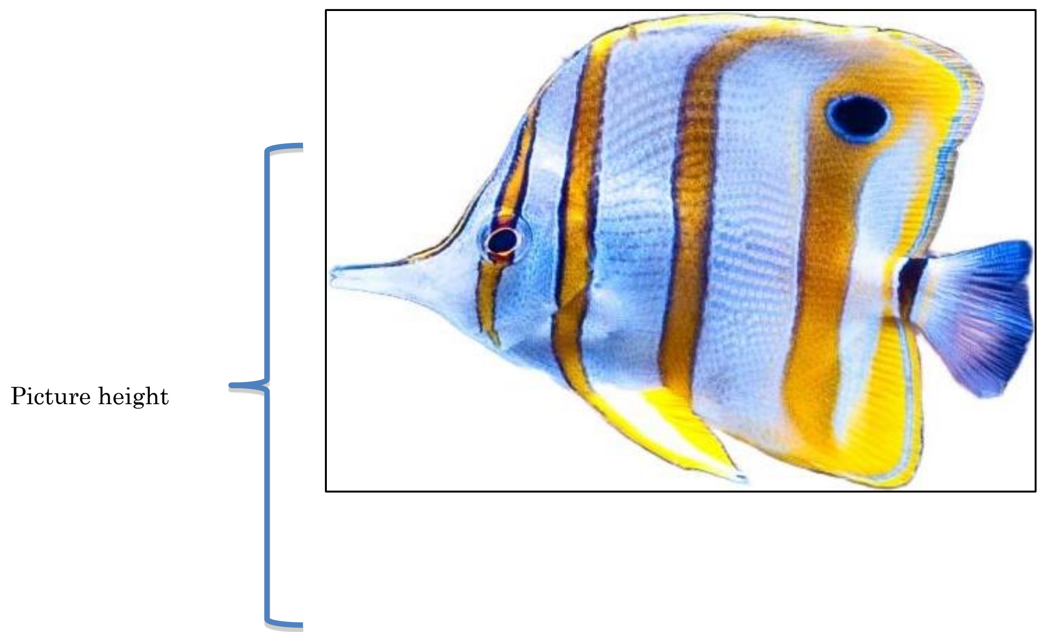
Appendix B

The width of pictures varied due to differences in fish length, so only the height of each picture was manipulated. However, to ensure that pictures were not distorted, the width of each picture was also changed, so that it remained proportionate to the height. Therefore the width of pictures for a given size classification (small, large, and midsize) may vary, but the height will not.



Appendix C

Massed													
	Large (5 *in* height)						**Small (1.25 *in* height)**						
Block 1	A_1	A_2	A_3	A_4	A_5	A_6	B_1	B_2	B_3	B_4	B_5	B_6	Block 7
Block 2	C_1	C_2	C_3	C_4	C_5	C_6	D_1	D_2	D_3	D_4	D_5	D_6	Block 8
Block 3	E_1	E_2	E_3	E_4	E_5	E_6	F_1	F_2	F_3	F_4	F_5	F_6	Block 9
Interleaved													
	Large 5 *in*	**Small 1.25*in***	**Large 5 *in***	**Small 1.25*in***	**Large 5 *in***	**Small 1.25*in***	**Large 5 *in***	**Small 1.25*in***	**Large 5 *in***	**Small 1.25*in***	**Large 5 *in***	**Small 1.25*in***	
Block 4	G_1	H_1	I_1	J_1	K_1	L_1	G_4	H_4	I_4	J_4	K_4	L_4	Block 10
Block 5	G_2	H_2	I_2	J_2	K_2	L_2	G_5	H_5	I_5	J_5	K_5	L_5	Block 11
Block 6	G_3	H_3	I_3	J_3	K_3	L_3	G_6	H_6	I_6	J_6	K_6	L_6	Block 12

Each letter (A – L) represents a fish family. Each subscript indicates a specific fish species. Each horizontal row represents a study block, which is a period of continuous viewing of fish pictures designated for that block.

Appendix D

Informed Consent Form

I, ____________________________ (print name), understand that I will be taking part in a research experiment where I will be asked to study pictures of fish, take a test, and make judgments about my experience. I understand that I should be able to complete this project within 60 minutes. I am aware that I am free to skip any questions in the unlikely event that I feel uncomfortable answering any of the items on the test or survey. I am also aware that my participation in this study is strictly voluntary and that I may choose to withdraw from the study at any time without any penalty. Additionally, I should not incur any penalty or prejudice because I am not physically able to complete the study. I understand that the information obtained from my responses will be analyzed only as part of aggregate data and that all identifying information will be absent from the data in order to ensure anonymity. I am also aware that my responses will be kept confidential and that data obtained from this study will only be available for research and educational purposes. I understand that any questions I may have regarding this study shall be answered by the researcher(s) involved to my satisfaction

____ Date: ______________

(Signature of participant)

____ Date: ______________

(Signature of researcher obtaining consent)

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Appendix E

General Experiment Instructions

In this experiment you will be asked to study pictures of fish and their corresponding family names. This experiment has two phases, the study phase and test phase. During the study you will view pictures of 72 different fish with their corresponding family names appearing directly below each picture. Each picture and family name will appear on the screen for 3 seconds. At the end of the study phase, before beginning the test phase you will complete a survey in which you will make judgments about your memory for each studied fish family. You will then take a test where you will be asked to categorize pictures of new, unstudied fish from the same fish families studied earlier. Lastly, you will make judgments about your overall learning.

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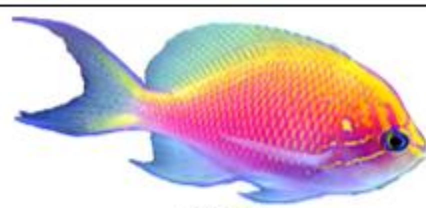
Appendix F

Please indicate on a scale from 8% (guessing) to 100% (absolutely certain) how likely it is that you will be able to correctly identify a new fish from each of the following families during the test phase? Write the actual percentage where it should fall on the scale. Also please be sure to use the full scale.

Angelfish

8%	54%	100%
Guess		Certain



Anthias

8%	54%	100%
Guess		Certain

Blenny

8%	54%	100%
Guess		Certain

Appendix F continued

Please indicate on a scale from 8% (guessing) to 100% (absolutely certain) how likely it is that you will be able to correctly identify a new fish from each of the following families during the test phase? Write the actual percentage where it should fall on the scale. Also please be sure to use the full scale.

Butterfly

8%	54%	100%
Guess		Certain

Cardinal

8%	54%	100%
Guess		Certain

Chromis

8%	54%	100%
Guess		Certain

Appendix F continued

Please indicate on a scale from 8% (guessing) to 100% (absolutely certain) how likely it is that you will be able to correctly identify a new fish from each of the following families during the test phase? Write the actual percentage where it should fall on the scale. Also please be sure to use the full scale.

Damsel

8%	54%	100%
Guess		Certain

Grouper

8%	54%	100%
Guess		Certain

Goby

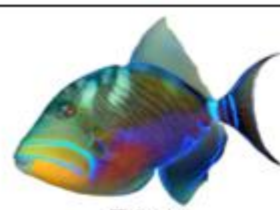
8%	54%	100%
Guess		Certain

Appendix F continued

Please indicate on a scale from 8% (guessing) to 100% (absolutely certain) how likely it is that you will be able to correctly identify a new fish from each of the following families during the test phase? Write the actual percentage where it should fall on the scale. Also please be sure to use the full scale.

Tang

8%	54%	100%
Guess		Certain



Trigger

8%	54%	100%
Guess		Certain

Wrasse

8%	54%	100%
Guess		Certain

Appendix G

Sample test item

What family is this fish a member of?

Angelfish	**Anthias**	**Blenny**	**Butterfly**	**Cardinal**	**Chromis**
Damsel	**Grouper**	**Goby**	**Tang**	**Trigger**	**Wrasse**

Appendix H

Retrospective Judgment

Adopted from Kornell and Bjork (2008)

During **massing** items from the same category are presented consecutively.

During **interleaving** items from various categories are presented in a mixed order, and items from the same category are never presented consecutively.

Which do you think helped you learn more, massed or interleaved study?

Massed	Interleaved

Appendix I

Information Letter

Thank you for participating this study. The present study was conducted in order to investigate how picture size affects the judgments students make about their learning as well as their performance on a category learning task.

Previous research has suggested that text shown in smaller font size decreases the ease at which individuals process material. This experiment hoped to find the same effect for pictures. Additionally, it was predicted that by decreasing picture size performance on the category-learning task would actually increase because the smaller, less important features would be less apparent and the larger features, which are more defining for each category, would be easier to focus on. This study is applicable to everyday life because understanding how and what influence the judgments is critical for creating material that promotes more accurate judgments.

Please note that we are not interested in your individual results; rather, we are only interested in the overall findings based on aggregate data. No identifying information about you will be associated with any of the findings, nor will it be possible for us to trace your responses on an individual basis.

If you are interested in obtaining the final results of this study based on aggregate data, or if you have any questions or concerns regarding any portion of this study, please do not hesitate to let us know now or in the future. Our contact information is found at the bottom of this letter. Additionally information for the Student Counseling Resource Center has been provided for the occasion that this experiment caused you distress of any kind.

Thank you again for your valuable contribution to this study. Sincerely,

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