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# Silent letters and the interaction of lexical and sublexical processes in spelling

## A case study in an English-speaking dysgraphic patient

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**ABSTRACT.** Various studies have suggested that lexical and sublexical processes may interact (Folk et al. 2002, Folk & Jones 2004, Laiacona et. al 2009). The present study examines whether the summated semantic and sublexical activation from semantic information and orthography-to-phonology conversion mechanisms help activate corresponding entries in the Phonological Output Lexicon. It was hypothesized that in words with silent letters, pronounced letters would receive activation from both the lexical and sublexical routes whereas silent letters would only be supported by the lexical route as a result of prior lexical-semantic knowledge. A patient, SoDa, was selected according to performance on Johns Hopkins Dysgraphia Battery. Six word lists were created totaling 167 words; there were two conditions, "opaque" and "transparent," that were varied according to position of the silent letter, whether initial, middle, or final. The words were verbally administered to SoDa, who was instructed to provide written spellings. Only the responses in which the error affected one of the letters in the silent consonant cluster in the opaque words or their transparent correlates were considered. In the middle condition, the consonant cluster containing the silent letter was more likely to contain an error both compared to the other letters in the word and compared to the fully pronounced correlate in the transparent word-match. The results are consistent with a graphemic buffer deficit, which disproportionately affects spelling in the middle position of words. The results lend support to the notion that lexical and sublexical processes interact and, together, activate letters in a word to varying degrees.

### 1. Introduction

The dual-route model posits the existence of two cognitive mechanisms – the lexical route and the sublexical route. The lexical route accesses and employs previously stored lexical-semantic information to solve reading or spelling tasks. Therefore, lexical mechanisms are specialized for the reading and spelling of familiar and irregular words. On the other hand, the sublexical route accesses and employs phonological principles and the phoneme-to-grapheme conversion route. Therefore, sublexical mechanisms are specialized for the reading and spelling of unfamiliar, nonwords, and regular words. How does the brain approach a given spelling or reading task? One way to understand the relationship between the lexical and sublexical routes is what Laiacona et. al (2009) called "independent cooperation". In this conception of the dual-route model, a word is processed in parallel by lexical and sublexical mechanisms. Simultaneous and independent function ensures that the brain can efficiently arrive at a pronunciation or spelling, which is important for language fluency. Ultimately, the demands of a given task will dictate whether the response produced is the result of lexical or sublexical processes. The lexical and sublexical routes can operate and be lesioned independently (Folk &

Jones, 2010). Joubert et. al (2004) showed that lexical and sublexical processes in reading activate different regions within a network of brain structures. Greater activation in the left inferior prefrontal gyrus was observed in sublexical tasks, whereas an area at the border of the left angular and supramarginal gyri was more engaged in lexical tasks. The fact that they can operate independently necessitates the conclusion that they exhibit "independent cooperation" in all cases. Other researchers have posited that the lexical and sublexical routes interact. An increasing body of work has investigated the possibility of interactivity between the lexical and sublexical routes. Studies have repeatedly shown that the sublexical process assists the selection of a target word over competing form neighbors by strengthening its graphemes (Folk et al. 2002, Folk & Jones 2004). Laiacona et. al (2009) also reported lexical and sublexical interaction supported regular word spelling in three of twelve Italian cases of mixed dysgraphia.

If the lexical and sublexical routes interact, one would expect that a given spelling is the product of contributions from the lexical and sublexical routes. Lexical priming experiments carried out by Folk, Rapp, and Goldrick (2002) and Folk and Rapp (2004) have obtained results that indicate contributions

from both the lexical and sublexical routes. For example, Folk, Rapp, and Goldrick reported errors made by a dysgraphic patient, LAT, that contained a combination of very low probability phoneme-grapheme correspondences, indicating contributions from both lexical and sublexical routes.

An interactive model of summative activation from both lexical and sublexical routes on the graphemic level is hypothesized. Hillis and Caramazza (1991) have previously proposed a summative model, but their model deals with semantics and whole word selection. They suggest that the summated semantic and sublexical activation from semantic information and orthography-to-phonology conversion mechanisms, together, help activate corresponding entries in the Phonological Output Lexicon to threshold levels, and thereby activate the correct response.

The experiment aims to gather support for an interactive model of summative graphemic activation using a task that involves spelling words with silent letters. In an interactive model, silent letters should receive the least amount of activation. Pronounced letters will receive activation from both the lexical and sublexical routes whereas as silent letters will only be supported by the lexical route as a result of prior lexical-semantic knowledge. Therefore, errors are most likely to occur at the positional location of the letter cluster containing the silent letter.

Figure 1. An illustration of the contributions of the lexical and sublexical routes in spelling “ledge”.

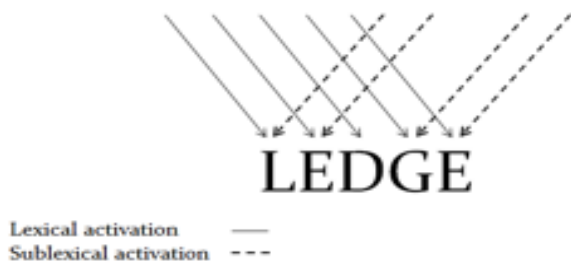
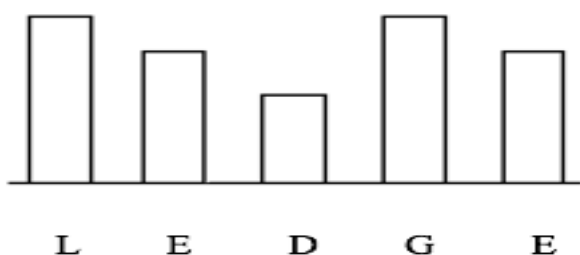
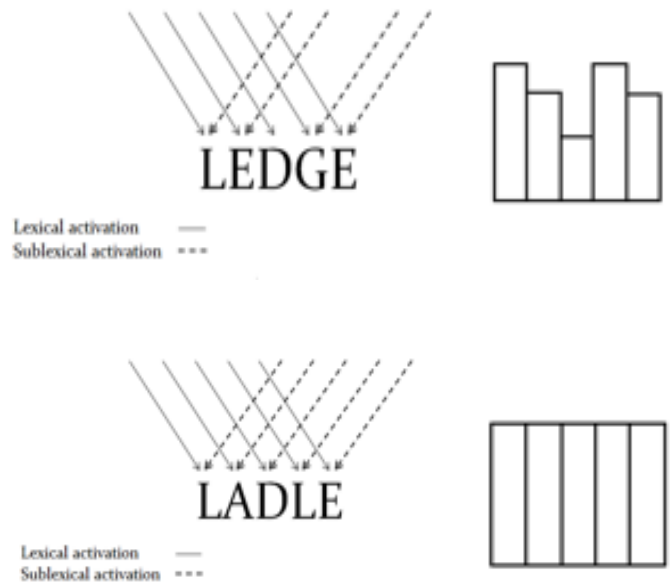


Figure 2. A graphic representation of the expected summative activation levels from lexical and sublexical routes for the word “ledge”.



Words with silent letters will be matched with words in which every letter is pronounced. In the latter condition, the formerly silent letter will be in the same position as a point of comparison. The performance of an English-speaking dysgraphic subject, SoDa, on this spelling-to-dictation task was recorded and analyzed.

Figure 3.



## 2. Case Report

SoDa suffered from a cerebrovascular accident (CVA) that involved the frontal and temporal areas of the left hemisphere, including Broca’s area. She is a university graduate. She obtained a Master’s degree in education and worked as a teacher. Immediately following her CVA, a severe impairment of speaking abilities was observed. In time, she showed a partial recovery of speaking abilities. However, articulatory and spelling difficulties remain. SoDa was administered parts of the Johns Hopkins Dysgraphia Battery to investigate her spelling deficit. The data were collected between October 2013 and December 2013. Several word lists were presented to SoDa. The tasks evaluated phoneme-grapheme conversion, word length, concreteness, part of speech, nonwords, and picture naming. Spelling accuracy was significantly influenced by word length, word frequency, word status, and response modality. The words presented were between 4 and 8 letters long, and spelling accuracy was generally lower for longer words, indicating a graphemic buffer deficit. Low frequency words

were spelled correctly at a significantly lower rate than high-frequency words, indicating an impaired lexical route (86% for high-frequency words and 55% for low-frequency words). Nonwords were spelled with significantly less accuracy than either regular or irregular words (3% for nonwords, 93% for regular words, and 87% for irregular words). In addition, dissociation was observed between written and spoken response modalities, with accuracy improving in the spoken condition. Overall, SoDa’s speaking is moderately fluent and her sentence processing and semantic capabilities are mostly intact.

### 3. Methods

#### Stimuli

A list of two-consonant clusters containing a single, silent, consonant letter was created. In total, 22 different consonant clusters were tested.

Table 1. Table of consonant clusters that contain silent letters that were used.

Consonant Clusters Tested			
Initial Position	Middle Position	Final Position	
ho (eg. honor)	dg (eg. ledge)	pt (eg. receipt)	ow (eg. arrow)
kn (eg. knife)	lf (eg. half)	gn (eg. foreign)	mn (eg. column)
gn (eg. gnat)	sw (eg. answer)	tg (eg. mortgage)	mb (eg. climb)
wr (eg. wrist)	ld (eg. could)	sc (eg. descend)	ch (eg. monarch)
wh (eg. whose)	st (eg. listen)	lm (eg. salmon)	
ps (eg. psycho)	ct (eg. indict)	ch (eg. orchid)	

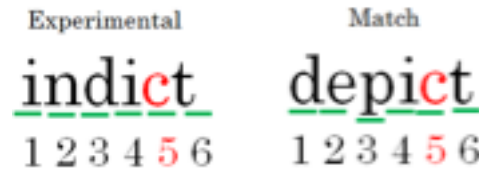
Six word lists were created totaling 167 words; there were two conditions, “opaque” and “transparent,” that were varied according to position of the silent letter, whether initial, middle, or final. Words for which the phonological form is inconsistent with the graphemic form, for example, “indict,” were considered “opaque”. Each word in the “opaque” condition was matched with a “transparent” word – one for which the phonological form is consistent with the graphemic form – for example, “depict”. All word lists were compiled using the Dictionary Utility Interface of the MRC Linguistic Database provided online by The University of Western Australia and selected so that they share the following characteristics:

1. All words are morphologically simple.
2. All words are heteronyms.
3. All words are between 4 letters and 11 letters long.

Words in the opaque condition were selected from the output generated by the MRC Linguistic Database for the following additional characteristics:

1. The word must contain a silent letter.
2. There may only be one silent letter in the word.
3. The silent letter must be a consonant.
4. The silent letter must be the first letter to occur (in first position) in a word in the initial condition. Likewise, the silent letter must occur between the first and last position in the middle condition and in the last position in the final condition.

Figure 4. “C” is the single, silent consonant letter in indict. The “c” in “depict” occurs in the same position and consonant cluster, but it is pronounced.



Words in the transparent condition were selected from the output generated by the MRC Linguistic Database for the following additional characteristics:

1. The word contains the sounded version of the consonant that is silent (unsounded) in the match word.
2. The consonant in question is in the same position in both the opaque word and transparent match.
3. The transparent match is approximately the same length as its opaque word.
4. The transparent match has approximately the same mean logarithmic HAL (Hyperspace Analogue to Language) frequency as its opaque counterpart.

The mean logarithmic HAL frequency, or Log\_Freq\_HAL, was the chosen measure of frequency used to



compare words in the lists. The mean Log\_Freq\_HAL was obtained from the English Lexicon Project provided online by Washington University in St. Louis.

In summary, the criteria for word selection ensured that the “opaque” word would contain a single silent (unsounded) letter that was matched with a “transparent” word that contained the same letter in the same position, but sounded rather than unsounded. Words with multiple silent letters or silent vowels were excluded to allow for the most specific and accurate analysis.

Testing was completed within a three week span which encompassed two testing sessions. A fully randomized list including the entirety of the stimuli was produced prior to testing. Due to a significant number of “Don’t Know” responses in the first testing session, the list was revised. A second fully-randomized list was created prior to the second testing date to test newly added words. This list also included both opaque and transparent words from initial, middle, and final conditions. The lists were presented in a writing-to-dictation task. Lab members read the stimuli aloud to SoDa. SoDa was instructed to repeat the word aloud to ensure comprehension. If necessary, the lab member would repeat the stimulus again and/or use it in a sentence. Then SoDa handwrote the spelling. SoDa’s handwritten responses were manually input into a spreadsheet for analysis.

#### 4. Results

All responses were first analyzed in terms of accuracy. The incorrect responses were isolated for further analysis. Only the responses in which the error affects one of the letters in the silent consonant cluster (wh-, -st-, -ow, etc.) in the opaque words or their fully-voiced correlates in the transparent words were considered. The frequency of this specific type of error was found in each condition. A percentage was calculated by dividing the number of this type of error over the number of words in that condition. The initial and final conditions showed similar error percentages and were combined for comparison with the middle condition. There was no significant difference between the error percentage in the initial+final condition for opaque words, the initial+final condition for transparent words, or the middle condition for transparent words. The error percentage was significantly great-

er in the middle condition for opaque words. It was more than double the error percentage in the combined initial and final conditions for opaque words.

Table 2.

Opaque Condition		Transparent Condition	
Given	Response	Given	Response
knit	net	kelp	heln
gnaw	nob	straw	su
gnat	nat	curfew	curvise
wrangle	ringale	withdraw	withdrawel
shadow	shawon	common	commer
damn	dam	victim	vimur
autumn	autem, auturm	bulb	buld
comb	comp	crib	crip
womb	wown	suburb	suburna

Table 3.

Opaque Condition		Transparent Condition	
Given	Response	Given	Response
pledge	plegish, prieve	hurdle	heaful
hedge	head	ladle	laido
fridge	rigid	paddle	pallow
bridge	bring, brig	fester	fenner
hustle	huckily	startle	strangh
bristle	brisson		
receipt	receiver		
mortgage	morgo		
ascent	accee		
orchid	orciade		

Table 4.

	Opaque	Transparent
Initial + Final	17.1% (9/53)	16.7% (9/54)
Middle	35% (12/34)	19.1% (5/26)

#### 5. Discussion

The results lend support to the notion that lexical and sublexical processes interact and, together, activate letters in a word to varying degrees, but not in every condition. Only the middle condition exhibits the expected result – the consonant cluster containing the silent letter is more prone to error compared to the other letters in the word and compared to the fully-pronounced correlate in the transparent word-match. The fact that the greatest percentage of error occurs in the middle condition lends further evidence a graphemic buffer deficit in SoDa. The middle of a word is often to the most prone to error for a patient

with a graphemic buffer deficit. The result of an elevated error percentage for the middle condition is only observed in the opaque condition. The transparent condition is not significantly higher than the error percentages observed in the initial and final conditions for opaque or transparent words. Why does this result occur selectively for words with median-position silent letters? Looking at the chart of consonant clusters tested, one notices that the middle position has the greatest number of consonant clusters and variety of silent letter identities within those clusters. Ehri and Wilce (1982) suggested that readers store spelling by studying how letters represent sounds. Therefore, silent letters – unsounded letters – should be more difficult to remember. Ehri and Wilce also suggested that due to their unique status, silent letters may become more salient in memory representation. Ehri (1987) confirmed the latter hypothesis by testing the reaction times of children to decide whether a known word with a silent letter, such as “listen,” contained its silent letter, in this case a “t”. Next, only the letter was presented, and the child had to identify words containing that letter in its silent form. Pronounced letters were identified more accurately, evidencing that silent letters are harder to remember. Silent letters were identified faster than pronounced letters and prompted the retrieval of more words than pronounced letters. Similarly, although the initial or final consonant clusters may be less frequent, they may also be less productive, meaning that there are fewer words to memorize. For the middle condition, despite the relative productivity of some of the consonant clusters, there are a greater number of consonant clusters and words to memorize, contributing to the elevated difficulty evidenced by the higher error percentage. Therefore, the disorder with a sensitivity to silent letters may actually occur before the graphemic buffer translates the letter string with which it is provided. Further research must be done to examine the relative frequencies of the consonant clusters in words. Some clusters, such as “sc” occur both at the beginning of words and in the middle of words. Ensuing tests might develop word lists that will isolate the effect of position.

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# Impaired Social Problem Solving in Anorexia Nervosa

## A Systematic Review and Implications for Future Treatment Interventions

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**ABSTRACT.** Social problem solving (SPS) is characterized by the ability to cope with social problems and resolve conflicts effectively. SPS deficits are often seen among patients with anorexia nervosa (AN), although there is a gap in knowledge regarding the specific nature of the relationship between SPS and AN. This review will (1) examine the cognitive and social impairments associated with SPS deficits among AN populations, (2) consider other physiological and psychological factors associated with AN, such as weight status and comorbidity, that may affect SPS skills, and (3) evaluate SPS interventions used to treat other psychiatric disorders as a way to garner insight about future SPS interventions on AN populations. The review concludes that SPS interventions present a promising treatment option for individuals with AN, and proposes directions for future research.

### 1. Introduction

Anorexia nervosa (AN) is a life-threatening psychiatric disorder that is characterized by having a body weight below minimally normal for age and height, an intense fear of becoming fat or gaining weight, and severe body image disturbance (American Psychological Association, 2013). AN is most commonly found in women, although the prevalence of AN in men is on the rise (Mitchison, Mond, Slewa-Younan, & Hay, 2013). In a recent prospective study using new Diagnostic & Statistical Manual-5 (DSM-5) criteria for AN, the lifetime prevalence rate for adolescent females with AN was 0.8%, with a peak onset age between 19-20 years (Stice, Marti, & Rohde, 2013). Although AN is a rare condition, it has the highest mortality rate of any psychiatric disorder, and a notably poor treatment prognosis (Birmingham, Su, Hlynsky, Goldner, & Gao, 2005). Fewer than half of all patients with AN are treated for their disorder, and among patients who receive appropriate treatment, the rate of relapse is great, and improvements may not be seen until many years later (Hoek 2006; Herzog, Schellberg, & Deter, 1997).

Clinical studies of AN have also demonstrated cognitive and social deficits (Roberts, Tchanturia, Stahl, Southgate, & Treasure, 2007; Treasure & Schmidt, 2013; McAdams & Krawczyk, 2011). One clinically relevant attribute is a diminished ability to engage effec-

tively in social problem solving (SPS) (Sternheim et al., 2012; Paterson et al., 2011; Swanson et al., 2010). SPS refers to the ability to cope with and resolve conflicts that arise in social situations, and relies on both cognitive and social processing (D’Zurilla & Chang, 1995). The cognitive component of SPS refers to a person’s ability to think about social problems in a rational way, and to generate a hypothetically effective solution. The social component of SPS, however, refers to an individual’s default problem solving style, or, his or her ability to implement these effective solutions in a real-world setting (D’Zurilla & Chang, 1995).

The relationship between SPS and AN is understudied. This review seeks to evaluate what is currently known about SPS with regards to AN, and what remains to be determined to inform whether SPS interventions would be useful for treating AN. Specifically, the present review will (1) describe commonly used measures of SPS in studies of AN that measure both the cognitive and the social component of SPS, (2) examine SPS skills among weight-recovered patients with a history of AN and patients who have other comorbid disorders (3) consider SPS training as a potentially effective intervention for individuals with AN, and (4) outline gaps in current knowledge of SPS and AN and limitations of current research.

## 2. SPS Measures

SPS can be assessed using a variety of instruments that measure a person's problem orientation and/or problem solving style. Problem orientation refers to a person's cognitive schema regarding social problems in general, and how confident they feel in solving them. Problem solving style, on the other hand, refers to how the individual actually behaves when a social problem arises in everyday life (D'Zurilla & Nezu, 2010). A number of instruments have been developed to measure SPS. There are only four, however, that measure both problem orientation and problem solving style: the Social Problem Solving Inventory- Revised (SPSI-R), the Social Problem Solving Resolution Task (SPRT), the Problem Solving Inventory (PSI), and the Interpersonal Problem-Solving Assessment Technique (IPSAT). The former two measures (the SPSI-R & SPRT) are the only two that have been used to measure SPS among a population with AN, and will therefore be discussed in further detail.

### SPSI-R

The SPSI-R is a 52-item Likert-type inventory that assesses problem solving orientation (the cognitive component) and problem solving style (the social component) (D'Zurilla, Nezu, & Maydeu-Olivares, 1998). Problem solving orientation exists on a dimensional scale from negative to positive. Individuals with positive problem orientation have confidence and agency in their ability to solve problems, whereas individuals with negative problem orientation lack confidence and self-efficacy in their ability to solve problems. In the SPSI-R, problem orientation is measured using questions like "Whenever I have a problem, I believe it can be solved." Participants rate on a scale of 1-5 whether that statement is "Not at all true of me" (1) or "Very true of me" (5).

There are three scales of problem solving style: rational, impulsive/careless, or avoidant. Rational problem solvers engage in effective decision making, solution generation, and implementation when confronted with a problem. Impulsive/careless problem solvers act on the first solution that comes to mind without thinking it through or considering alternative options. Avoidant problem solvers rely on others to solve their problem, or wait for the problem to resolve itself. Questions that measure problem solving style include "When making decisions, I do not evaluate my options carefully enough" or "I wait to see if

a problem will resolve itself first before trying to solve it myself." These are rated on the Likert scale described above.

Both problem orientation and problem solving style are scored dimensionally, rather than categorically. Each of the five following subscales is scored individually: positive problem orientation (PPO), negative problem orientation (NPO), rational problem style (RPS), impulsive/careless style (ICS), and avoidant style (AS). In other words, the SPSI-R accurately reflects the nuanced behavior styles people may have when they approach social problems, and recognizes that individual differences in social problem solving exist on a spectrum.

There are two studies that have used the SPSI-R to delineate the relationship between SPS and AN. Paterson and colleagues (2011) sampled 27 female patients with AN and 62 healthy control females who were evenly matched on age. The AN group scored significantly lower than the healthy control group on the NPO scale and on the ICS and AS scales. Swanson et al. (2010) found similar results. Using a sample of 43 AN patients and 76 healthy control females, who were again evenly matched on age, they found that the AN group scored significantly lower on the NPO scale and the AS scale (but not the ICS scale).

Both of these studies found that AN patients scored higher on NPO scale than healthy controls did. This suggests that their lack of self-confidence in social problem solving hampers their ability to cope when social problems arise. Although conflicting results existed regarding the ICS scale, both studies also found that patients with AN were more likely than healthy controls to exhibit an avoidant problem solving style. Both of these studies excluded men from the sample. Previous research using the SPSI-R on healthy populations has found that women score significantly higher than men on the negative problem orientation scale (D'Zurilla, Maydeu-Olivares, Kant, 1998). This is especially relevant, given that AN is much more commonly found in women than in men (Stice, Marti, & Rhode, 2013).

### SPRT

The SPRT is a verbal, interview-style measurement that consists of 10 social problem scenarios. The researcher prompts the participant by asking him/her (1) "What is the best thing to do in this situation?" and

(2) "What would you do if you were in this situation?" (Channon & Crawford, 1999). The first question requires participants to generate an optimal solution to the problem. The second question is more personalized, and requires participants to state how they would actually solve the situation. Responses to both questions are evaluated by one judge using pre-existing criteria on whether the solution is both practically effective and socially sensitive. Answers receive one point if they are effective, and one point if they are sensitive, with a maximum score of two points total for each of the 10 scenarios.

Only one study has examined SPS among individuals with AN using the SPRT (Sternheim et al., 2012). Results indicated that no significant differences exist between AN and healthy control groups on optimal solution generation. This somewhat contradicts the findings of studies that have used the SPSI-R, which found that negative problem orientation (which translates to optimal solution generation in this study) is highly associated with individuals with AN (Paterson et al., 2011; Swanson et al., 2010). Instead, this study indicates that these individuals are, in fact, able to generate optimal solutions to solve social problems, but struggle with putting these solutions into action. Regarding personal solution implementation, AN patients produced significantly poorer personal solutions compared to healthy controls (Sternheim et al., 2012). These personal solutions were both less practical and less sensitive compared to the personal solutions of the healthy controls.

The solutions in the SPRT that are "sensitive but not practical" appear conceptually similar to the avoidant problem solving style in the SPSI-R. Similarly, SPRT solutions that are "practical but not sensitive" appear similar to the impulsive/careless SPSI-R problem solving style. Contrary to studies that found avoidant style in AN using the SPSI-R (Paterson et al., 2011; Swanson et al., 2010), a study by Sternheim et al. (2012) using the SPRT found there was no difference between healthy women and women with AN in providing personal solutions that were sensitive but not practical.

### Summary

While both the SPSI-R and SPRT have been empirically shown to have good reliability and validity (D'Zurilla & Maydeu-Olivares, 1995; Sternheim et al., 2012), these measures have not been validated

among AN populations. Given the contradictory findings of these two measures with regards to AN populations specifically, it is possible that a new social problem solving measure ought to be developed, with features that are specific to this AN population.

### 3. Contributing Factors to SPS Deficits in AN

Additional physiological and psychological factors may influence the relationship between SPS and AN. Physical complications associated with chronic starvation and malnutrition likely exacerbate SPS deficits, possibly by impairing executive functioning. Additionally, a high rate of psychiatric comorbidity makes it difficult to determine whether SPS deficits are a feature of pure AN or a trans-diagnostic risk factor (O'Brien & Vincent, 2003). It is not yet well-understood if SPS deficits are a trait or state feature of AN. To begin to clarify these issues, this section will examine SPS skills first in weight-recovered (Wt-R) individuals with a history of AN, and second in patients with psychiatric conditions that are often comorbid with AN.

#### Weight-Recovered (Wt-R) Populations

AN research typically defines Wt-R as maintaining a normal weight status (90-110% of normal body weight) and having regular menses in the last year (Strober, Freeman, & Morrell, 1998). To date, no studies have examined SPS among Wt-R populations. Previous research, however, has shown that both social and cognitive deficits persist even after AN patients return to normal weight status. For instance, Wt-R individuals scored lower than healthy controls on a social Stroop task, with a significant bias towards negative social stimuli (such as angry/threatening stimuli) (Harrison, Tchanturia, & Treasure, 2010).

Cognitive deficits persist after weight recovery as well. Among these are impaired cognitive flexibility (Holliday, Tchanturia, Landau, Collier, & Treasure, 2014), meaning that these individuals may exhibit a rigid cognitive style and inability to modify their behaviors, even when it is no longer advantageous. Specifically, an individual with AN may be unwilling or unable to generate alternative solutions to a problem, in spite of negative feedback. For example, Wt-R individuals perform significantly worse on healthy controls on tasks like the Wisconsin Card Sorting Test (WCST), a measure of cognitive flexibility (Tchanturia et al., 2012). Given this bias towards rigid and inflexible thinking, it is reasonably assumed that this might



translate into difficulties in engaging in effective SPS. Further research is needed, however, to ascertain if Wt-R populations experience difficulty in SPS with reference groups.

### Comorbid Populations

AN has a high rate of comorbidity. Among these disorders, major depressive disorder (MDD), obsessive-compulsive disorder (OCD), and anxiety-related disorders have been shown to have a comorbidity prevalence of 86% (O'Brien & Vincent, 2003), 35% (Kaye et al., 2004), and 55-62% (Kaye et al., 2004; Milos, Spindler, Buddeberg, & Ruggerio, 2003) respectively. AN also has a high rate of personality disorder comorbidity. Obsessive-compulsive personality disorder (OCPD) has a comorbidity prevalence of 22%, while borderline personality disorder (BPD) has a comorbidity prevalence of 25% (Sansone, Levitt, & Sansone, 2004). It is difficult to determine, however, whether SPS deficits are a feature of "pure" AN, or if these deficits are affected by comorbid disorders.

Given the high comorbidity prevalence among patients with AN and MDD (86%; O'Brien & Vincent, 2003), it is conceivable that SPS deficits are partly, or entirely, a function of depressive symptoms. The SPSI-R has been used to evaluate SPS among patients with depressive symptoms, but no history of AN. Results indicated that depressive symptoms were highly correlated with negative problem orientation ( $p < .01$ ) (Haugh, 2006). A study by Giel et al. (2012) demonstrated that impaired set shifting, a deficit typically associated with AN, was actually correlated with severity of depression and not with severity of AN symptoms. Due to the high comorbidity prevalence between these two disorders, it is possible that the overlapping symptomology means researchers do not yet have a complete understanding of what defines "pure" AN. To date, no studies have examined SPS among patients with comorbid AN and MDD.

AN is also often comorbid with various anxiety-related disorders (Kaye et al., 2004). Studies examining SPS among patients with anxiety disorders found that both state and trait anxiety is correlated with negative problem orientation (Belzer, D'Zurilla, Maydeu-Olivares, 2002). This study also found, however, that anxiety was correlated with both rational and impulsive/careless problem solving styles, indicating that anxiety can be either beneficial or detrimental to practical problem solving skills. Neither of

these styles, however, was associated with AN in studies using the SPSI-R. In such studies, the presence of AN was typically associated with the avoidant problem solving style (Paterson et al., 2011; Swanson et al., 2010). This suggests that although anxiety disorders and AN are both associated with negative problem orientation, SPS deficits regarding problem solving style may not be influenced by comorbid anxiety.

There are several traits that are shared across psychiatric disorders, including AN, that may predict SPS deficits. For instance, Chang (2002) demonstrated that SPS deficits mediated the link between perfectionism and suicide ideation. Paterson et al. (2012) found that the presence of self-esteem mediated the association between positive problem orientation among patients with AN. Perfectionism and low self-esteem are often subclinical, accompanying symptoms of many of the comorbid disorders discussed previously (Bastiani, Rao, Weltzin, & Kaye, 1995; Paterson et al., 2011) and could be related to the SPS deficits found in individuals with AN.

### Summary

Cognitive deficits persist in Wt-R individuals with a history of AN, but SPS has not been directly investigated in a Wt-R AN population. Moreover, symptoms of AN are often muddled by psychiatric comorbidity. It is therefore likely that not enough information is known about "pure" AN (AN without any comorbid disorder or symptoms) to surmise that SPS deficits are a feature of trait, rather than state, AN.

### 4. SPS as a Target Treatment Intervention for AN

SPS has been largely successful as a treatment intervention for adults with other psychiatric disorders that are often comorbid with AN, as previously outlined. These interventions have been most widely used among adults with depressive symptoms, and specific protocols are described later in this section (Nezu & Perri, 1989; Klein et al., 2011). SPS has not yet been a targeted intervention area for individuals with AN. Given the high comorbidity prevalence of MDD and AN (O'Brien & Vincent, 2003), these previous interventions of SPS and depression are useful to examine with regards to the potential utility of designing SPS interventions for adults with AN.

Nezu & Perri (1989) designed an SPS intervention study for adults with depression, hypothesizing that SPS deficits are a vulnerability for depression,

and therefore that SPS skills training might combat this vulnerability. Indeed, they found that those participants who underwent this intervention showed significantly decreased depressive symptoms compared to the wait-listed control group who received no intervention. Klein and colleagues (2011) also conducted an intervention study measuring SPS and depression, using medication in conjunction with therapy. In contrast to Nezu & Perri, they predicted that SPS improvement would be a measurable outcome of alleviated depressive symptomology. As predicted, SPS skill improvement was a function of this reduction in depressive symptomology.

Regarding the specific protocols of an SPS intervention for AN, insight may be garnered from these previous interventions. An SPS intervention study for adults with personality disorders (PD) consisted of weekly two-hour, single-sex, 8-member group session for 16 weeks (Huband, McMurrin, Evans, & Duggan, 2007). Participants learned social problem solving skills from two mental health professionals. SPS skills were taught using the "Stop & Think!" social skills program which helps individuals learn interpersonal social skills and conflict resolution tactics (McMurrin et al., 2001).

Nezu & Perri (1989) conducted their intervention for adults with depression over 10 weeks, for 1.5-2-hour sessions every week. Their intervention included two groups that received SPS skills training; one group focused on both changing attitudes about problems in general, and inhibiting the tendency to respond automatically to problems without thinking first. The second SPS group received an abbreviated version, which specifically excluded the cognitive intervention regarding changing attitudes and beliefs about problems, thus solely focusing on the social aspect of solution implementation in a real-world setting.

SPS interventions can also be conducted in a one-on-one session. Though not labeled explicitly as social problem solving, Klein et al. (2011) instructed participants to engage in Situational Analysis (SA) with their study therapist. These sessions consisted of analyzing a recently distressing social encounter, and generating alternative responses and thoughts/feelings that help to inform future interactions. Thus, SPS interventions can be retrospective or prospective in nature, provided that they teach the individual about

ways to engage in more effective SPS in the future.

## Summary

SPS has not yet been a target area for treatment intervention for adults with AN. Given the success of SPS interventions for adults with depression, as well as the staggering prevalence rate of AN with MDD (86%; O'Brien & Vincent, 2003), this is likely a worthwhile target for treatment intervention. Both interventions previously outlined that incorporated SPS skills were successful in alleviating depressive symptoms. It is reasonable to infer that SPS interventions for people with AN would be successful at least in alleviating depressive symptoms that so often co-occur with AN, if not in alleviating symptoms associated with AN directly.

## 5. Conclusion

The present review aimed to highlight cognitive and social impairments associated with SPS deficits among individuals with AN, and illuminate the gaps in understanding SPS in AN. Few measures of SPS accurately measure the cognitive (solution generation) and social (solution implementation) abilities separately, and fewer still have been utilized among AN specifically. It has also considered the potential clinical utility of SPS interventions for people with AN, given its efficacy in alleviating depressive symptoms and treating personality disorders, which are often comorbid with AN symptoms.

SPS among AN represents an important area of research with direct clinical relevance to AN treatment. Further research directions include developing validated measures of SPS among currently ill and Wt-R AN patients, and investigating whether there are SPS differences among subtypes of AN (binge/purge or restrictive). Future studies could also include neuroimaging techniques to identify potential disturbances in neural circuits involved with the cognitive and social components of SPS. Finally, future studies should aim to develop a clinical intervention aimed at improving SPS skills, to determine if this approach can strengthen SPS skills in AN.

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# The Relationship between Profanity and Intelligence

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**ABSTRACT.** Profanity and censorship are prevalent in our culture. Many negative opinions about cursing exist, but there is little actually known about how harmful it can be. The purpose of this experiment was to see if cursing is correlated with intelligence. The hypothesis is that there will be no relationship between cursing and intelligence. A 28 question survey that assessed cursing frequency was given to 46 college enrolled participants. After the survey, the participants were asked to complete the Wonderlic Personnel Test in order to assess their Intelligence Quotient. After running a linear regression analysis between the factors in the survey and the IQ scores, no statistically significant relationship was found between cursing and intelligence. There was a statistically significant correlation found between IQ score and whether or not the participant reported that he or she attempts to expand his or her vocabulary. These findings show that although cursing may not be socially desirable, it is not a predictor of intelligence or the lack thereof. It was shown that vocabulary and the desire to expand it may play a large role in intelligence. This should be emphasized in scholastic environments, especially for children before the age of three. Developing an extensive vocabulary as soon as possible seems to lead to higher intelligence.

## 1. Introduction

Profanity sends a message whilst emitting emotion. It is meant to capture attention and display a particularly strong emotion. Steven Pinker (2007) identifies these emotions as disgust, dread, revulsion, fear, and contempt. In our ancestral times, these emotions' purpose was survival. For example, disgust has been shown to be a vestigial safeguard against disease and rage serves the biological imperative to survive by generating aggression (Lewis, 1998). Profanity and emotion play off each other to convey specific messages and to generate appropriate responses. Although emotions do help communicate a message, cursing serves its own purpose. Pinker (2007) takes the emotions that he has identified and attaches them to five different modes of cursing, each serving a secondary purpose. Dysphemistic swearing depicts the subject matter in a purposefully provocative manner. Abusive swearing is used in order to intimidate. Idiomatic swearing expresses that the atmosphere is informal, or arouses interest. Emphatic swearing emphasizes another word in an adverbial or adjectival manner. Cathartic swearing articulates an intense emotional state, usually one of shock or pain.

These types of swearing go deeper than just communication, and force an emotional response or understanding upon listeners.

The cathartic mode of cursing may explain a potential neurobiological reason that verbal profanity exists. A study conducted by Richard Stephens (2011) shows that cursing can be a source of pain relief. 71 undergraduate participants from Keele University participated in a pain relief study in which the participants submerged their hands in five-degree Celsius water for as long as possible. They were to repeat one neutral word for the first trial until they gave up or reached a five-minute limit. They then repeated the hand submerging test while being able to curse at their leisure. Results show that participants could last longer and endure more pain when allowed to curse. 67 students of the 71 reported less pain and endured 40 seconds longer on average, meaning that profanity could be used as a method of pain relief.

Intelligence is a difficult concept to define; however, it is generally understood to be the measure of cognitive ability. There are two widely accepted but very different theories of intelligence. One is<sup>16</sup>

Cattell's theory of fluid and crystallized intelligences. Fluid intelligence is an overall cognitive ability that allows for problem solving and logical thinking. Crystallized intelligence is the use of skills and experience in a useful way (Ferrer et al. 2009). The other paradigm is Gardner's theory of multiple intelligences. This theory states that it is necessary to break down intelligence into categories to accurately portray the concept as a whole. The categories are logical-mathematical, linguistic, musical, spatial, bodily-kinesthetic, intrapersonal, and interpersonal (Gardner & Hatch, 1989). Despite the debate on which theory is more accurate, psychometricians have developed tests that assess intelligence with accuracy (Gardner & Hatch, 1989). Although it is difficult to define and predict, IQ can generally be accurately measured.

Both nature (genetic factors) and nurture (environmental factors) are responsible for intelligence. Studies are inconclusive as to which factor plays a larger role in determining intelligence (Nisbett et al., 2012). The environment that a child is exposed to at a young age can act as a confounding variable in studies that try to measure heritability's effect on intelligence. With this being said, young children that are highly stimulated in adaptive homes tend to possess higher IQ scores. Positive stimulation varies greatly across people of different socioeconomic statuses (Unz, 2012). Wealthier people can afford greater education and care for their children, which may boost their IQ beyond what it would be in different environments. Generally, results show that cognitive stimulation at a young age will yield higher intelligence, despite any of the unobservable hereditary effects.

While IQ is stable over a person's lifetime, personality is not. Perhaps people with certain personality types curse more frequently, or are generally more intelligent. In one study, people ranging from ages 18 to 60 were compared in both intelligence and personality to examine any trends (Nauert, 2006). Higher levels of openness and lower levels of extraversion were important predictors of general knowledge in young adults. In older people, low levels of agreeableness tended to correlate with higher intelligence. Conscientiousness may also play a role in predicting performance, but not necessarily intelligence. Personality tends to fluctuate more than intelligence, making this only a mildly useful tool in predicting intelligence.

The present research will attempt to uncover

any relationship between profanity and intelligence. The low social desirability of cursing may allow people to tie negative notions to cursing, particularly that the speaker is unintelligent. As previously stated, there is a dearth of information in regards to this topic and there are no definite predictors of intelligence. This study may generate some important findings on the issue. A survey addressing cursing will be given to the participants. Following this survey, an IQ test will be administered. My hypothesis is that no relationship will exist between cursing and intelligence.

## 2. Method

### Participants

Participant recruiting was done by advertising via word of mouth on Manhattan College's campus. This convenient sampling style yielded 46 valid participants. All participants were Manhattan College undergraduate students. The ages ranged from 18 to 23 years old ( $M = 20.16$ ). There were 15 females and 31 males in this study. There was one African American participant, six Asian, six Hispanic, three multiracial, and 30 white participants. One factor dealt with

### Materials

The IQ test used was the Wonderlic Personnel Test. It is a popular group intelligence test that is primarily used for assessing the work performance and problem solving skills of potential employees. Test items cover logical reasoning, vocabulary, and mathematical skills (Pollick, 2012). The participant is given 12 minutes to answer as many of the test's 50 questions as possible. No points are removed for wrong answers, so the participants were encouraged to answer as many questions as possible. Due to copyright issues, details about the test items will not be provided. The possible range of scores for the Wonderlic is 60 to 160.

The cursing survey was based on a 6-point Likert scale (Appendix A). The possible range of scores for each question on the cursing survey was 0 to 5 with 0 indicating the statement never applied to the participant and 5 indicating that the statement very frequently applied to the participant. The survey was written with Pinker's (2007) five types of cursing in mind as well as a general cursing frequency factor and a verbal intelligence countermeasure. A factor analysis displayed that only two factors existed in the

cursing in general, its frequency as well as mode of cursing. The cursing factor's reliability was .938. It asked for cursing and slang frequency in both writing and speech. It also went into detail on how the participant cursed, considering both the utility of the curse as well as how it was used grammatically. The other factor represented verbal eloquence and vocabulary. This vocabulary scale's reliability was .553. This factor addressed use of vocabulary and its mastery.

Procedure

Participants were gathered in a calm and quiet environment. The participants received a copy of the informed consent (Appendix B) form and the administrator reviewed it with them. Those that complied received a copy of the cursing survey to complete. After all the participants finished the survey, the administrator distributed the Wonderlic Personnel Test. The administrator reviewed the test with the participants and explained the way it is graded and the time constraints. Then the administrator completed a sample question with the participants to ensure that the participants understood how to answer the questions properly. After all the participants were ready, the administrator set a timer for 12 minutes and allowed the participants to complete the test. The administrator collected the tests at the time limit. The participants were then verbally debriefed with an explanation of the study and how their data would be used. A coding system was used on the survey and test to ensure the privacy of the participants.

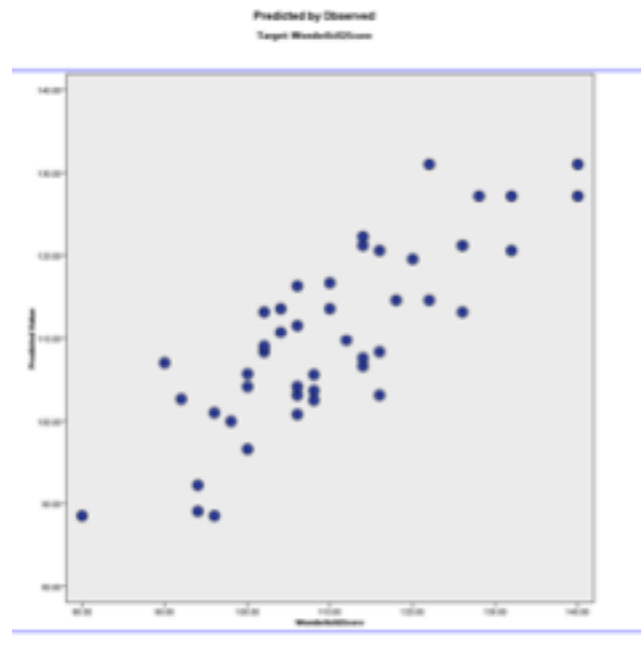
3. Results

The mean responses from the expletive frequency in speech and writing were  $M = 2.98$  and  $M = 2.87$  respectively. The standard deviations were  $SD = 1.35$  and  $SD = 1.56$  respectively. Despite these scores being slightly above average, there was no significant correlation between these items and intelligence,  $r(44) = .031, p > .05$  and  $r(44) = .019, p > .05$ . A linear regression analysis shows that there is no statistically significant relationship between the cursing or vocabulary factor and intelligence,  $R^2 = .304, p > .05$  and  $R^2 = .262, p > .05$ . After correlating all the items on the survey to intelligence, one question stood out. The question, "Do you attempt to expand your vocabulary?" and IQ shared a significant relationship,  $r = -.312, p < .05$ . The data from the regressions are shown graphically below (graph 1 and 2). The hypothesis is

supported by these data, displaying no significant relationship between cursing and intelligence (despite graphical appearances).

The observed range for the Wonderlic Personnel Test was 80 to 140. The mean score was  $M = 110.35$  points with a standard deviation of  $SD = 13.17$  points. The median score was 108 and the mode was 106. This distribution was normative; however, the entire curve was shifted 10 points higher than the population average. This can be seen in the graph below (graph 3).

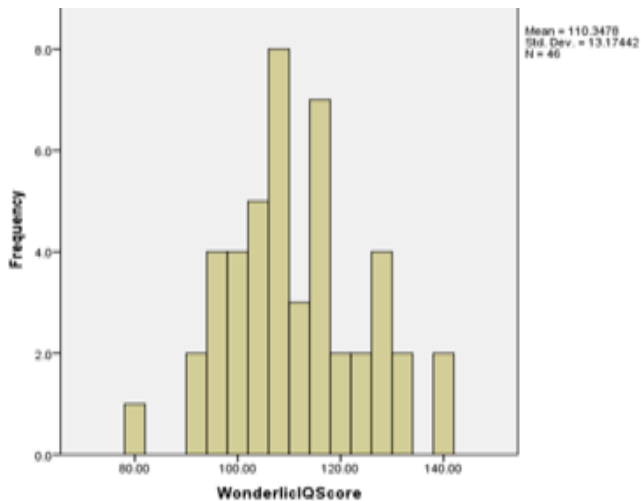
Graph 1. Cursing Factor Regression



Graph 2. Vocabulary Factor Regression



Graph 3. The Distribution of IQ Scores.



#### 4. Discussion

The results of the experiment show that there is no significant relationship between cursing and intelligence. These results support the hypothesis that cursing cannot be used as an accurate predictor of intelligence. There was a significant correlation between intelligence and the question, "Do you attempt to expand your vocabulary?" Those who answered that they frequently attempt to expand their vocabulary also tended to have a higher IQ. Although this study did not examine vocabulary as a predictor of intelligence, the statistics show that vocabulary, or the drive to increase it, may be a predictor of intelligence. This study had many limitations that merit comment. Not only was the sample small, but also all of the participants were college students. Although IQ is stable, being placed in an environment that is designed to foster intelligence may nullify potential effects of cursing. Also, the reliability of the vocabulary factor was low in comparison to the cursing factor. The vocabulary scale was only intended as a counter measure, or an attempt to measure something that could be considered "opposite" of cursing. More skillfully designed vocabulary questions on the survey may have yielded more accurate results for this factor. Likewise, the IQ test used did not specifically address verbal intelligence. The Wonderlic is accurate, quick to administer, and easy to grade, but it does not give any specific data on intelligence. Using an overall intelligence test is not necessarily a pitfall of this study; however, it is worth noting. A verbal section of a standardized test such as the SAT or GRE could yield more salient data,

given that cursing is intuitively a verbal issue.

There is a dearth of research when it comes to the effects of cursing. Many people find cursing to be offensive and harmful, even though there has not necessarily been any direct correlation between profanity and harm. This is partially because there is no clear definition of harm in regards to offensive speech, making it unethical to forcibly expose participants to any harm (Jay, 2009). One way this research can be done is to try to see if there are any stress relief qualities of cursing, similar to the pain relief qualities that cursing has. To get more accurate data, one can even conduct interviews or stress tests after a cursing tantrum. This will require time and effort; however, it can lead to meaningful findings that can display a further usefulness to using words that trigger emotion. Another direction research can take is to try and develop a cursing dependency scale. This can display who uses these words as a crutch as opposed to those who use them on occasion. Defaulting to the versatility of curse words and slang may be the culprit for the lack of vocabulary in some cases. This cursing dependency scale could be correlated to intelligence, rather than just cursing frequency. This will further drive home the point that vocabulary is essential to intelligence, particularly in children. A useful addition to this approach can also be an assessment of drive to increasing vocabulary. The significant question, "Do you attempt to expand your vocabulary" only asked if participants attempt to expand their vocabulary, not if they have an extensive vocabulary. The desire to enhance one's vocabulary may be what is predicting intelligence. In theory, the evidence of this desire to improve vocabulary would be knowing and using more words; however, a scale that addresses drive could yield more significant results.

Although cursing did not display a relationship to intelligence, it can still be responsible for some intellectual damage. Learning ability, particularly for language, spikes during early childhood. If a child is placed in a healthy and stimulating verbal environment, the environment can increase the child's verbal ability. Hampering the child's exposure to vocabulary at this crucial point in life can be detrimental to the child's intelligence. Evidence from Hart and Rinsely (1995) indicates that children of professional parents hear 30 million words by the age of three. Middle class parents' children hear 20 million words



by the age of three. Unemployed African American mothers' children hear only 10 million words by the age of three. The quality of the words is much richer from families of higher socioeconomic status. This fits with the trend of verbal stimulation leading to a higher IQ among children stated previously. Although this study did not examine profanity, it is still cogent. If parents default to the versatility of cursing around their children, the children will follow. The lesson to be learned from this study is that any institution or person that is within a child's surroundings must be cognizant of their choice of language. This means not only avoiding curse words, but also using elaborate vocabulary as frequently as possible. The constant and correct use of language will help expose children to new vocabulary and stimulate them intellectually.

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# Role of GluN2A containing NMDA receptors in memory reactivation: Molecular and behavioural evidence

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**ABSTRACT.** Whereas substantial evidence supports the role of the amygdala in fear-memory conditioning, little is known about the molecular mechanisms involved. It is currently believed that the MAPK-ERK signalling pathway may be key in supporting both consolidation and reconsolidation. Additionally, recent research has suggested that GluN2A NMDA receptors of the basal lateral amygdala are required for memory restabilisation, although their functions in memory reactivation are unclear. We predicted that GluN2A NMDARs in the basal lateral amygdala (BLA) would be involved in mediating memory reactivation through the MAPK-ERK signalling pathway. To test this hypothesis, we used Western-blot to analyse subcellular localization of ERK 20 minutes after fear-memory reactivation in rats treated with a GluN2A antagonist directly in the BLA (NVP-AAM0077). Nuclear ERK concentration was not found to be significantly modified post reactivation in NVP-treated animals relative to control groups (vehicle). Nevertheless, a trend was found in the cytoplasm, suggesting that GluN2A NMDARs may contribute to short-term adaptation of the ERK signalling during reactivation. Together, these findings provide insights for future research. Alternative research techniques and methodological approaches are considered.

## 1. Introduction

The field of memory research has long been dominated by memory consolidation theory, according to which memories are stored and stabilised over time after a new learning experience (McGaugh, 2000). In 1968, Misanin & Lewis were the first to show that post-retrieval memory could be disrupted (Misanin & Lewis, 1968). The evidence for a labile phase of memory during reactivation triggered further research on the mechanisms underlying post-reactivation storage, a process that has come to be known as reconsolidation (Karim Nader, 2003). Over the past ten years, an increasing number of research papers have focused on the cellular processes involved in reconsolidation.

Capitalizing on decades of research in fear memory formation, the role of protein synthesis has been thoroughly investigated in the amygdala and hippocampus – two brain regions known to be involved in the formation and reactivation of fear memories (LaBar & Cabeza, 2006). Using an auditory fear-conditioning paradigm, Duvarci et al. (2005) showed that infusing the inhibitor of protein synthe-

sis anisomycin in the lateral amygdala following reactivation of a fearful memory led to amnesia. These results were consistent with the hypothesis that reconsolidation in the lateral amygdala requires protein synthesis (Nader et al., 2000).

It is well established that in addition to protein synthesis, consolidation requires the activation of various signalling pathways, among which the extracellular signal regulated kinase mitogen activated protein kinase (ERK-MAPK) plays a key role in contextual and cued fear learning (Sananbenesi, 2002; Trifilieff et al., 2007). The ERK-MAPK pathway is a cytoplasm-to-nucleus module, in which Raf proteins phosphorylate MAPKKs (MEK), which in turn activate ERKs. Once activated, ERKs translocate to the nucleus where they regulate transcription factors (Peyssonnaud & Eychène, 2001). Hence, the presence of ERKs in the nucleus suggests ERKs activation downstream the ERK-MAPK signalling pathway.

Evidence for the role played by the ERK-MAPK pathway in consolidation and reconsolidation of fear memories is strong. In rodents, MEK inhibitors pre-

venting ERK activation have been shown to disrupt cued fear memory consolidation in the amygdala (Schafe et al., 2000). Furthermore, Duvarci et al. (2005) have found that the infusion of MAPK kinase inhibitor in the lateral amygdala during memory reactivation also blocked reconsolidation, thus confirming the involvement of the ERK-MAPK pathway. Together, these findings provide strong evidence that ERK-MAPK signalling is a crucial component of fear-memory reconsolidation in the amygdala, although the upstream activators of ERK have not been well established.

ERK-MAPK activity has been linked to the NMDA subtype of glutamate receptors (NMDAR) of the amygdala, which have been shown to play a critical role in reconsolidation of fear-conditioned memories (Lee et al., 2013; Pedreira et al., 2002). NMDAR are commonly made of three major subtypes, GluN1/2/3, arranged using four subunits (GluN1-3A-D) (Dingledine et al., 1999). NMDARs of the basal lateral amygdala appear to mediate reconsolidation through molecular signalling via the GluN2A subunit (Milton et al., 2013). The contribution of amygdala GluN2A receptors to the formation of fear memory has previously been investigated in Pavlovian conditioning paradigms using infusions of NVP-AAM-077 (NVP), a GluN2A antagonist (Dix et al., 2010; Weitlauf et al., 2005). However, the cellular mechanisms underlying the molecular activation of GluN2A during reactivation have not yet been investigated.

We explored the effects of a GluN2A NMDAR antagonism, using NVP, in the basolateral amygdala specifically prior to cued-fear memory reactivation. Upon activation, ERK has been shown to translocate from cytoplasm to nucleus, where it modulates DNA transcription either through direct phosphorylating transcription factors or through intermediate substrates kinases (Davie & Spencer, 2001; Murphy et al., 2002). ERK also has a number of cytoplasmic targets, which can mediate short-term adaptations of the signalling cascade (Wortzel & Seger, 2011).

Based on previous research suggesting that GluN2A NMDAR may play a crucial role in fear memory consolidation and the known connection between NMDAR and the MAPK-ERK signalling pathway, we hypothesized that the activation of ERK in subcellular compartments would be reduced subsequent to NVP infusions, confirming the implication of the MAPK-ERK signalling cascade in the GluN2A NMDAR in memory

reactivation. To test this hypothesis, we fractionated tissues in the basal lateral amygdala (BLA) and we used SBS-polyacrylamide gel electrophoresis (Western-Blot) as a primary method to detect the phosphorylated ERK (pERK) in the nucleus and cytoplasm. We used densitometry to assess differences in ERK activation post-reactivation between NVP (NVPRet) and vehicle treated rats (VehRet) and compared the results with a control group of NVP (NVPNoRet) and vehicle treated rats (VehNoRet) in a no-retrieval condition.

Western-Blotting has been shown to be particularly efficient in isolating and quantifying specific proteins (Towbin et al., 1979). The ability to separate proteins by sizes through electrophoresis and to detect pERK with targeted antibodies after electro-transfer was a key element in choosing this method. By evaluating the presence of ERK in our different treatment groups, we could compare the trafficking of pERK between cytoplasm and nucleus. In this report, the Western-Blot method is thoroughly discussed in the context of our experiment. Limitations are considered and alternative methodological approaches are explored.

#### Overview of the experiment

Personal responsibilities: Behavioural assessment of Pavlovian conditioning, Cryostat sectioning, fractionation of BLA tissues, protein extraction, Bradford protein assay, electrophoresis, densitometry and statistical quantification.

## 2. Methods and Material

### Subjects

The subjects consisted of 24 male List-Hooded rats weighting 250-300g (Charles River Laboratories) housed in pairs on a reversed light-dark cycle. Subjects were food restricted but not deprived (25g per rat per day). All procedures were conducted in accordance with the UK Animals (Scientific Procedures) Act 1986.

### Surgery

Subjects were implanted a stainless steel guide cannula in the basolateral amygdala nuclei of each hemisphere for intra-cerebral drug administration, as described by Milton et al. (2008). Obstructors were inserted in the cannulae at all times to main-

tain integrity between infusions. A 7-day recovery period was observed prior to starting testing and behavioural scoring. The coordinates were 3.6 mm posterior to bregma, 4.5 mm lateral to the mid-line, and 3.6 mm ventral to dura mater.

#### Intra-cerebral infusions

Rats were infused solutions intra-cerebrally using a syringe pump (28 gauge plastic, projecting 2mm beyond the guide cannula) at a rate of 0.25  $\mu$ l min for a period of two minutes. The syringe was removed one minute after the infusion ended to ensure adequate diffusion of the solution. All rats received a habituation to infusion at the end of the first training session, consisting of a 0.5 $\mu$ l sterile saline solution administered evenly through each cannula. Prior to the last reactivation session, half the rats were administered a pure solution of phosphate buffered saline (PBS). The other half received a GluN2A NMDAR antagonist, NVP. The solution consisted of a concentration of 5  $\mu$ g/ml NVP per litre in PBS and was injected with the same protocol used during habituation.

#### Behavioural procedure

Behavioural testing took place in four conditioning chambers (Paul Frey). Rats first underwent a 1h habituation period over 2 days in one of the chamber during which no auditory stimuli were presented and no electrical shock administered. The first set of fear conditioning session took place 24h later in the same experimental chamber. Rats were given 30 minutes to habituate, subsequent to which the first CS (clicker sound 10 Hz, 80 dB, 60s) was triggered, immediately followed by a 0.5 mA, 0.5-second electrical foot shock (US) delivered through the ground grid. This combination of clicker CS-US pairing was repeated 3 times with an intertrial of 5 minutes between the last shock and the next CS.

A memory reactivation test was conducted 24h later, where rats were exposed to a 4 minutes context exposure followed by the CS. After another 24h period, the rats were divided into four groups. A group of 12 rats was infused the same saline solution tested on the training day whereas another group of 12 rats was infused the NVP solution. The same memory reactivation test was performed on half the subjects of each set (6 rats infused with saline and 6 infused with NVP). The other half was not tested sub-

sequent to the injection to be used as a control group. Data for the training and reactivation sessions was recorded via CCTV on a DVD for subsequent manual scoring of behaviour.

#### Data analysis

The behavioural data recorded was scored individually by three observers blind to treatment and results were compared to ensure reproducibility. Scores were attributed manually with 1 corresponding to freezing (inertia apart from breathing) and 0 corresponding to movement. The percentage of time freezing was computed for 1-minute pre-CS and during the CS at 5 seconds intervals. The results were compared with a baseline percentage of freezing for each rat prior to any fear conditioning pre-CS. Statistical analyses were performed with SPSS v.21 for Mac using a mixed-model ANOVA. Freezing over time (Pre CS, CS1, CS2 and CS3) was used as within subject factors with four repeated measures. Treatment (Vehicle or NVP) and retrieval groups (Ret or NoRet) were used as between-subject factors. Deviations from sphericity were identified with the Mauchly's sphericity test and corrected using Greenhouse-Geisser equation if  $< 0.75$  and Huyn-Feldt equation if  $> 0.75$  (Cardinal & Aitken, 2013).

#### Histology

Rats were sacrificed by carbon dioxide asphyxiation approximately 20 minutes after the last session, which is the expected duration for ERK activation (Merlo, 2014). Brains were rapidly frozen at -80  $^{\circ}$ C. Brain sectioning was performed at -17 degrees Celsius using cryostat at 150  $\mu$ m and 30  $\mu$ m samples were regularly taken through the BLA to be preserved in PFA and stained with violet cresyl. The position of the cannulae within the amygdala were observed and recorded on a rodent brain atlas (Paxinos & Franklin, 1997) for each rat during sectioning. The 30  $\mu$ m stained samples were used to verify the placement of cannulae in the amygdala using light microscopy. Amygdala tissues were extracted from the 150mm samples using a 0.99 mm diameter puncher and stored at -80 degrees Celsius for subsequent West-Protein extraction

Cytoplasmic protein extracts and nucleic protein extracts were obtained by individually homog-

enizing the BLA tissue from each animal in a glass-Weathon dounce with 100  $\mu$ l of buffer A (10 mM HEPES, pH 7.9, 1.5 mM MgCl<sub>2</sub>, 10 mM KCl, 1 mM DTT, 1  $\mu$ g/ml Pepstatin A, 10  $\mu$ g/ml leupeptin, 0.5 mM PMSF, and 10  $\mu$ g/ml aprotinin) centrifuged at 1000g for 15 min at 4°C. The protein extracts (supernatant) were subsequently stored at -80°C and resuspended twice with a 20 minutes interval in 25  $\mu$ l of buffer B (20 mM HEPES, pH 7.9, 1.5 mM MgCl<sub>2</sub>, 0.84 mM KCl, 0.5 mM DTT, 0.5g mM EDTA, 1  $\mu$ g/ml Pepstatin A, 10  $\mu$ g/ml leupeptin, 0.5 mM PMSF, and 10  $\mu$ g/ml aprotinin, 50% v/v Glycerol). The pellet was then centrifuged at 11,000g for 15 minutes at 4°C. The protein content was identified by Bradford assay. is the expected duration for ERK activation (Merlo, 2014). Brains were rapidly frozen at -80 °C. Brain sectioning was performed at -17 degrees Celsius using cryostat at 150  $\mu$ m and 30  $\mu$ m samples were regularly taken through the BLA to be preserved in PFA and stained with violet cresyl. The position of the cannulae within the amygdala were observed and recorded on a rodent brain atlas (Paxinos & Franklin, 1997) for each rat during sectioning. The 30  $\mu$ m stained samples were used to verify the placement of cannulae in the amygdala using light microscopy. Amygdala tissues were extracted from the 150mm samples using a 0.99 mm diameter puncher and stored at -80 degrees Celsius for subsequent Western-Blotting.

#### Western-Blotting

Cytoplasmic and nucleic protein samples were prepared with 2x Laemmli and Lysis buffers boiled for 5 minutes at 100°C. Cytoplasmic and nucleic proteins were separated using a 10% SDS-PAGE and transferred into nitrocellulose membranes using Transblot system set at 150V for 45 minutes. The transfers and well positions were verified with Ponceau Rouge. Membranes were blocked in 0.1% condensed milk Tris-Buffered-Saline (TBS), 0.1% Tween20 and subsequently rinsed 3 times with TBS to remove non-significant proteins. Blots were incubated overnight with Phospho-p44/42 MAPK (Erk1/2; Thr202/Tyr204; 1:500; Cell Signaling Technology) and mouse anti-actin (AC-15; 1:5000, AbCam); in blocking solution and rinsed 3 times with TBS-T.

Membrane surfaces were coated with chemiluminescent reagents (GE Healthcare) and placed in a cooled CCD camera (ChemiDoc-It, UVP). 8 Images were taken over 40 minutes using VisionWorks.

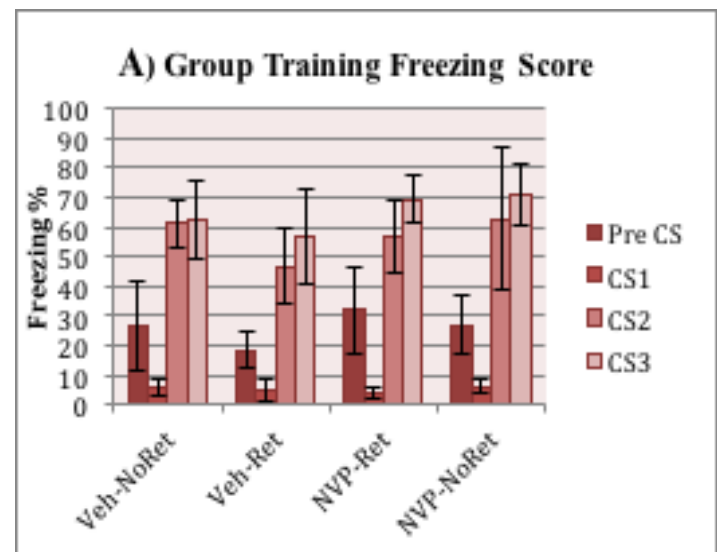
Captures were analysed and quantified with ImageJ software (version 1.48v, National Institutes of Health). Mouse pERK antibody working concentration was controlled to ensure a linear relationship between the protein content loaded in the blot and the intensity of signal revealed. The variations in protein load were controlled by using actin as a normalizing criterion for each sample.

Measures of the optical density of the bands were taken and optical density of the experimental group was calculated. Values were normalized to the mean optical density of the control group. Each sample was run in duplicate. Analysis of the four groups was performed with a one-way ANOVA using Dunnett's test for comparison with control group VehNoRet. Unpaired T-tests were used when a comparison between two groups was required.

### 3. Results

#### Behavioural data: GluN2A-NMDARs are not required for memory reactivation

All four groups of rats were conditioned by pairing a clicker sound (CS) with an aversive electric foot shock. As expected in Pavlovian fear conditioning paradigms, all rats showed a marked increase in the percentage of freezing after the first pairing with no significant variability between groups ( $F_{3,15} = 35.4$ ,  $p < 0.001$ ,  $\eta^2 = 0.87$ ). The following day, each rat was presented with one CS and all four groups showed strong fear memory retention (Fig.1), as demonstrated by a large increase in freezing time rate after hearing the auditory CS ( $F_{1,17} = 242.5$ ,  $p < 0.001$ ,  $\eta^2 = 0.93$ ).





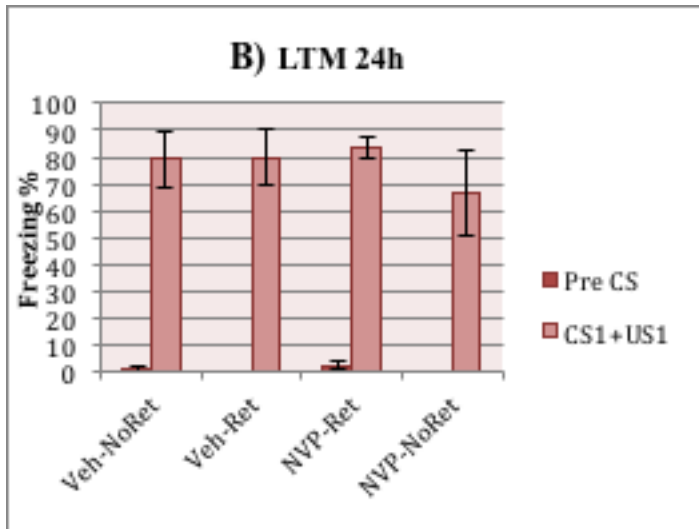


Figure 1. Pavlovian conditioning and reactivation session - Height of bar = mean, Error bar =  $\pm 1$  SEM

A) All groups show conditioned response to CS after first CS+US pairing with no significant variations. B) Conditioning is stable 24h after the training session, as demonstrated by a sharp increase in freezing rate after hearing the CS in the reactivation session.

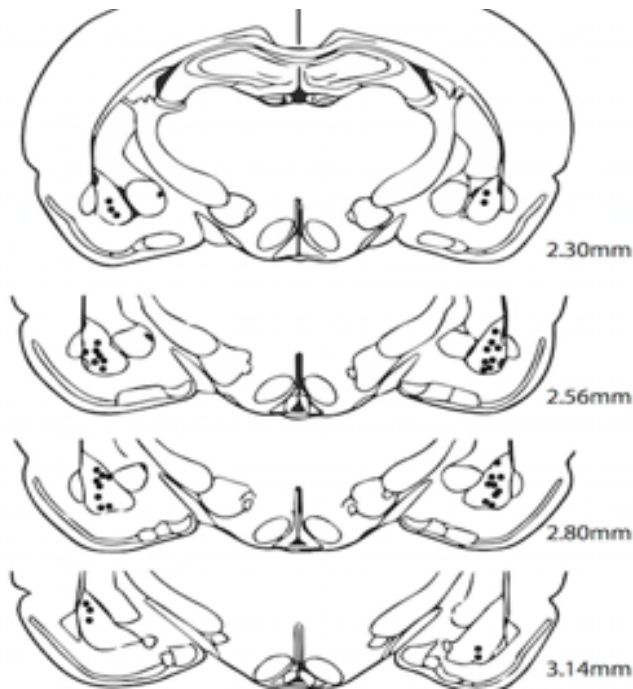


Figure 2. Cannulae placements. Cannulae placements were within the BLA for 21 rats. 3 rats were taken out of the sample due to misplaced cannula. This schematic representation of the brain adapted from Paxinos & Watson (2004) shows the sites for both Veh and NVP groups (black circles). Coordinates are given from bregma.

Half of the subjects were tested 24h later (Ret Group). A vehicle solution (n=5) or GluN2A-NMDAR antagonist NVP (n=6) were infused in the BLA of the tested group (Fig.2) prior to a further exposure to the CS. Freezing rates were measured Pre CS and post CS for each subgroup.

For both groups, fear conditioning remained stable with a sharp increase in freezing rate post CS ( $F_{1,9}=66.94, p<0.001, \eta^2=0.09$ ). Consistent with previous findings (Milton et al., 2013), infusion of NVP prior to the memory reactivation session did not significantly affect freezing response to CS in the treated group ( $F_{1,9}=3.38, p=0.099, \eta^2=0.273$ ).

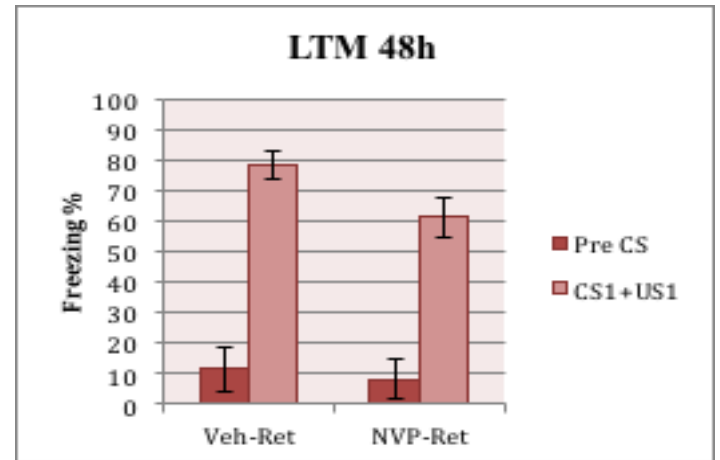


Figure 3. Freezing rate in reaction to CS does not decrease significantly after infusion of NVP vs. infusion of control vehicle solution.

Hence, NVP did not have an acute effect on reactivation of fear-conditioned memory during the test at 48h. These results suggest that GluN2A NMDARs are not required for reactivation.

#### Molecular data I: Blockade of GluN2A does not alter ERK signalling in the nucleus

Quantification of ERK activation in the nucleus with densitometry did not reveal significant statistical differences between the four groups,  $F_{3,14}=0.447, p=0.723$  (Fig.4). Most importantly, GluN2A blockade with NVP did not appear to significantly reduce nuclear ERK activation relative to the VehRet group post reactivation,  $t_8=2.06, p=0.073$ . These results suggest that NVP-blockade of GluN2A does not affect the activation of ERK in the nucleus.

The expression of ERK in the nucleus was lower for the Veh group in the retrieval condition than in the no-retrieval condition,  $t_8=-7.349, p<0.001$ ; con-

versely, ERK was slightly more activated in the nucleus of the NVP group in the retrieval condition than in the no-retrieval condition, although the difference was non-significant,  $t_6 = 0.507$ ,  $p = 0.630$ . Thus, a clear relationship between pERK in the nucleus and memory reactivation cannot be established. It is important to note that expression of ERK in the nucleus of the VehNoRet group was subject to a large variability (SEM = 40.17).

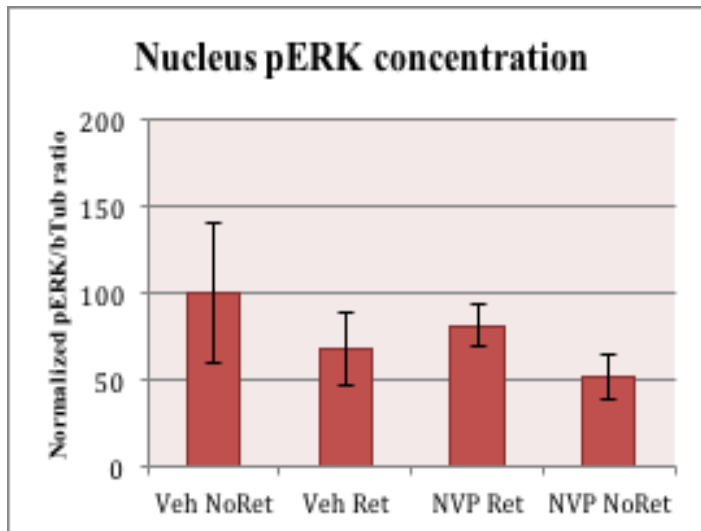


Figure 4. pERK concentration in the nucleus is not significantly decreased in the NVPRet group relative to the three control groups.

Molecular data II: GluN2A might play a role in mediating short-term adaptations of ERK signalling

Relative to the VehRet group, a reduction in ERK activation was observed in the cytoplasm of the NVPRet group post reactivation, although the difference was non-significant,  $t_8 = -0.380$ ,  $p = 0.714$ . No significant difference in ERK concentration was observed in the no-retrieval condition between the NVP group and the vehicle group,  $t_8 = 0.962$ ,  $p = 0.364$ . Nevertheless, the results suggest a trend whereby ERK activation is increased in VehRet relative to VehNoRet. Conversely, GluN2A blockade appears to reduce ERK activation in the NVPRet relative to the NVPNoRet control group (Fig.5). Together, these findings indicate that GluN2A NMDAs might play a key role in mediating short-term adaptations of ERK signalling. Testing on a larger sample is necessary to establish whether the differences are statistically significant.

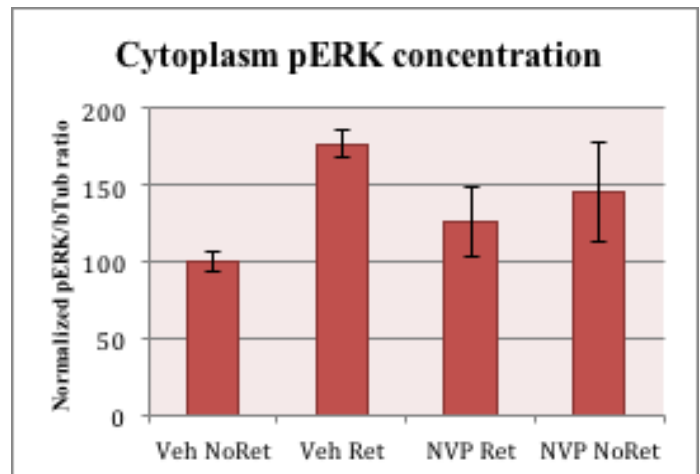


Figure 5. pERK appears reduced in the cytoplasm for the NVPRet group relative to the NVPNoRet group. Conversely, pERK appears increased in the VehRet group relative to the VehNoRet group. In addition, pERK is lower in the NVPRet group than in the VehRet group.

#### 4. Discussion

##### Role of GluN2A NMDARs in memory reactivation

The lack of a significant difference in freezing rates between NVP-treated and vehicle-treated animals during the reactivation session suggests that GluN2A NMDA receptors do not play a key role in regulating fear-conditioned behaviour. These results confirm previous reports reporting that GluN2A are required for restabilisation but not for destabilisation of fear memories (Milton et al., 2013). As our experiment sought to investigate the molecular mechanisms involved in restabilisation, rats were to be sacrificed 20 minutes post-reactivation to analyse subcellular ERK activation. The chosen timeline was based on a protocol designed by Merlo et al. (2014) to explore changes in pERK during the restabilisation phase. Nevertheless, it is important to note that the process of restabilisation could be initiated or reach a peak after a longer delay. Accordingly, it is possible that ERK activation would reveal different patterns if rats were sacrificed after 60 minutes (Merlo et al., 2014).

Although GluN2A NMDARs do not appear to mediate behavioural response to fear memory reactivation, GluN2B antagonists have been shown to significantly impact fear memories in rats (Milton et al., 2013). From this observation, it has been suggested that GluN2B NMDARs are required for destabilisation of fear memories. In consequence, our experiment de-



sign could be adapted using a GluN2B antagonist before reactivation to prevent anisomycin-induced amnesia. In this case, we would predict that freezing rate would be subsequently reduced post-reactivation in rats treated with the GluN2B antagonist. The molecular mechanisms involved could be investigated with Western-Blot.

#### Molecular aspects of the ERK signalling pathway in memory reactivation

Our experiment could not establish a link between memory reactivation and downstream nuclear ERK signalling. Although no significant differences were found in cytoplasmic ERK activation, a trend was observed whereby GluN2A blockade resulted in reduced ERK activation in the NVPRet group relative to the NVPNoRet group. Conversely, activation of ERK was increased in the VehRet group relative to the VehNoRet group. Considering the sample size, the possibility of this inversed relationship being significant cannot be excluded. Indeed, as suggested by our results, it is not unlikely that reduction in cytoplasmic ERK activation resulting from GluN2A blockade would be statistically significant in a larger sample.

Although translocation of ERK in the nucleus plays a key role in DNA transcription, ERK has been shown to regulate gene expression through indirect mechanisms involving cytoplasmic targets (MacDonald, 2004). For example, one target of ERK is the cytoplasmic MAPK-activated protein kinase 2 (MAPKAPK2). Evidence suggests that MAPKAPK2 may be involved in stabilising actin filaments during osmotic stress, which contribute to the regulation of both transcription and gene expression (MacDonald, 2004; Zheng et al., 2009). Similarly, ERK regulates transcription through phosphorylation of Ribosomal protein S6 Kinases (RSKs). RSKs appear to modulate nuclear Fos expression and CREB phosphorylation, both of which have been shown to accompany memory retrieval and are likely to play a key role in memory reconsolidation (Hall et al., 2001).

ERK also appears to phosphorylate multiple cytoplasmic substrates and to activate several other kinases. For instance, ERK seems to induce phosphorylation of ETS domain-containing protein Elk-1, which may be involved in relaying glutamatergic signals to the nucleus (Davis et al., 2000). In addition, ERK-induced Elk1 phosphorylation has been report-

ed to force Elk1 translocation to the nucleus, where it is likely involved with synaptic plasticity and learning (Besnard et al., 2011).

Furthermore, several cytoplasmic components are implicated in ERK negative feedback regulation, which allows signals to be terminated. One of the ways ERK suppresses signaling is by phosphorylating Son of Sevenless (SOS), which interferes with its binding to the Grb2 domain, hence inhibiting Ras activation of the ERK pathway (Lim et al., 2014). Additional negative feedback mechanisms also involve ERK-induced transcription of genes encoding Map Kinase Phosphatases (MKPs), which dephosphorylate the activation ERK of loop and attenuate the strength of signalling.

In summary, ERK activation in the cytoplasm might be responsible for indirect regulation of transcription factors. Furthermore, ERK might play a key role in modulating short-term adaptations of the MAPK-ERK signalling pathway using cytoplasmic negative feedback loops. Assuming that GluN2A blockade reduces ERK activation in the cytoplasm post-reactivation, our experiment suggests an important role of the MAPK-ERK signalling pathway in modulating the process of memory restabilisation.

#### 5. Methodological limitations Limitations

Western-blot is one of the most efficient methods to detect the relative concentration of specific proteins within a sample based on detection with antibodies of interest. Nevertheless, the extent of antibody binding to the specified protein has been shown to be sensitive to experimental errors resulting from complex, multistep manipulations. For example, this method requires that each sample contain the same amount of total protein. While it seems relatively difficult to control the exact protein content of a sample, we have taken this constraint into account by adjusting the dilution factor of our Laemmli and Lysis buffers relative to the protein concentration of each sample.

Second, the comparison of samples based on the protein of interest/loading control ratio is not unproblematic. This process of normalization assumes that loading control proteins are stable under most circumstances. However, it appears that levels of protein can differ between groups depending on the

experimental manipulation (Aldridge et al., 2008). Specifically,  $\beta$ -actin expression has been shown to increase significantly after spinal cord injury (Liu & Xu, 2006). Although the stability of  $\beta$ -actin has not been specifically tested in the context of brain injury, it is important to note that the insertion of the cannula in the lateral amygdala could induce a change in  $\beta$ -actin concentration, making it an unsuitable candidate for normalization. In our experiment, all rats underwent surgery. Accordingly, any increase in  $\beta$ -actin concentration resulting from injury would likely be consistent across our samples. In consequence, comparison between samples would not be significantly impacted by a trauma-induced change in  $\beta$ -actin concentration.

Variability in quantifying proteins of interest with Western-Blot is widely acknowledged. Experimental manipulations, human errors, choices of dilution, incubation time, normalization, types of antibody or concentration of loading control all have an influence on the final quantification. Another important aspect to keep in mind is that labelled enzymes used for chemiluminescence tend to diverge slightly from linearity in terms of signal to noise ratio (LICOR, 2015). Hence, Western-Blot is considered as a semi-quantitative method.

#### Addressing Western-Blot limitations

A first step to increase reliability of Western-Blot results is to control for differences in protein loading using either bicinchoninic acid assay (BCA) or Bradford assay and to discard outliers, as performed here. Statistical difference between loading control and within samples should be compared using a standard curve to adjust dilution. Second, samples should be positioned randomly on the gel and gels should be run in duplicate or triplicate to test for differences in loading. This step ensures that optical density values are correlated with protein content for the chosen concentration. These two processes were strictly respected in our experiment.

In lieu of  $\beta$ -actin, Dittmer & Dittmer (2006) have suggested the use of GAPDH as a loading control. Changes in band densities appear visible at lower protein concentration for GAPDH. In the case of low-abundance proteins such as ERK, it could be beneficial to compare the duplicated results obtained with  $\beta$ -actin with a second set of testing with GAPDH to reduce random noise in the data.

At last, both positive and negative controls can improve reliability of the data. A positive result in reaction to a lysate from a tissue sample known to express ERK would indicate that the procedure is valid even if the samples test came back negative. Similarly, a negative control using a null cell line could be used to confirm that protein binding is specific to the protein target (Mahmood & Yang, 2012). These processes are particularly important when Western-Blot is used in the context of clinical virology but also bear implications for scientific research.

#### Alternatives

Western-Blot is particularly adapted to the detection of target proteins in tissue samples, primarily because of its high specificity and sensitivity. As discussed however, the Western-Blot process is delicate and susceptible to large variability depending on dosage, dilution, concentration and choice of loading control. Other protein-detection techniques present different sets of constraints and advantages.

Fluorescent multiplex Western-Blot uses fluorophores for labelling during immunodetection. Proteins of interest can be quantified by measuring the photons emitted by the fluorophore in response to excitation by a light source. The use of fluorophores reduces variability in quantification by improving the linear dynamic range up to a 10 fold compared to chemiluminescence (McDonald, 2010). Moreover, the use of different photo-stable dyes allows the quantification of multiple proteins in a single experiment, which is particularly useful when looking at signalling interactions or when investigating the role of several receptor types.

Enzyme-linked immune assays (ELISA) use an enzyme to convert a neutral substrate to a coloured product in the presence of antigen-antibody binding. Unlike electrophoresis, which separates the protein of interest based on molecular weight, ELISA use absorbance detection and nucleic acid quantification. Thus, depending on the protein studied, ELISA may be more sensitive to false positive than Western-Blot. Nevertheless, the quantification process appears less versatile than for Western-Blot. The numerical data computed by the ELISA kinetic plate reader is less subjected to variability than the data obtained via Western-Blot image processing software (Jansen et al., 1998).

Of particular interest is the increasing use of flow cytometry in cell signalling profiling. This laser technique measures intact cells or particles based on their light-scattering abilities and fluorescence channels (Krutzik & Nolan, 2003). Light signals are converted into electronic pulses, which are automatically quantified. Flow cytometry presents several advantages over Western-Blot and ELISA. First, it is particularly accurate to quantify kinase activation in contexts where cell numbers are low or sample is limited (Grammer et al., 2004). Second, it is a multivariable method that allows the analysis of several antigens at the cell level. This point bears implications for studies seeking to investigate the role of interactions between multiple signalling pathways or looking at pharmacodynamic modulation. For example, flow cytometry has been used to simultaneously identify the molecular targets of two MEK inhibitors and to demonstrate their effects on pERK activation with great precision (Chow et al., 2001).

#### Future research

Our findings identify key directions for future research. An analysis of ERK activation in retrieval-condition could be performed after blockade of other subunits of the NMDARs or of other receptors in the basal lateral amygdala. For example, AMPA receptors in both the amygdala and the hippocampus have been shown to play an important role in memory reactivation (Bast et al., 2005; Milton et al., 2013).

Future research in memory retrieval could also take advantage of methodological advances in flow cytometry to study not only the effect of a specific signalling pathway but also the simultaneous activation of several kinases downstream of a receptor subunit, thus providing information on the effects of interacting signalling pathways during reactivation. Other research focusing on memory retrieval have suggested the implication of noradrenaline and calcineurin (Abel & Lattal, 2001; Murchison et al., 2004). The extent to which these various signalling pathways interact with one another during reactivation should provide insights into their specific roles and mechanisms. Specifically, it is hoped that the interaction of kinases involved in regulation of gene transcription during memory retrieval will be identified.

#### 6. Conclusion

To conclude, our experiment could not establish the role of GluN2A NMDARs on ERK activation in the nucleus following reactivation. Instead, we observed a trend whereby ERK was reduced in the cytoplasm of the NVPRet group relative to the VehRet group in the retrieval condition; and conversely, ERK was more concentrated in the NVPNoRet group than in the VehNoRet group in the no-retrieval condition. In addition, NVP-treatment had no noticeable effect on fear-conditioned behaviour in comparison to the control group.

Together, these results suggest that memory reactivation is unlikely to be primarily modulated by GluN2A NMDARs. Nevertheless, the reversed patterns observed in the cytoplasm in the retrieval and no-retrieval conditions indicate that GluN2A NMDARs may play a role in modulating short-term adaptations of the signalling pathway during reactivation. The advantages and limitations of Western-Blot and alternative techniques are discussed in consideration of future research opportunities.

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# Do You Know What I See? Visual Perspective Taking in Nonhuman Animals

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**ABSTRACT.** Visual perspective taking is not only an essential skill for effective visual communication (Emery, 2000), but also an indicator of the presence of social cognition and theory of mind in nonhuman animals (Heyes, 1998). In this paper, we review some of the prominent experimental paradigms and research findings on visual perspective taking in various nonhuman species, such as the begging task, the guesser-knower task, and competitive paradigms. However, in spite of the plethora of research that has been done, it still remains inconclusive as to whether or not nonhuman animals are capable of visual perspective taking due to the varied and contradictory findings of past studies. Several possible explanations exist for these discrepancies, which include varying definitions of the term “perspective taking,” the lack of attention given to species-specific ecological validity, confounding variables such as associative learning and visual-spatial skills, differences in the experimental set-up and release time in competitive paradigms, and the lack of close replications. It is suggested that future research should aim to overcome the challenges of this area of study so as to be able to develop an empirically sound understanding of visual perspective taking in nonhuman animals.

The social intelligence hypothesis (Kummer, Daston, Gigerenzer, & Silk, 1997) or the Machiavellian intelligence hypothesis (Byrne & Whiten, 1988) proposes that due to the social competition for resources and mates, evolution has favoured individuals who were able to successfully predict and manipulate the behaviour of others. One mental operation that is suggested to have evolved out of this social competition is the ability to understand the perspectives and psychological states of others (MacLean & Hare, 2012). Interestingly, the social intelligence hypothesis is not unique to humans, as it is proposed that social intelligence can be expected to have evolved in any species that display the following criteria: large brain relative to body size, the presence of large and long-lasting social groups, and a long life span (Tomonaga, Uwano, Ogura, & Saito, 2010). A number of animal species meet these criteria, such as certain primates, corvids, bats, elephants, hyenas, and cetaceans (Tomonaga et al., 2010). This then poses the question: are nonhuman animals capable of understanding the mental states of others?

Theory of mind refers to “the capacity to make lawful inferences about the behaviour of other agents on the basis of abstract, theory-like representations of the causal relation between unobservable mental states and observable states of affairs” (Penn & Povinelli, 2007, p. 732). However, because theory of mind is a phenomenon that cannot be directly perceived, but rather, must be inferred from behaviour (Povinelli, Dunphy-Lelii, Reaux, & Mazza, 2002), a major challenge to its study is identifying behaviours that provide sufficient evidence for the existence of such higher order cognitions. Heyes (1998) proposes that among the most promising approaches to the study of theory of mind and social cognition among animals are perspective-taking tasks.

Visual perspective taking is defined as “the ability to appreciate what others can and cannot see” (Held, Mendl, Devereux, & Byrne, 2001, p. 1338). Researchers in the field of comparative psychology have long been interested in understanding visual perspective taking among nonhuman animals, as being able to perceive the attentive state of another is an essential skill for effective visual communication (Emery, 2000). This is because successful transmission of a

signal is not only dependent on the sender's ability to produce the signal, but also on the recipient's ability to perceive the signal (Emery, 2000). This is particularly critical for visual communication, whereby the receiver must not only be in close proximity, but must also be oriented toward, and attentive to, the sender (Gacsi, Miklosi, Varga, Topal, & Csanyi, 2004). As such, determining whether nonhuman animals are capable of visual perspective taking, and understanding the various cues that they use to infer the perspective and attentive state of another would shed light on how these species are able to successfully communicate in the wild. However, beyond its functional importance, visual perspective taking also bears inferential significance, as the ability to take on the visual perspective of others is said to be one of the most promising indicators of the presence of social cognition and theory of mind in nonhuman animals (see Heyes, 1998). Thus, given that visual perspective taking could potentially unveil the answer to the pivotal question of the existence of theory of mind in nonhuman species, it is no wonder then that researchers have consistently been striving to develop experimental methodologies that are capable of adequately testing for visual perspective taking in nonhuman animals.

While much is already known about the development of visual perspective taking in humans, concrete evidence of such ability in nonhuman species still remains elusive despite extensive research (Heyes, 1998). In a review of experimental methodology for primate social cognition, Hare (2001) highlights that arguably the biggest challenge of studying perspective taking among nonhuman species is that animals are nonverbal. In human developmental psychology, the study of perspective taking has relied almost exclusively on participants' ability to verbally communicate what he or she knows, such as in the classic "false-belief" task that is commonly used among children (Hare, 2001). In contrast, researchers of nonverbal animals must rely on behavioural measures through which perspective taking abilities can be convincingly inferred (Hare, 2001). As such, there is often no way to be certain that the behaviours demonstrated are the result of the ability to understand what others can and cannot see, and thus, the findings of such studies are often subject to many alternative explanations. In light of this, researchers have sought to develop various experimental par-

adigms, all with the common goal of attempting to better understand visual perspective taking among nonhuman animals.

One of the oldest approaches to studying visual perspective taking among animals is the guesser-knower task that was first introduced by Premack in 1988. In this task, the subject watches as an experimenter places a piece of food into one of two containers that are located behind an opaque screen such that the subject is unable to see directly which of the containers is being baited. The subject also has visual access to two trainers – one trainer ('knower') can see which container is being baited, but the other ('guesser') cannot because the screen is blocking its view. Once the container is baited, the subject is then allowed to ask one of the two trainers for 'advice' on which container has the food, and the trainer responds by pointing to one of the two containers, after which the subject chooses between the two containers. The critical test in this task is whether or not the subject would be able to discriminate which of the two trainers had witnessed the baiting and therefore knew where the food was. In Premack's (1988) original study, four chimpanzees were tested; two consistently chose the informed trainer ('knower'), while the other two did not have a clear preference for either trainer. Despite the small sample size and the inconclusive findings, Premack's (1988) study was nonetheless a momentous one, as the basic approach to the guesser-knower task has continued to be used in the study of visual perspective taking of many other species (see Cooper et al., 2003; Povinelli & Eddy, 1996; Povinelli, Nelson, & Boysen, 1990).

However, in spite of its widespread use, the guesser-knower task is not without its criticisms. Among the major limitations to this approach is that success on the task can be attributed to more parsimonious explanations of associative learning, and thus, may not be an adequate test of higher order cognition (Held et al., 2001). In addition, the use of human trainers also poses further threat to the validity of this task. Firstly, by using humans instead of conspecifics, experimenters are expecting subjects to be able to interpret the behaviours of another species (Held et al., 2001) – this is not only irrelevant to successful visual perspective taking among conspecifics, but may also be a tall order. Second, because both trainers know their roles as either the 'guesser' or the

'knower,' it is hard to ascertain that they are not unconsciously providing cues to the subject as to which of them is the 'correct' choice.

Seeking to refine the guesser-knower task and examine visual perspective taking among a less-studied species, Held et al. (2001) conducted a study using domestic pigs. In this study, ten pigs were trained to move from a starting point into one of four corridors that they had previously seen a human enter while carrying a bucket containing food. During these training sessions, subjects received food rewards for choosing the right corridor. In subsequent transfer tests, the subject being tested could not see the corridors, but could see two conspecifics in individual start boxes on its left and right – one had visual access to the corridors and the baiting, while the other did not. The two companion pigs were released and the subject was observed to see which of the two companions it followed. Subjects were not rewarded for their performance on the transfer tests, to minimize the possibility of associative learning (Held et al., 2001). Furthermore, because the conspecifics did not know which was the correct answer for the test subject, it is unlikely that either the 'guesser' or the 'knower' could have provided cues to the subject (Held et al., 2001). The results revealed that out of nine subjects (one subject was removed from statistical analysis), eight of the subjects followed the 'knower' at a frequency that was below chance level – a finding that Held et al. (2001) attributed to specific corridor preferences. Only one pig showed a significant preference for the 'knower,' in line with behaviour that is expected of one who is able to take on the visual perspective of another (Held et al., 2001).

However, Maginnity and Grace (2014) highlight that in tasks that require subjects to rely on human cues, species such as chimpanzees and pigs may be at an inherent disadvantage, simply by virtue of their lack of social interactions with humans. In contrast, domestic dogs would be the perfect species for such a procedure, as they have extensive socialization with humans and are sensitive to many human cues (Maginnity & Grace, 2014). Thus, in a series of well-controlled experiments based on the guesser-knower task, Maginnity and Grace (2014) tested domestic dogs on whether they would be able to discriminate between a human trainer who saw the container being baited and one who could not because

the trainer was absent during the baiting (Experiment 1), covered her eyes during the baiting (Experiment 2) or gazed away from the container during the baiting (Experiment 3). In all conditions, the dogs showed a significant preference for the container that was pointed to by the 'knower,' thus suggesting that dogs are sensitive to cues that are indicative of human attentional states (Maginnity & Grace, 2014). Therefore, Maginnity and Grace (2014) emphasize that the failure of other species on the guesser-knower task in past research may not be due to their inferior cognitive abilities, but rather, the lack of ecological validity of the methods employed to test for them.

Comparable findings have also been obtained in studies that have used a similar approach – the begging task. Yet another classic approach to studying visual perspective taking, the begging task, was originally developed by Povinelli and Eddy (1996) in their study of chimpanzees. In this task, subjects are required to beg for food from one of two human trainers – one whose vision is obscured (e.g., by wearing a blindfold or having a bucket over the head) and one who is able to see (Povinelli & Eddy, 1996). The rationale behind this task is that if subjects were able to understand the visual perspective of others, they would beg preferentially from the trainer who could see their begging actions and therefore respond by providing food, as opposed to the trainer whose vision is obscured (Povinelli & Eddy, 1996). While studies involving chimpanzees have failed to convincingly demonstrate their ability to engage in visual perspective taking (Povinelli & Eddy, 1996), studies on dogs appear to yield much more promising results in that dogs preferred to beg for food from the human who could see (Cooper et al., 2003; Gacsi et al., 2004; Udell, Dorey, & Wynne, 2011). However, interestingly, their behaviour changed depending on the way in which the person's vision was obscured – for example, they were more likely to ignore a person who was reading a book than a person who had a bucket over his or her head (Cooper et al., 2003). Given the fact that the dogs' behaviour varied simply as a function of the object that was used, Udell et al. (2011) highlight a critical question – do dogs succeed on this perspective-taking task because they possess theory of mind, or is their success simply a demonstration of associative learning from prior experience with humans?

Several researchers have argued that dogs do



not acquire these skills due to prior experience, but rather, as a species as a whole, dogs have evolved “human-like social skills” during the course of domestication (Hare & Tomasello, 2005). If such an argument is true, then domesticated dogs should outperform undomesticated canids on this perspective-taking task, regardless of the age or prior experiences of the dog being tested (Udell et al., 2011). However, if such a genetic predisposition is not necessary, then both domesticated dogs and undomesticated canids should be able to learn to beg preferentially from humans who can see based on prior experiences of receiving rewards from attentive humans (Udell et al., 2011). Therefore, Udell et al. (2011) devised a study to examine whether hand-raised wolves (who had been reared by humans since infancy and had regular contact with humans), pet dogs (who also had regular interactions with humans) and shelter dogs (who had minimal interactions with humans) would perform differently on the perspective-taking begging task.

The results of their study revealed that similar to domesticated dogs, wolves were also capable of succeeding on the begging task, demonstrating the ability to behave in accordance with a human’s attentional state (Udell et al., 2011). In addition, it was also shown that in the initial stages, the shelter dogs were not as sensitive to the attentional states of humans as compared to pet dogs, though this behaviour improved with subsequent trials (Udell et al., 2011). Udell et al. (2011) then suggest that these findings demonstrate that dogs’ success on perspective-taking tasks cannot be attributed to domestication alone, and neither can they be taken to imply the possession of higher order social cognition; rather, they assert that “Dogs’ ability to follow human actions stems from a willingness to accept humans as social companions, acquired early in ontogeny, combined with conditioning to follow the limbs and actions of humans to acquire reinforcement” (Udell et al., 2010, p. 328). The findings of Udell et al. (2011) demonstrate a significant point in the research of social cognition among animals; that is, it is overly simplistic to merely ask whether or not a species displays behaviours that support the presence of social cognition, but rather, it is important to take into consideration the specific conditions under which these behaviours are demonstrated. By doing so, research would be able to shed light on the possible origins of these behaviours, and

thus provide clearer insight as to whether such behaviours are truly evidence of higher order social cognition, or simply the product of associative learning.

If tasks that rely on interactions with humans have high ecological validity for dogs, what then would be a suitable research paradigm for other species? Hare (2001) suggests that for chimpanzees, the answer may lie in their competitive nature. In contrast to dogs whose selective pressures have encouraged cooperation with humans, chimpanzees’ lives revolve heavily around intense competition with conspecifics for resources (Hare, 2001). Therefore, it can be expected that chimpanzees’ social cognitive abilities were evolved out of the need to out-compete their conspecifics; thus, such abilities would most likely be displayed in a competitive situation (Hare, 2001).

Among the studies that have made use of chimpanzees’ natural tendency to compete is an experiment by Hare, Call, Agnetta, and Tomasello (2000). In a nutshell, the experiment involved a dominant and a subordinate chimpanzee that were competing for food. The subordinate could always see where the food was being hidden, while the dominant chimpanzee could see the food being hidden in one condition, and in another condition, could not (Hare et al., 2000). The results revealed that when the dominant chimpanzee could not see the food being hidden, the subordinate went for the food; however, when the dominant chimpanzee had seen the food being hidden, the subordinate refrained and stayed back (Hare et al., 2000). The findings indicate that the subordinate chimpanzee had an understanding of what the dominant chimpanzee could and could not see – thus, the subordinate knew that, when the dominant chimpanzee could not see the food being hidden, it did not know where the food was, and it would be safe for the subordinate to go for the food (Hare et al., 2000). However, if the dominant chimpanzee had seen the food being hidden and therefore knew where the food was, the subordinate would have to compete with the dominant for the food, and as a result, chose to stay away (Hare et al., 2000).

Further research by Brauer, Call, and Tomasello (2007) aimed to examine the specific factors that would influence chimpanzees’ behaviour in competitive situations, and it was found that it was not merely the presence of competition, but the intensity of the competition that was a crucial factor. Brauer

et al. (2007) conducted an experiment that was similar to that of Hare et al.'s (2000), but surprisingly, the subordinate chimpanzees in their study showed no preference for the food that was hidden from the dominant's view. Instead, the subordinate was able to successfully obtain the food regardless of whether or not it could be seen by the dominant chimpanzee (Brauer et al., 2007). This contradicting result led Brauer et al. (2007) to hypothesize that the spatial arrangement of the experimental set up had reduced the competitiveness of the situation in comparison to that of Hare et al. (2000). This was due to the fact that in the present study, the food was placed in closer proximity to the subordinate chimpanzee (Brauer et al., 2007). Thus, knowing that it had an advantage over the dominant chimpanzee, the subordinate tried to obtain as much food as possible (Brauer et al., 2007). To test this hypothesis, Brauer et al. (2007) conducted a second experiment in which the food was now placed in closer proximity to the dominant chimpanzee. As hypothesized, the subordinate showed a clear preference for the food that was out of sight of the dominant, thus providing further support for the conjecture that chimpanzees are capable of demonstrating visual perspective taking in competitive situations (Brauer et al., 2007).

However, in line with the notion that the intensity of the competition is an important factor in influencing the subordinate's behaviour, it is crucial to note that the procedures of Hare et al. (2000) and Brauer et al. (2007) differed in terms of the amount of time between the release of the dominant and subordinate chimpanzees. In Hare et al.'s (2000) study, both the dominant and subordinate chimpanzees were released into the room at the same time, while Brauer et al. (2007) only released the dominant chimpanzee once the subordinate had entered the room. This difference in release time would likely have made the situation in Brauer et al.'s (2007) experiment less competitive than that of Hare et al. (2000), thus making it difficult to compare and interpret the results across studies.

Beyond chimpanzees, competitive paradigms have also been found to be useful in the study of other competitive species, such as goats (Kaminski, Call, & Tomasello, 2006) and long-tailed macaques (Overduin-de Vries, Spruijt, & Sterck, 2014). Using an experimental paradigm similar to that of Hare et al. (2000),

Kaminski et al. (2006) examined the visual perspective taking abilities of domestic goats. However, given that goats in the wild live in complex social groups and have been known not only to compete with one another but also to form alliances and hierarchies, Kaminski et al. (2006) additionally took into account the relationship between the specific two subjects being tested. The results revealed that the subordinate's behaviour relied heavily on whether or not it received demonstrations of aggression from the dominant goat (Kaminski et al., 2006). Subordinates who were treated aggressively showed a significant preference for the hidden food, while those who did not receive aggression preferred the visible food (Kaminski et al., 2006). As a result, subordinates who did not receive aggression ended up obtaining more food – they first obtained the visible piece of food, followed by the hidden piece of food (Kaminski et al., 2006). Although this behaviour may seem to contradict the findings of Hare et al. (2000) and Brauer et al. (2007), Kaminski et al. (2006) suggest that these findings do in fact provide support for goats' ability to engage in visual perspective taking – the reason being that the subordinate knew what the dominant could and could not see, and thus, knew that the visible food was at greater risk of being taken by the dominant in comparison to the hidden piece (Kaminski et al., 2006). Therefore, in order to secure the maximum amount of food, the subordinate went for the visible piece first (Kaminski et al., 2006). However, when the dominant goat posed a threat to the subordinate by behaving aggressively, the subordinate preferred the hidden piece so as not to have to compete with the dominant.

It is important to note that in contrast to Hare et al. (2000) and Brauer et al. (2007), the dominant goat in Kaminski et al.'s (2006) study was only released once the subordinate had chosen between the two pieces of food. Thus, because the subordinate was likely to have been able to reach the visible piece of food before the dominant, subordinates who did not receive aggression significantly preferred to go for the visible piece of food first. Similar results were obtained by Overduin-de Vries et al. (2014) in their study of long-tailed macaques, as it was found that subjects who were faster significantly preferred to go for the visible piece of food first, followed by the hidden piece of food, thereby securing both pieces; however, those who were slower showed a preference for

the hidden food. Taken together, these findings suggest that in more naturalistic competitive situations, animals such as chimpanzees, goats and long-tailed macaques are capable of understanding what others can and cannot see, and use this information to their advantage.

Much research has been done to examine visual perspective taking among primates and dogs, but what about humans' more evolutionarily distant relatives? In contrast to chimpanzees, dolphins are phylogenetically distant from humans, with the closest common ancestor of humans and cetaceans living over 65 million years ago (Browne, 2004). However, dolphins have large brains relative to their body size, with certain species such as the bottlenose dolphin having much larger brains than chimpanzees, and coming in second only to humans in terms of brain size (Browne, 2004), thus making them possible candidates of social intelligence (Tomonaga et al., 2010).

Few studies on perspective taking have been done among cetaceans, one of which is a study by Tomonaga et al. (2010), which aimed to examine whether bottlenose dolphins were sensitive to their trainers' attentional states. This study involved four male bottlenose dolphins that lived in captivity and were well trained to follow their trainers' hand gestures. They were then tested to determine whether they would respond to their trainer's hand signals if their trainer was in a position that implied inattentiveness, such as facing their back toward the dolphin or having a bucket placed over his or her head. The results of the study revealed that overall, the dolphins did not respond any differently to the different attentional states demonstrated by their trainer, and continued to obey the hand signals for positive reinforcement. However, because these dolphins were raised in captivity and were well trained to obey these hand signals, the interpretation of these findings remains uncertain (Tomonaga et al., 2010). Although it is possible that the dolphins' lack of attention to their trainers' attentional states implies the inability to engage in visual perspective taking, it is highly likely that their continued obedience to the trainers' hand signals were the result of having been extensively trained to obey the human trainer. Thus, further research is necessary to examine whether these behaviours still hold true in situations that allow for more spontaneous reactions (Tomonaga et al., 2010).

More recently, interest has also been directed toward other non-primate species, one of which is the African elephant. African elephants live in a complex network, and as such, communication is essential in their everyday interactions (Smet & Byrne, 2014). Although elephants do not use visual signals as their primary means of communication, research has shown that elephants do respond to subtle visual signals (Smet & Byrne, 2013) and are capable of producing communicative gestures as well (Poole & Granli, 2009). To better understand African elephants' ability to infer the attentional states of others, Smet & Byrne (2014) conducted a study with 10 captive African elephants. In this experiment, the elephants were first exposed to an experimenter who would call the elephant's name, place a piece of fruit on a tray, and then move the tray toward the elephant's reach for it to obtain the fruit (Smet & Byrne, 2014). After three days of these 'no-delay' trials, the elephants were then tested with 'delay' trials whereby, after placing the fruit onto the tray, the experimenter pretended to forget to move the tray toward the elephant – leaving it out of reach of the subject (Smet & Byrne, 2014). During this delay, the experimenter adopted one of several facial and body orientations that implied either attention or inattention (Smet & Byrne, 2014). It was observed that the elephants made significantly more experimenter-directed gestures when the experimenter's face and body were directed toward them as compared to when the experimenter was facing away (Smet & Byrne, 2014). In addition, these gestures were produced significantly more frequently when the experimenter was present versus absent, thus demonstrating that these behaviours were not random, but were dependent on the presence of an experimenter who could perceive them (Smet & Byrne, 2014).

In spite of the plethora of research that has been done on visual perspective taking, it still remains inconclusive as to whether or not animals are capable of visual perspective taking, due to the varied and contradictory findings of past studies. Several possible explanations exist for these discrepancies, one of which is that the interpretation of research findings varies in accordance with the definition of the term "perspective taking" and the context in which it is used. For example, Held et al. (2001) refers to perspective taking as "the ability to appreciate what an-

other can and cannot see" (p. 1338), while Hare (2001) defines perspective taking as the ability "to consider and react to another's perceptions, desires and beliefs as opposed to just their behaviour" (p. 272). Note that while Held et al. (2001) refers solely to visual perspective taking, Hare's (2001) definition refers to a much broader context that involves the understanding of another's cognitions. In light of this difference, the conclusion of whether animals are capable of engaging in perspective taking would undoubtedly be dependent on the definition of the term "perspective taking" that one is referring to.

Besides that, although there has been an increased focus on ensuring internal validity of experimental methodology, limited attention has been paid to species-specific ecological validity (Hare, 2001). Considering the incredible diversity of animals, it would be overly simplistic to assume that all non-human species would respond in a similar manner. As such, low ecological validity makes it difficult not only to test for visual perspective taking, but also to generalize the findings to a real world setting (Hare, 2001). This could possibly explain why certain species may appear to demonstrate visual perspective taking abilities when tested on one task, but not on another. Therefore, it is important for researchers to understand the unique niche of different species and to take advantage of these differences in their study of visual perspective taking. As evidenced by dogs' success on tasks that involve interaction with humans (Cooper et al., 2003; Gacsi et al., 2004; Maginnity & Grace, 2014; Udell, et al., 2011) and chimpanzees' success on competitive tasks (Brauer et al., 2007; Hare et al., 2000), ensuring the ecological validity of experimental paradigms would likely help to unravel the seemingly varied and contradictory findings of past research.

In addition, a nonverbal paradigm also makes it difficult to account for other confounding variables that could potentially influence subjects' behaviour on the task. This prevents researchers from being able to convincingly rule out alternative explanations and conclude with certainty that a subject's success on an experimental task is indeed due to the ability to engage in visual perspective taking. Arguably one of the biggest confounding variables is the possibility of associative learning, which is a major challenge to designing an effective experiment on visual perspec-

tive taking. Because subjects are often obtained from zoos, research centers or from volunteer pet owners, the life histories of the subjects are rarely known to the researchers, thereby making it difficult to account or control for prior learning or experiences in their own home environments (Elgier, Jakovcevic, Mustaca, & Bentosel, 2012). This is of significant consideration, as novel behaviour is a key factor in providing support for the use of higher order cognition that goes beyond simple associative learning (Elgier et al., 2012).

To illustrate, dogs have been found to be successful on the begging task, whereby they beg preferentially from the attentive human rather than the inattentive human. However, such behaviour could possibly be due to associative learning from experiences with their owner – for example, at a dinner table, pet dogs are more likely to receive food from a person who can see the dog begging, which then causes them to form an association between begging from an attentive person and receiving food (Udell & Wynne, 2008). In contrast, the life experiences of shelter dogs are strikingly different, as they are often ignored by workers and visitors (Horowitz, 2011). As a result, shelter dogs may come to learn that the attentional state of a human is of no significance to them (Horowitz, 2011), subsequently leading to poor performance on the begging task. Unfortunately, past experiences of the subjects may very well be an inherent and unavoidable confound, as Held et al. (2001) highlight that "any possible design that would discount these possibilities [of prior learning] would also stack the odds heavily against the development of mental state attribution even if subjects had the potential. Test animals would have to be kept in social isolation, to be able to categorically rule out pre-experimental learning of the relationship between seeing and subsequent behaviours in others, without understanding what the seer knows" (p. 1351).

Besides prior learning, animals' performance on perspective taking tasks could also be confounded by other cognitive abilities, such as visual-spatial skills. In their study of chimpanzees' understanding of their own visual experiences, Krachun and Call (2009) found that chimpanzees were able to successfully maneuver themselves around occluded objects in order to see them. In contrast to studies involving another individual, there were no gaze or behavioural



cues that the chimpanzees could have relied on (Krachun & Call, 2009). This success demonstrates that chimpanzees have an understanding of the spatial relations between themselves and objects in their environment, suggesting that they are capable of knowing what can be seen from different angles and positions (Krachun & Call, 2009). Although it still remains unclear as to whether chimpanzees employ a comparable strategy when deducing the visual perspective of others, this then raises the question of whether visual-spatial skills are confounding, or even necessary, factors for successful visual perspective taking. Could animals' poor performance on visual perspective taking tasks be attributed to inferior mental rotation, as opposed to the inability to understand the mental states of others? Such questions provide further avenues for future research.

Finally, the diverse findings of various studies could also be the result of differences in the methodology employed by different researchers. As demonstrated by Brauer et al. (2007), even slight changes in the set up of the experimental room led them to obtain strikingly different results from Hare et al. (2000), the very researchers from whom they adopted the competitive paradigm. Further research revealed that the change in the spatial arrangement of the room had altered the competitiveness of the situation, which in turn, affected the behaviour of the subjects (Brauer et al., 2007). If even minor differences in methodology could result in contradicting findings between studies that employed the same experimental paradigm, it should come as no surprise then that studies using different research paradigms have yielded such a wide array of results. This highlights the importance of taking such differences into consideration when comparing findings across studies, as well as the significance of conducting close replications in the quest to better understand visual perspective taking among nonhuman animals.

In conclusion, the social intelligence hypothesis (Kummer et al., 1997) posits that visual perspective taking can be expected to have evolved in all animal species that possess a large brain, long-lasting social groups, and a long life span – suggesting that animals such as chimpanzees, dolphins, dogs, and elephants have the capacity to understand and appreciate the perspectives of others (Tomonaga et al., 2010). However, despite the abundance of research that has

been carried out to examine the visual perspective taking abilities of nonhuman animals, the inconsistent methodologies as well as the varied and contradictory findings of past research render them inconclusive. Thus, future research should aim to overcome the challenges of this area of study so as to be able to develop an empirically sound understanding of visual perspective taking in nonhuman animals. that surrounds the issue.

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# Depression Diagnosis and Treatment: Reformation Required

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**ABSTRACT.** By the numbers, depression is a staggeringly prevalent mental disorder. 350 million people are depressed worldwide, \$11.3 billion is spent on antidepressants annually, and the rate of depression diagnoses has grown 400% since the 1980s. There is a clear necessity for an improvement in current medical practices. Figuring out the root causes, formulating stronger methods of diagnosis, and properly identifying and treating those who suffer from depression is imperative to public health in America and abroad. I propose that advancing scientific quantification of depression by improving the efficacy of research practices and funding will reform the current inadequacy of depression diagnosis and treatment. This proposal is threefold. My first suggestion for reforming depression diagnosis and treatment rests in the publication of all research, studies, and clinical trials associated with the mental disorder. Secondly, we must emphasize a quantitative format for diagnosis and treatment based on the neurobiological specificities of the individual. Finally, we need to consider a system of checks and balances between academic and industrial research to prevent the dissemination of inaccurate information and faulty drugs. It is my hope that advancing neuroscience research through these proposals will elucidate the line between emotion and emotional disorders, helping us treat and diagnose de-

## 1. Introduction

350 million people are depressed worldwide. \$11.3 billion is spent on antidepressants annually, but the rate of depression diagnoses has grown 400% since the 1980s (Ross, 2012). What if this is all wrong? A study by Johns Hopkins reports that 60% of depression diagnoses are in fact misdiagnoses (“Are We as Depressed as We Think,” 2013). Misdiagnoses leads to more people thinking they have depression, and more people subsequently purchasing medication to fix it. What if the antidepressants do not work? A 2008 study from Irving Kirsch of Harvard Medical School estimates that 75% of the time, “an antidepressant’s effect could have been obtained merely by taking [a] placebo” (Mukherjee, 2012). Where are the mistakes being made? I believe they are being made in the inadequate diagnosis criteria and treatment plans for depressed patients, propagated by the current status of depression research.

Figuring out the root causes, formulating stronger methods of diagnosis, and properly identifying and treating those who suffer from depression

is imperative to public health in America and abroad. Insufficient standards for depression diagnosis, uncertainty among clinicians, and deficient knowledge of the depressed brain leads to misdiagnosis and mistreatment of patients. There is a clear necessity for an improvement in current medical practices. Since depression is part of a complex network within human neuroanatomy and genetics, fixing this problem lies in the understanding of depression’s neurobiological underpinnings in association with happiness. Improving our cognizance of depression depends on our ability to quantify emotion through neuroscience research. Advancing scientific quantification of depression by improving the efficacy of research prac-

## 2. Depression and Happiness Share Neurobiological and Genetic Bases

Quantifying emotion in the human body has the potential to improve proper diagnosis of depression and create individualized treatments for patients. Advanced technologies such as functional magnetic resonance imaging (fMRI), positron emission tomog-

fast scan voltammetry (FSV) allow measurement of brain activities and neurotransmitters associated with emotion (Leyton, 2009, 234). For example, these tools have revealed brain regions such as the amygdala, and neurotransmitters such as serotonin, norepinephrine, and dopamine to have a strong correlation with happiness compared to other brain regions and neurotransmitters (“The Neurobiology of Emotion”). Furthermore, certain genes that code for specific proteins, enzymes, and functions unite the brain systems and chemicals connected with emotion. An individual’s confluence of neurobiology and genetics dictates normal emotional states, as well as the extent of his or her nonstandard reactions to emotional stimuli.

Depression has a similar basis in the malfunctioning of these systems. The disorder is not simply the abundance or dearth of neurotransmitters interacting with the brain. Instead, the network of neurotransmitters and their relation to the network of the brain creates a working spectrum of emotion. For depression specifically, the newest and most promising research considers the subcallosal cingulate, a bundle of nerve cells that “function as a conduit” between brain regions controlling consciousness and emotion; this bundle of nerve cells depends in part on the proper functioning of the serotonin system, which has strong links to human happiness (Mukherjee, 2012). A malfunctioning of any one system mitigates the chances for another connected system to work properly, leading to disorder.

Understanding and quantifying happiness can illuminate an ensuing disorder in mental states by creating a solid foundation for explicit, objective criteria. According to Professor Morten L. Kringelbach of Oxford (2009), neuroimaging techniques are especially helpful in measuring happiness. He explains, “[self-reported happiness] ratings throughout a human neuroimaging experiment . . . [can be correlated] with changes in activity in the human brain” (p. 204). This technique can be used for measuring happiness,

### 3. Depression Statistics in the U.S. and Abroad

Unfortunately, depression knows no boundaries. Over 30 million Americans are currently using antidepressant drugs (Ross, 2012). Internationally, a study in the *PLOS Medicine* journal found that “depression is the second leading cause of years lived with disability,” (Ferrari et al., 2013) with 9 percent of

the U.S. and 4 percent of the world diagnosed with it. As universal as happiness, “people of all ages, backgrounds, lifestyles, and nationalities” suffer from depression (“Major Depression Facts,” 2013). It is a silent and debilitating pandemic. This data indicates an enormous global problem, but researchers have limited knowledge about depression’s reliance on the malfunctioning of specific neural pathways associated with emotion.

The increasing frequency in global depression rates and the statistics of depression prevalence and misdiagnosis are monumental causes for concern. Are people getting more depressed, or are doctors getting worse at diagnosing patients? Do antidepressants really work if depression rates are increasing? Answers to these questions have many variables, but the common uniting factor in resolving these problems is researching how depression manifests itself in humans. Depression is detrimental to health, longevity, and productivity; decreasing its rife-ness would in-

### 4. A Global Call for Reform

Domestic and international pervasiveness is the first reason for reform. Improving standards for diagnosis can help doctors identify genuine cases of depression in patients and reduce false positives. In a publication on depression in the journal *Health Affairs*, the authors announced, “doctors should be better educated on diagnosing depression” (Shute, 2011). Giving the public and the doctors who treat them more precise information about the mental disorder will increase public awareness concerning proper identification and treatment.

Secondly, the medical formulation for diagnosis is qualitative and open to interpretation. The backbone of depression diagnosis rests with the American Psychiatric Association’s (APA) *Diagnostic and Statistical Manual of Mental Disorders (DSM)*. According to the DSM, one must have “five or more . . . symptoms over a two-week period, most of the day, nearly every day” (Nuckols). These symptoms include “depressed mood,” “significantly diminished interest . . . in activities,” “significant weight loss [or weight gain] when not dieting,” “insomnia or increased desire to sleep,” “restlessness or slowed behavior,” and “fatigue or loss of energy” (“Depression Tests and Diagnosis,” 2014). Additionally, the DSM states symptoms can be based on “your own feelings” or the “observations of some-



a subjective medical framework. There are too many opportunities for open interpretations of symptoms in these guidelines. Giving medical care providers leeway for diagnosis engenders misdirected distribution of prescriptions. Improvement lies in the advancement of objective criteria through compelling research.

Finally, refining suitable treatments for depression is essential. Scientists are not completely sure why antidepressants work for some people and not others (Hendriksen, 2014). Additionally, “almost three-quarters of [antidepressant] prescriptions are written without a specific diagnosis” (Shute, 2011). In this current system, over-prescription of drugs leads to the unnecessary propagation of adverse side effects. These include nausea, weight gain, decreased sex drive, insomnia, and anxiety (“Depression Tests and Diagnosis,” 2014). Antidepressants seem to produce side effects that are the same as the symptoms of the depression that they are supposed to treat. In fact, the FDA also mandates that all antidepressants carry a “black box” notice: the strictest label warning for prescription drugs due to an increased risk of suicide (“Depression Tests and Diagnosis,” 2014). The need for a black box warning indicates a limited understanding of how antidepressants work, but doctors do not often exercise extreme precautions before prescribing. Considering primary care doctors, not psychiatrists, wrote 254 million prescriptions globally in 2010 for mild to moderate depression, we need to reevaluate the usefulness of antidepressants and the basis for which certain drugs are prescribed to prevent the risk of severe side effects due to misdiagnoses (Shute, 2011). There is more; in a report for ABC News, reporter Lauren Cox states that doctors and psychiatrists make their “best guess” in prescribing antidepressants for their patients (2009). Insufficient standards for diagnosis and a limited knowledge of how antidepressants work are to blame. Even if doctors are operating under their best intentions for the

## 5. What We Currently Know About Depression and Happiness

Finding more concrete evidence showing a physical link to emotion is the first step in moving away from diagnoses and treatments based on guesses. Certain regions of the brain are linked to emotions in greater proportion than others, and the extent to

which someone feels sad or happy depends on individual neurobiological idiosyncrasies. Scientific quantification of depression and happiness is made possible through technological advances; for example, connecting humans to various brain scanning machines, emotional reactions can be directly correlated with a change in neural activity documented by an attached computer. Specifically, the hippocampus has garnered attention regarding signals between brain neurons in relation to the subcallosal cingulate, mentioned earlier. Doctor Siddhartha Mukherjee of Columbia University says in his article “Post Prozac Nation” for the New York Times, “In the nondepressed brain, circuits of nerve cells in the hippocampus may send signals . . . to regulate mood,” but “when the hippocampus malfunctions . . . emotional pain can be generated and amplified out of context” (2012). Thus, specific brain regions may play certain roles in properly functioning emotions.

We also know that the brain has other chemicals working for it, assisting in emotional response. Analyzing the brain’s patterns of activity in conjunction with serotonin, norepinephrine, and dopamine may offer improved ways to describe depression and happiness. These three neurotransmitters transmit signals in the brain. Neuroscientist Susan Greenfield (2000) in her book, *The Private Life of the Brain*, posits that neurotransmitters act like a “fountain,” (p. 41) greatly affecting the brain and causing neurons to generate electrical signals. Mukherjee (2012) adds that neurotransmitters are “dynamic factors that make nerves grow, perhaps forming new circuits.” Scientists and researchers agree that these neurotransmitters play a role in emotion, but this is the only consensus that has significant accompanying research. Requiring objective methods to diagnose and treat depressed patients depends on the greater comprehension of known functions and systems related to emotion.

Depression and happiness are also linked innately through genetics. We know there are particular genes associated with increases in happiness. For example, the 5-HTTLPR gene makes a serotonin transporter molecule, but an individual can receive long versions or short versions at birth as a pair of alleles. Of the 2574 teens part of a research study analyzing the effects of 5-HTTLPR, those with the two long versions of the gene were twice as likely to say

different individuals (“Depression Tests and Diagnosis,” 2014). Consider two patients sharing the same depression diagnosis under current medical standards. There is a high probability each patient will react differently to antidepressants, psychiatric therapy, or a combination of the two (Mukherjee, 2012). Genetic predispositions may explain inconsistencies in treatment response. Individualizing treatment plans through identification of unique genetic and neurobiological factors properly acknowledges depres-

## 6. Depression is a Shape-shifting Disorder

Like a fingerprint, depression symptoms are unique to individuals. The DSM assigns diagnoses by correlating similarities in physical and emotional indicators among patients. Main subtypes of depression include Major Depressive Disorder, Persistent Depressive Disorder, Premenstrual Dysphoric Disorder, Substance and Medication-induced Depressive Disorder, and Disruptive Mood Dysregulation Disorder (Nuckols). The last subtype, updated in 2013, is the DSM’s latest attempt at refining diagnosis descriptions; Disruptive Mood Dysregulation Disorder describes abnormal tempers and irritability in children ages six to eighteen exclusively. However, Major Depressive Disorder is the number one psychological disorder in the western world (“Depression,” 2011). The National Institute of Mental Health differentiates Major Depressive from Persistent Depressive Disorder by the duration of symptoms, with the latter involving a two-year minimum (“Depression,” 2011). Doctors and researchers are strenuously attempting to map a sea of subtypes with limited knowledge of why each is different within an individual.

Even though new versions of the DSM are released with improvements to previous classifications of disorders, the broad statements and generalized characteristics of each subtype currently do not possess proper medical specificity begetting accurate diagnosis and treatment. The official, recognized link among these disorders is “the presence of sad, empty, or irritable mood, accompanied by somatic and cognitive changes that impact function” (Nuckols). In essence, the medically accepted commonality between these subtypes is general sadness and apparent changes in body and brain function: a broad umbrella statement. We can explain roughly how each subtype is different, but we cannot fully explain why. Current

research points us to regions of the brain, neurotransmitters, and certain genetic tendencies, but without

## 7. Treatments Are a Guess and Check

Regardless, depression is still a real and debilitating mental disorder. Treatments aim to alleviate depressive emotions by increasing the likelihood of positive emotions. The entire structure of antidepressant medication hinges upon our current knowledge of which neurobiological factors make people happy and why. It is no surprise that scientists are still not sure how and why antidepressants work (“Depression,” 2011). Current research has shown that modern antidepressants increase the concentrations of specific neurotransmitters by preventing reuptake in the brain (“Depression Tests and Diagnosis,” 2014). The brain naturally reabsorbs neurotransmitters, and antidepressants block this reabsorption. The belief is that increasing concentrations of “feel-good” neurotransmitters such as serotonin will relieve depression symptoms. The most popular antidepressants created with this notion of a chemical imbalance include serotonin, norepinephrine, and dopamine reuptake inhibitors. Zoloft, Lexapro, and Prozac are three such drugs (Cox, 2009). When doctors prescribe an antidepressant, they make an educated guess based on their experience. The drug could potentially work, or the patient will need to try a different one in two to six weeks because his or her body does not respond to it well.

Are drugs the only option for depressed patients? Anti-drug advocates would say no, claiming there are other methods of treatment that are safer and more effective than medication. These treatments work holistically, healing the connection between the brain and body. Alternatives such as yoga, acupuncture, and physical exercise have been shown to significantly improve mood in individuals with mild to moderate depression (Ross, 2012). These activities work on the same premise as antidepressants, without the side effects: stimulating the release of “feel good” chemicals (“Depression and Exercise,” 2014). Supporting the theory of depression as a chemical imbalance, Greenfield maintains that depression is an inappropriate hyperactivity of neurons. She states that neurotransmitters may “involve limitation of neuronal connections activated at any one moment,” and antidepressants decrease this excessive “neuronal

not explain why multiple studies show no correlation regarding neurotransmitter concentrations in autopsies of depressed patients (Mukherjee, 2012). Serotonin, norepinephrine, and dopamine may be involved in depression and happiness, but the extent of their involvement is unclear.

#### 8. The Brain Requires Further Mapping

Current theories of how depression works rely on correlative data: therein lies the problem. A higher concentration of neurotransmitters does not always equal a happier person, just as one brain region is not entirely responsible for emotion. Scientists are trying to find specific examples of causality in depression, but are limited by our current understanding of the brain. Even with advanced technologies such as fMRI and PET scans, there is no definitive statistic on how much of the brain we know, only that we do not know a great deal. In a program on the brain for PBS, Kurt Fischer, the director of the Mind, Brain, and Education program at the Harvard Graduate School of Education, lightheartedly says, “we do not know very much!” (“How Much Do We Really Know”). In the same program, UCLA clinical professor Daniel Siegel responds that humans are “just beginning to identify how systems in the brain work together in an integrated fashion to create complex mental processes” (“How Much Do We Really Know”). The brain’s system of emotion is integral for quantifying depression, but emotion could also be widely linked to other brain systems. Isolating brain research to specific regions allows in-depth analysis, but to improve depression diagnosis and treatment, researchers will need to focus on breadth as well: connecting the brain’s intricacies to form a more detailed picture of human emotional response.

Neuroscience has advanced our understanding of the brain from a center of thought to a sophisticated, hyper-connected assemblage of numerous systems. When the brain malfunctions because of internal or external stimuli in depression, quantifying the ensuing emotional disorder is an impressive feat to undertake. Furthermore, different subtypes of depression may involve a variety of factors. In some people, certain neurotransmitters could have a larger role in emotion than others (Mukherjee, 2012). Im-

#### 9. Reexamining Publications and the Spread of Accurate Information

An advanced knowledge of depression relies on the dissemination of credible academic publications and properly funded research. Academia thrives on this foundation—but unfortunately—many studies are not published on purpose. Hindering the development of reliable treatments are the numerous unpublished studies on antidepressants. Withholding information from the public and academic spheres severely limits the circulation of knowledge for which drugs work and why. Irving Kirsch’s (2010) meta-analysis, examining 38 published clinical trials involving more than 3,000 depressed patients, showed that the placebo effect was the cause of most mood improvement. Worse still, upon digging up unpublished depression studies using the Freedom of Information Act, Kirsch (2010) and his colleagues found antidepressants highly ineffective; half of the trials showed no difference between placebo and drug. Inconclusive data or limited sample sizes are valid reasons for unpublished studies, but choosing not to publish clear examples of antidepressant ineffectiveness skews trustworthy “published” information.

If one reads the Federal Drug Administration’s guidelines on supporting approval for antidepressant medication, one to two studies providing “substantial evidence” of a drug’s efficacy is adequate (“FDA Report: Guidance for Industry,” 1998). Putting this guideline into perspective, a laboratory can conduct 10 studies, two of which show a small advantage in taking an antidepressant while the other eight reveal no perceivable benefit, and the drug can receive FDA approval. Kirsch (2010) prudently notes that an antidepressant’s effect does not have to be large; “it doesn’t have to be clinically significant; it just has to be statistically significant.” This system of approval unjustly propagates subpar performance of antidepressants

#### 10. Reforming Data Discrepancy

Requiring only statistical significance perpetuates a culture of approval based on the medication’s creator, not the medication’s user. The FDA’s method of antidepressant approval also allows patients to be prescribed drugs that might not even work. My first suggestion for reforming depression diagnosis and treatment rests in the publication of all research, studies, and clinical trials associated with the mental disorder. This includes all tests conducted on antidepressants, as well as alternative forms of treatment. If

the very least be made accessible to the public. The Freedom of Information Act is a solid foundation for open distribution of knowledge, but it only applies to federal agency records, requires a written request for specific information, and the agencies are not required “to do research for you, analyze data, answer written questions, or create records in response to your request” (“How Do I Make a FOIA Request,” 2010). Additionally, if a pharmaceutical company conducts a private clinical trial separate from a federal entity, there is no guarantee that an individual can ask for or acquire the results if they are not submitted to the FDA.

Why would pharmaceutical companies conduct private trials, or refuse to publish certain studies? Consider GlaxoSmithKline’s (GSK) involvement in the largest healthcare fraud settlement in U.S. history. GSK failed to report safety data to the FDA, promoted unapproved uses for antidepressants Paxil and Wellbutrin, and bribed doctors to promote and prescribe these medications improperly. In 2012, GSK was required to pay \$3 billion dollars and agree to monitoring by the U.S. government for five years (“GlaxoSmithKline,” 2012). GSK was worried about its profit, not its patients. The largest U.S. health care scandal in history involved antidepressants, but it is not an isolated incident. Other companies such as AstraZeneca, Novartis, and Bayer (creator of Aspirin) have also been accused of malpractice (Ray, 2014). Transparency is the key to exposing which drugs work. Transparency can be achieved through requiring higher standards for FDA approval, and mandating that all trials and studies are accessible. Without this openness, pharmaceutical companies will per-

### 11. Shifting From Qualitative to Quantitative Diagnosis

Beyond improving the rate of publication and transparency, my second suggestion for reform emphasizes a quantitative format for diagnosis and treatment based on the neurobiological specificities of the individual. We know there are multiple subtypes of depression, numerous stimuli that cause it, and even more bodily factors that influence it. Diagnosis and treatment will benefit from personalized care that evolves from the greater comprehension of how all these aspects work together. There is no reason for depressed patients to have the same medica-

tion if individuals respond differently based on their biological and genetic makeup. Specific treatment plans will develop through further brain and genetic research. For example, assume advanced analysis of a person has shown that his specific neurobiological idiosyncrasies place strong emphasis on serotonin. Recall the long version of the 5-HTTLPR gene as one such idiosyncrasy. If his happiness inordinately depends on serotonin, existing antidepressants that are known to promote increased serotonin concentrations can be used with enhanced specificity. This example draws on the chemical imbalance theory, but knowing how happiness malfunctions in other individuals to cause depression can be instrumental in creating other patient-specific treatment plans. Isolating specific neurobiological pathways in patients is a crucial step towards quantitative and objective medical approaches to depression. Moving away from the qualitative depression diagnosis standards outlined in the DSM requires that doctors have a better knowledge of how depression works. Quantifying the components involved in depression yields the possibility of reducing depression misdiagnoses and decreasing antidepressant prescriptions. Individ-

### 12. It Is Wise to Invest

Reforming depression diagnosis and treatment as dictated above requires proper investment in brain research concerning human emotion. This must be accomplished by reconciling the relationship between academic and industrial research: my last suggestion for reform. Academic research in this sense pertains to independent studies usually funded by government grants. On the other hand, industrial research is done for pharmaceutical companies funded by these same companies. UC Berkeley’s Understanding Science online resource contains an analysis of how research is funded, and it elucidates how science can be used for the benefit of one party. “A pharmaceutical company paying for a study of a new depression medication, for example, might influence the study’s design or interpretation in ways that subtly favor the drug that they’d like to market” (“Who Pays for Science,” 2014). Differing sources of funding introduce biases based on motives. Therefore, certifying that unaffiliated academic research laboratories test industrial studies will reduce business bias in an effort to improve research as a whole. To make wise



and industrial research to prevent the dissemination of inaccurate information and faulty drugs.

### 13. Measurable Movements Forward

Investment in research based on the neurobiological and genetic networks linked to depression and the publication of all studies will usher in a quantitative reformation of diagnosis and treatment. I am confident that the initiation of my suggestions will reduce cases of misdiagnoses, domestic and international expenditure on antidepressants, and misinformation on the foundations for emotions in association with mental disorders. Depression's hold on humanity is of egregious scale. If implemented, these reforms could impact mental health globally by improving the way doctors and patients perceive depression. Doctor Siddhartha Mukherjee (2012) aptly explains the wonderment of the brain's complexities with an analogy. "The painter Cézanne, confronting one of Monet's landscapes, supposedly exclaimed: 'Monet is just an eye, but, God, what an eye.' The brain, by the same logic, is still a chemical soup — but, God, what a soup." It is my hope that advancing neuroscience research through these proposals will elucidate the line between emotion and emotional disorders, expanding our perspectives on what it means to be

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# Effects of negative self-evaluation bias on depression, rumination, and distractibility

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**ABSTRACT.** This study is a follow-up to a previous study on depression, rumination, and distractibility. According to the response styles theory, rumination and distraction are two different ways to respond to a negative stimulus. Previous research on the relationship between rumination and distraction and their effect on depression have focused mainly on the active use of these response styles. In the previous study, we examined how distractibility, or the natural tendency to be distracted, was related to rumination or depression. We found that self-reported distractibility was positively correlated with rumination and depression, whereas objective distractibility was moderately negatively correlated with rumination. To explain the discrepancies in the results of the previous study, we hypothesized that negative self-evaluation bias might be a moderator of both the relationship between self-reported distractibility and objective distractibility and the relationship between self-reported distractibility and self-reported depression and rumination. In this study, we examined how negative self-evaluation bias affected the relationships among depression, rumination, and distractibility. Participants were asked to answer questionnaires to self-evaluation bias, rumination, distractibility, and depression, and to perform an attention task. Self-reported level of rumination, depression, and distractibility all had a positive correlation with each other as expected. However, negative self-evaluation bias was an independent significant predictor for depression and rumination but not a moderator for the relationship between self-reported distractibility and self-reported depression and rumination. Further, it was neither a significant predictor for objective distractibility nor a moderator for the relationship between self-reported distractibility and objective distractibility. Contrary to our hypothesis, negative self-evaluation bias was an independent significant predictor for depression and rumination but not a moderator for any relationship among depression, rumination, and distractibility.

## 1. Introduction

The relationship between individual differences in distraction and rumination as coping methods to deal with responses to negative stimuli has been extensively explored in numerous studies. Further, Nolen-Hoeksema (Nolen-Hoeksema, 1991; 1998) proposed a theory about the interaction of rumination and depression as vulnerability factors to depression. According to the response styles theory (RST), two different coping styles in response to a negative stimulus are related to one's vulnerability to depression. In this theory, as explained in various studies (Hilt, McLaughlin, & Nolen-Hoeksema, 2010; Nolen-Hoeksema, 1991; Sarin, Abela, & Auerbach, 2005), one is considered to be using a ruminative response to a

negative stimulus if one focuses on the negative stimulus (e.g. thinking about a bad grade in a test) and its consequence (e.g. thinking that he or she will fail the class because of the bad grade). On the other hand, one is considered to be using a distractive response to a negative stimulus if one actively attempts to distract oneself from the negative stimulus to replace it with a neutral or positive stimulus (e.g. watching a funny movie when feeling depressed). RST states that those who utilize distraction as a coping method are less likely to be depressed compared to those who utilize rumination as a coping method. Although various papers such as the ones above explore the relationship between depression and distraction as an active attempt to disengage oneself from focusing on negative affect, there is little research on the relation-

is to further explore the relationship among individual differences in cognitive and self-reported measures of distractibility, rumination, and depression, as well as the effect of self-evaluation bias on those measures.

In a large number of empirical studies, depression has been shown to be positively correlated with ruminative responses to negative affect (Nolen-Hoeksema, 1998; Wilkinson, Croudace, & Goodyer, 2013). Furthermore, a meta-analysis by Olatunji, Naragon-Gainey, and Wolitzky-Taylor (2013) showed that self-reported rumination is positively correlated with self-reported depression and that clinically depressed patients have significantly higher self-reported use of rumination than non-patients. Furthermore, a study by Donaldson, Lam, and Mathews (2007) found that self-reported use of ruminative coping style was positively correlated with self-reported depression and anxiety in depressed adolescents and children. Similarly, the same study by Donaldson et al. (2007) found that trait rumination was positively correlated with negative attention bias (e.g. focusing more on a negative stimulus such as insults compared to a neutral or a positive stimulus) for depressed patients. In contrast, other studies have found that use of distractive response style was negatively correlated with self-reported depression. A study by Roelofs et al. (2009) showed that adolescents who have a greater tendency to use distraction compared to rumination are less depressed and anxious over time. Another study by Huffziger and Kuehner (2009) showed that inducing distraction after negative mood induction shows mood improvement for former depressed patients.

As shown in various studies above, it is evident that rumination is positively correlated with depression, whereas distraction as an active coping method is negatively correlated with depression. In addition, a study by Watkins, Teasdale, and Williams (2000) suggested that active distraction disrupts categorical memory recall, one of the mechanisms used for rumination. According to Watkins, Teasdale, and Williams, categorical memory recall is defined as the propensity to remember repeated events in the past. In this study, the participants completed the Autobiographical Memory Test (AMT), which asked them to recall a personal memory tied to six positive words (e.g. happy), six negative words (e.g. failure), or six neutral words (e.g. bread) at three points in the ex-

periment – before distraction/rumination induction, after distraction/rumination induction, and after decentering/control prompt task. In the distraction/rumination induction, the participants were asked to engage in either distraction or rumination based on the given prompts (e.g. “Think about the shape of a large black umbrella” for distraction and “Think about what your feelings might mean” for rumination). The results indicated that participants who underwent the distraction induction had a lower proportion of categorical memory recalled than those who underwent rumination induction, thus consistent with the hypothesis that distraction blocks memory mechanisms that may contribute to rumination.

Although the various studies above explore distraction and rumination as coping methods, there is little research on how one’s natural tendency to be distracted affects one’s vulnerability to depression. Therefore, a study by Suh and Barch (in press) was conducted in order to examine the relationship among individual differences in cognitive and self-report measures of distractibility, rumination, and depression. In the study, distractibility was defined as one’s natural tendency to be more distracted by stimuli, whether it is internal (i.e. occurring within one’s own mind, such as daydreaming) or external (i.e. occurring from the outside world, such as a car horn). The results of the study showed that self-reported distractibility was positively correlated with self-reported depression and rumination. In contrast, objective distractibility indexed by attention task accuracy was negatively correlated with self-reported rumination. Furthermore, objective distractibility was not correlated with self-reported distractibility. In the discussion of this study, Suh and Barch conjectured that this discrepancy between objective distractibility and self-reported distractibility may be due to negative self-evaluation bias of those who are more depressed. In other words, it is possible that depressed people may exaggerate their self-reports about their distractibility due to their negative self-evaluation bias. If so, this may be why self-reported distractibility did not correlate with objective measures of distractibility and correlated positively rather than negatively with rumination.

In various studies, negative self-evaluation bias has been associated with depression. Here we define negative self-evaluation bias as the tendency



negative intrusion in recall, produced more false alarms in recognizing negative adjectives, and recognized more negative adjectives correctly than non-depressed participants. Furthermore, depressed patients have been shown to evaluate their competencies, behavior, and self-worth to be worse than the general public (Blatt, 1995; Kovacs & Beck, 1978). In addition, a meta-analysis of longitudinal studies by Sowislo and Orth (2013) showed that low self-esteem is predictive of depression and anxiety.

In this study, we aimed to explore the possible effect of negative self-evaluation bias as a moderator on both the relationship between self-reported distractibility and self-reported rumination and depression and the relationship between self-reported distractibility and objective distractibility. As this study aimed to replicate the results of the previous study as well, it followed a similar procedure as the previous study but with added questionnaires to measure the level of self-evaluation bias. We hypothesized that self-reported depression would be positively correlated with self-reported rumination. Furthermore, we predicted that the relationship between self-reported distractibility and self-reported rumination and depression would vary as a function of negative self-evaluation bias, with lower negative self-evaluation bias associated with a more positive correlation between self-reported distractibility and self-reported rumination and depression and higher negative self-evaluation bias associated with a more negative correlation between self-reported distractibility and self-reported rumination and depression. However, we hypothesized that the correlation between objective distractibility and self-reported rumination and depression would continue to be negative. Furthermore, we predicted that the relationship between self-reported distractibility and objective distractibility would vary as a function of negative self-eval-

## 2. Method

### Participants

141 undergraduate volunteers (Mage = 19.16, SDage = 1.15; 37 male, 104 female) from Washington University in St. Louis were recruited through a volunteer website maintained by the Psychology Department. All participants met the criteria of minimum age of 18 years old, no self-reported history of mental illness, and no self-reported use of psychotropic

medication at the time of the study. Table 1 shows the demographic characteristics of the sample group. All participants were between the ages of 18 and 24 and were Washington University undergraduates with at

Table 1. Demographic characteristics of the sample group

	Male (N=37, 26%)	Female (N=104, 74%)
Age (M, SD)	19.19, 1.35	19.14, 1.07
Ethnicity (N, %)		
Asian	8, 21.6%	31, 29.8%
Black or African American	1, 2.7%	6, 5.8%
Hispanic	1, 2.7%	4, 3.8%
White	26, 70.3%	59, 56.8%
More than one race	1, 2.7%	4, 3.8%
Education in years (M, SD)	13.54, 1.07	13.37, 1.03

### Measures

**Rumination.** The Rumination Responses Scale (RRS; Nolen-Hoeksema & Morrow, 1991) is a 22-item scale used to measure everyday ruminative responses to negative affect. The scale ranges from 1 (almost never) to 4 (always), with total scores indicating the overall likelihood of using ruminative responses. It has been shown to be a reliable and valid measure of rumination, with the internal consistency (Cronbach's alpha) of .89 (Nolen-Hoeksema & Morrow, 1991; Roelofs, Muris, Huibers, Peeters, & Arntz, 2006).

**Depression and anxiety.** The Beck Depression Inventory (BDI-II; Beck, Steer, & Brown, 1996) is a 21-item scale widely used to measure self-reported levels of depression, with internal consistency (Cronbach's alpha) of .93 (Beck et. al., 1996). The Beck Anxiety Inventory (BAI; Beck, Epstein, Brown, & Steer, 1988) is a 21-item scale used to measure self-reported levels of anxiety with internal consistency (Cronbach's alpha) ranging from .92 to .94 (Beck et. al., 1988). This scale was used to address potential confounding variables, as depression is known to positively correlate with anxiety. Thus, BAI was used to determine whether any obtained effects were specific to depression, as compared to anxiety.

**Self-Reported Distractibility.** A number of measures were used to assess different aspects of self-reported distractibility. The Daydreaming Frequency Scale (DFS; Singer & Antrobus, 1970) is a 12-item subscale of the Imaginal Processes Inventory that measures the self-reported level of mind wandering in everyday life. The option ranges from A (never) to E (most of the time), with total scores signifying the overall likelihood to engage in daydream-

reliability, and good concurrent validity (Giambra, 1993; Tanaka & Huba, 1985). The Mindful Attention Awareness Scale – Lapses Only (MAAS-LO; Carriere, Cheyne, & Smilek, 2008) is a 12-item scale modified from MAAS (Brown & Ryan, 2003), a 14-item scale used to measure the level of everyday lapses of attention (e.g. “I get so focused on the goal I want to achieve that I lose touch with what I’m doing right now to get there.”). MAAS-LO aims to only look at attention lapses, so it eliminates two items from MAAS, one related to the consequences of attention lapses and another related to attention lapses while driving. The responses for each item range from 1 (almost always) to 6 (almost never). MAAS has been shown to have good test-retest reliability and validity with Cronbach’s alpha of .92 (Brown & Ryan, 2003). The Cognitive Failures Questionnaires (CFQ; Broadbent, Cooper, Fitzgerald, & Parkes, 1982) is a 25-item scale used to measure the level of everyday cognitive failures due to attention lapses (e.g. “Do you find you forget why you went from one part of the house to the other?”). The responses for each item range from 0 (never) to 4 (very often), and the total score corresponds to the overall forgetfulness. It is shown reliable and valid with the Cronbach’s alpha ranging from .85 to .89 (Broadbent et al., 1982; Tipper & Baylis, 1987).

**Attention task.** To measure distractibility during cognitive performance, we used a modified Erikson flanker task (Forster & Lavie, 2014). In this task, the participants were presented with a target, either the name of 6 Disney characters (Mickey, Donald, Pluto, Pooh, Piglet, Tigger) or 6 superheroes (Superman, Spiderman, Hulk, Wolverine, Batman, Robin) for 2000 ms following a central fixation point (500 ms) on a computer screen. The target was presented in one of the six positions from the central fixation point, ranging from 2.3 degrees below to 2.3 degrees above. The majority of the trials (90%) were presented with just the target. The remaining 10% of the trials had an equal chance of having a task-congruent distractor, task-incongruent distractor, or a task-irrelevant distractor. A task-congruent distractor is a picture from the same set as the target (e.g. Mickey if the target is Pooh). A task-incongruent distractor is a picture from the other set (e.g. Superman if the target is Pooh). A task-irrelevant distractor is a picture from neither the Disney nor the superhero set (a picture from a 6 cartoon character set: SpongeBob SquarePants, Hel-

lo Kitty, Cartman from the South Park cartoon, Bart Simpson, an Angry Bird, and Pikachu). These distractors were presented either to the left or right to the target. Participants were asked to push buttons to indicate whether the target was a superhero name or a Disney character name as fast and as accurately as possible. Participants completed 6 blocks of 60 trials, and the first three trials of each block were considered practice trials and were excluded from analysis. Participants were asked to verbally identify all of the cartoon characters involved in this task prior to the start of the task to make sure they were already familiar with all the characters. As a measure of distraction, we focused on the difference between the no-distractor condition and the task-incongruent condition by calculating the differences in reaction time (correct trials only) and accuracy between the two conditions.

**Self-Evaluation Bias.** Three different questionnaires were used to measure different aspects of self-evaluation bias. The Cognitive Styles Questionnaire – Short Form (CSQ-SF; Meins et al., 2012) is an abridged version of the Cognitive Styles Questionnaire (CSQ; Alloy et al., 2000), which contains 24 scenarios (12 positive and 12 negative) with 9 items for each scenario, that measures how one attributes various life events to different causes (e.g. stable vs. unstable, internal vs. external, specific vs. global). The responses for each item use a 5-point Likert scale ranging from strongly agree to strongly disagree, with higher scores indicating more negative cognitive style. Specifically, higher scores suggest the tendency to attribute life events to stable, internal, and global causes, as well as the tendency to assume negative consequences. Furthermore, higher scores suggest more negative self-evaluation. CSQ-SF is shown to be reliable and valid with the Cronbach’s alpha of .81 (Meins et al., 2012). The Rosenberg Self-Esteem Scale (RSES; Rosenberg, 1965) is a 10-item scale used to measure self-reported levels of self-esteem. The responses for each item use a 4-point Likert scale ranging from strongly agree to strongly disagree. RSES is shown to be reliable and valid with the Cronbach’s alpha of .91 (Sowislo, Orth, & Meier, 2014). The Generalized Self-Efficacy Scale (GSES; Schwarzer & Jerusalem, 1995) is a 10-item scale used to measure self-reported

## Procedure

First, participants completed an informed con

sent form to make sure they knew the general procedure and risk of participating in the study. Then, they completed the modified Eriksen flanker task according to the steps described above. After the task, they completed the battery of questionnaires about depression, rumination, distractibility, and self-evaluation bias as listed above. In the end, they were debriefed with an explanation of the goal of the study. Participants were tested in groups of 4 in individual

Data Analysis

**Correlations.** All data analysis was performed with SPSS 21. First, to analyze the relationships among the measures of rumination, depression, distractibility, and self-evaluation bias, we computed Pearson Product-Moment correlation among all the questionnaires. Then, to analyze the relationships among all the measures and attention task performance, we computed Pearson Product-Moment correlation for all questionnaires and task reaction time and accuracy. To do so, we first computed the difference between the no-distractor and incongruent distractor conditions for reaction time and accuracy of the attention task. For reaction time, the no-distractor condition was subtracted from the incongruent condition (higher value calculated indicates more distraction), whereas incongruent condition was subtracted from the no-distractor condition for accuracy (higher value calculated also indicates more distraction). We then computed Pearson Product-Moment correlation for all questionnaires and task RT and accuracy difference.

**Regressions.** Before engaging in regression analysis, we first consolidated the self-report measures of distractibility (CFQ, DFS, and MAAS-LO) and self-evaluation bias (GSES, RSES, and CSQ-SF) into two summary scores, as they all showed strong inter-correlation and this reduced the number of statistical comparisons. All self-report measures were first converted to standardized z-scores. Then, the z-scores for GSES and RSES were reversed, as they were reverse-scored with higher scores suggesting lower negative self-evaluation bias. We then calculated the internal reliability for the self-report measures of distractibility and self-evaluation bias. The self-report measures of distractibility (CFQ, DFS, and MAAS-LO) showed good internal reliability with Cronbach’s Alpha of .66. The self-report measures of self-evaluation

bias (GSES, RSES, CSQ-SF) showed good internal reliability with Cronbach’s Alpha of .77. Therefore, we were able to sum the z-scores for the self-report measures of distractibility, as well as self-evaluation bias, to create summary scores for self-reported distractibility and self-evaluation bias. Then, we performed a series of regression analyses to test our hypothesis. First, we calculated an interaction term between self-reported distractibility and self-evaluation bias by multiplying the summary scores for self-reported distractibility and self-evaluation bias. Then, we used

3. Results

Descriptive Statistics

Table 2 shows the descriptive statistics for the questionnaires used in this study.

Table 2. Descriptive statistics for the questionnaire scores.

	BDI-II	BAI	RRS	CFQ	DFS	MAAS-LO	GSES	RSES	CSQ-SF
<i>M</i>	9.55	9.91	44.794	46.52	21.55	41.80	3.06	19.50	198.85
<i>SD</i>	7.946	9.226	13.02	12.251	8.787	8.702	0.464	4.920	26.302

*Note.* BDI-II = Beck Depression Inventory – II; BAI = Beck Anxiety Inventory; RRS = Rumination Responses Scale; CFQ = Cognitive Failures Questionnaire; DFS = Daydreaming Frequency Scale; MAAS-LO = Mindful Attention Awareness Scale – Lapses Only; GSES = Generalized Self-Efficacy Scale; RSES = Rosenberg Self-Esteem Scale; CSQ-SF = Cognitive Styles Questionnaire – Short Form

Rumination and Depression

The Pearson Product-Moment correlation coefficients among BDI-II, BAI, RRS, CFQ, DFS, MAAS-LO, GSES, RSES, and CSQ-SF are shown in Table 3. As expected, we were able to replicate the well-documented relationship between rumination and depression. RRS, which measures the self-reported level of rumination, had a strong positive correlation with BDI-II.

Table 3. Pearson Product-Moment correlations among individual measures of self-reported depression, anxiety, rumination, distractibility, and self-evaluation bias.

	BAI	RRS	CFQ	DFS	MAAS-LO	GSES	RSES	CSQ-SF
BDI-II	.47**	.56**	.29**	.27**	.38**	-.37**	-.61**	.55**
BAI		.36**	.20*	.19*	.14	-.26**	-.37**	.27**
RRS			.43**	.43**	.40**	-.21*	-.48**	.45**
CFQ				.38**	.49**	-.23*	-.35**	.40**
DFS					.31**	.02	-.20*	.23**
MAAS-LO						-.18*	-.37**	.38**
GSES							.54**	-.44**
RSES								-.65**

\*\* *p* < .01, 2-tailed.

\* *p* < .05, 2-tailed.



Note: BDI-II = Beck Depression Inventory – II; BAI = Beck Anxiety Inventory; RRS = Rumination Responses Scale; CFQ = Cognitive Failures Questionnaire; DFS = Daydreaming Frequency Scale; MAAS-LO = Mindful Attention Awareness Scale – Lapses Only; GSES = Generalized Self-Efficacy Scale; RSES = Rosenberg Self-Esteem Scale; CSQ-SF = Cognitive Styles Questionnaire – Short Form

**Self-Reported Distractibility, Rumination, Depression, and Self-Evaluation Bias**

We hypothesized that self-reported distractibility and rumination would be positively correlated as observed in the previous study. As expected, RRS had a strong positive correlation with the measures of self-reported distractibility (CFQ, DFS, and MAAS-LO). Similarly, we had also hypothesized that self-reported distractibility and depression would be positively correlated. As expected, BDI-II had a strong positive correlation with CFQ, DFS, and MAAS-LO. Table 4 shows the Pearson Product-Moment correlation coefficients among BDI-II, BAI, RRS, self-reported distractibility summary score, and self-reported self-evaluation bias summary score. As expected, the same relationships as seen in the prior study were observed among all measures. The self-reported distractibility summary score was positively correlated with BDI-II and RRS, and the self-reported self-evaluation bias summary score was also positively correlated with BDI-II and

Table 4. Pearson Product-Moment correlations among summary scores of self-reported distractibility and self-evaluation bias, self-reported depression, anxiety, and rumination.

	BAI	RRS	DIST	BIAS
BDI-II	.47**	.56**	.40**	.61**
BAI		.36**	.23**	.36**
RRS			.55**	.46**
DIST				.40**

\*\*  $p < .01$ , 2-tailed.

\*  $p < .05$ , 2-tailed.

Note: BDI-II = Beck Depression Inventory – II; BAI = Beck Anxiety Inventory; RRS = Rumination Responses Scale; DIST = Summary score for self-reported distractibility measures (CFQ, DFS, and MAAS-LO); BIAS = Summary score for self-reported self-evaluation measures (GSES, RSES, and CSQ-SF)

**Attention Task Performance and Self-Report Measures**

Table 5 shows the descriptive statistics for the attention task, including the reaction time differences and the accuracy differences between the no-distractor condition and the incongruent distractor condition. The one-way repeated measures ANOVAs for accuracy and reaction time (RT) comparing the conditions (no distractor, congruent distractor, neutral

distractor, and incongruent distractor), replicated the result of the previous study. There was a significant main effect of condition for reaction time,  $F(3,128) = 225.68, p < .001$ . Post-hoc contrasts indicated that the incongruent condition was slower than the neutral condition ( $p < .05$ ). Furthermore, both the incongruent and neutral conditions were significantly slower than the no-distractor condition ( $p < .001$ ). Further, the no-distractor condition was significantly faster than the congruent condition ( $p < .001$ ). There was also a significant main effect for accuracy,  $F(3,128) = 85.03, p < .001$ . Post-hoc contrasts indicated that all conditions were significantly different ( $ps < .001$ ). Performance was best in the congruent condition, followed by the no-distractor condition, followed by

Table 5. Descriptive statistics for the task data.

	Incongruent Distractor		Irrelevant Distractor		Congruent Distractor		No Distractor	
	RT (ms)	ACC	RT (ms)	ACC	RT (ms)	ACC	RT (ms)	ACC
M	723.309	0.865	704.578	0.919	612.398	0.961	597.168	0.940
SD	103.63	0.08	101.75	0.07	67.67	0.05	54.60	0.04

Note: RT = Reaction time (in ms); ACC = Accuracy.

Table 6 shows the Pearson Product-Moment correlation coefficients among the self-report measures and the task performance. As described in the methods, the dependent variables for the task performance were distractibility scores. As shown in Table 6, DFS was not correlated with the accuracy measure of distractibility, but was positively correlated with the RT measure of distractibility. In other words, greater objective distractibility as measured by RT was associated with greater self-reported distractibility. However, all other self-report measures for distractibility as well as depression, rumination, and self-evaluation bias were not correlated with accuracy or reaction time



Table 6. Pearson Product-Moment correlations among self-reported distractibility, rumination, depression, anxiety and attention task data.

	(No distractor) – (Incongruent)	
	Reaction time	Accuracy
Beck Depression Inventory	.06	-.12
Beck Anxiety Inventory	-.07	.04
Rumination Responses Scale	.07	.00
Cognitive Failures Questionnaire	.13	-.10
Daydreaming Frequency Scale	.18*	-.05
Mindful Attention Awareness Scale – Lapses Only	.12	-.01
Generalized Self-Efficacy Scale	.10	.14
Rosenberg Self-Esteem Scale	.01	.11
Cognitive Styles Questionnaire – Short Form	.08	-.04

\*  $p < .05$ , 2-tailed.

### Regression Analysis

As described in the introduction, we hypothesized that the relationship between self-reported distractibility, depression, rumination and objective distractibility would differ as a function of an individual's level of self-evaluation bias. Specifically, we hypothesized that among those individuals with high negative self-evaluation bias, self-reported distractibility would be positively correlated with depression and rumination while relatively uncorrelated with objective distractibility. In contrast, among individuals with low negative self-evaluation bias, we hypothesized that self-reported distractibility would be negatively correlated with depression and rumination but positively correlated with objective distractibility. To test these hypotheses, we conducted a series of linear regressions that included the main effects of self-evaluation bias (using the summary score) and self-reported distractibility (using the summary score) as well as their interaction to predict depression, rumination, and objective distractibility.

For the regression predicting rumination, we found significant main effects of self-evaluation bias ( $t = 3.66$ ,  $\beta = .28$ ,  $p < .001$ ) and self-reported distractibility ( $t = 5.56$ ,  $\beta = .43$ ,  $p < .001$ ). However, the interaction between self-evaluation bias and self-reported distractibility was not significant ( $t = -.24$ ,  $\beta = -.02$ ,  $p = .81$ ). Similarly, for the regression predicting depression, we found significant main effects of self-evaluation bias ( $t = 7.13$ ,  $\beta = .54$ ,  $p < .001$ ) and self-reported distractibility ( $t = 2.49$ ,  $\beta = .19$ ,  $p < .014$ ) but only a mar-

ginally significant effect of the interaction between self-evaluation bias and self-reported distractibility ( $t = 1.95$ ,  $\beta = .14$ ,  $p = .053$ ). For the regression predicting RT measure of objective distractibility, we found significant main effects of self-reported distractibility ( $t = 2.37$ ,  $\beta = .23$ ,  $p < .019$ ) but no significant effect of self-evaluation bias ( $t = -1.06$ ,  $\beta = -.10$ ,  $p = .29$ ) and no significant interaction between self-evaluation bias and self-reported distractibility ( $t = -0.44$ ,  $\beta = -.04$ ,  $p = .66$ ). For the regression predicting accuracy measure of objective distractibility, we found no significant main effects of self-reported distractibility ( $t = -.24$ ,  $\beta = -.02$ ,  $p = .81$ ) or self-evaluation bias ( $t = -1.12$ ,  $\beta = -.11$ ,  $p = .26$ ), and no significant interaction between self-evaluation bias and self-reported distractibility ( $t = -0.34$ ,  $\beta = -.03$ ,  $p = .74$ ).

### 4. Discussion

In this study, we aimed to explore the effects of negative self-evaluation bias on rumination, depression, and distractibility. Specifically, we hypothesized that self-reported depression would be positively correlated with self-reported rumination. Furthermore, we hypothesized that the relationship between self-reported distractibility and self-reported rumination and depression would vary as a function of negative self-evaluation bias. We predicted that lower negative self-evaluation bias would be associated with a more negative correlation between self-reported distractibility and self-reported rumination and depression, whereas higher negative self-evaluation bias would be associated with more positive correlation between self-reported distractibility and self-reported rumination and depression. Lastly, we had also hypothesized that the relationship between self-reported distractibility and objective distractibility would vary as a function of negative self-evaluation bias as well, with lower negative self-evaluation bias associated with a more positive correlation between self-reported distractibility and objective distractibility.

With respect to rumination and depression, we were able to replicate the positive correlation between self-reported rumination and self-reported depression seen in our previous study and in many other studies (Nolen-Hoeksema, 1998; Olatunji et al., 2013; Suh & Barch, in press; Wilkinson et al., 2013). Furthermore, we were able to replicate the overall

positive correlation between self-reported distractibility and self-reported rumination and depression as seen in previous study. However, contrary to our predictions, we did not find any moderating effect of negative self-evaluation bias on either the relationship between self-reported distractibility and self-reported rumination and depression or the relationship between self-reported distractibility and objective distractibility. We had hypothesized that negative self-evaluation bias might be a moderator of the relationship between self-reported distractibility and self-reported rumination and depression. However, the regression analysis showed that self-reported distractibility and negative self-evaluation bias were independent significant predictors of self-reported rumination and self-reported depression, with no significant interaction in predicting rumination. Negative self-evaluation bias was a significant predictor of self-reported rumination and depression, which is consistent with the previous studies described in the introduction. As described in the introduction, prior work suggests that negative self-evaluation bias is positively correlated with depression and that high level of negative self-evaluation bias is predictive of symptoms of depression and anxiety (Blatt, 1995; Kovacs & Beck, 1978; Sowislo & Orth, 2013; Zuroff, Colussy, & Wielgus, 1983). Therefore, the result from the regression analysis, in conjunction with the positive correlation shown between negative self-evaluation bias and self-reported rumination and depression, is consistent with prior research as described above. However, our hypothesis that negative self-evaluation bias would moderate these relationships was not supported.

We had also hypothesized that negative self-evaluation bias may be a moderator of the relationship between self-reported distractibility and objective distractibility. However, the regression analysis showed that the interaction between negative self-evaluation bias and self-reported distractibility in predicting objective distractibility was not significant. Even independently, negative self-evaluation bias was not a significant predictor for either RT or accuracy measures of objective distractibility, whereas self-reported distractibility was a significant predictor for only the RT measure of objective distractibility. Furthermore, it is worth noting that we were not able to replicate our previously reported relationship

between self-reported distractibility and objective distractibility. In the previous study, the accuracy measure of objective distractibility was negatively correlated with self-reported rumination, although to only a modest extent. However, in this study, the accuracy measure was not correlated with any other measures, whereas the RT measure was positively correlated with DFS, a scale for self-reported distractibility. The failure to replicate the results from the previous study suggests that the correlation shown in the previous study may have been a chance correlation and that there is no strong or robust relationship between objective distractibility and rumination.

Although we could not find supporting evidence for the hypothesis in regards to negative self-evaluation bias, it is worth noting that we were able to replicate the previously observed relationship between individual differences among distractibility, rumination, and depression. Self-reported distractibility was positively correlated with self-reported rumination and depression, whereas objective distractibility was not correlated with self-reported depression. This result is contradictory to the well-established relationship between active distraction and depression, as various prior studies show that active distraction works against depression and rumination (Nolen-Hoeksema, 1991; 1998; Roelofs et al., 2009; Huffziger & Kuehner, 2009). Therefore, the results of this study suggest that distractibility, or the natural tendency to be distracted, do not function the same way as distraction as an active coping method. This seems to be true for distractibility measured both objectively (as shown by the correlational results from the attention task) and subjectively (as shown by the correlational results from the self-report measures). Instead, our results suggest that the positive correlation between self-reported distractibility and depression may be evidence of cognitive deficits in executive control, attention, and memory commonly found in depressed patients (Hasselbalch, Knorr, & Kessing, 2011; Rock, Roiser, Riedel, & Blackwell, 2014; Snyder, 2013).

It is worth noting the limitations of the study. The most significant limitation was the sample group composition. Only Washington University undergraduates who signed up via the Psychology Subject Pool were included in the study, and the sample had a high

gender skew towards female (74% of the sample). Thus, our results may not be representative of the general population, and it is possible that different results might be found in a more diverse population. Furthermore, the majority of the relationships that were that were statistically significant were self-report measures, which may not be the most accurate depiction of the participant's behavior in real life due to various biases. For example, the answers may be distorted by the social desirability bias, which could drive an individual exaggerate their answers to fit with what is desirable in society (e.g. saying they are nicer than they actually are). Moreover, participant's answers may be affected by his or her mood at the time (e.g. scoring higher on a happiness scale because he or she just watched something funny). In order to overcome this limitation, in future work it would be informative to gather data from the perspective of the participant's friends or family members in order to obtain a more complete depiction of the participant.

In conclusion, this study showed that negative self-evaluation bias was significantly associated with depression and rumination but was not a moderating factor in the relationship among rumination, depression, and distractibility. Although we could not find any moderating effect for negative self-evaluation bias, we were able to replicate the results shown in prior work, which showed that negative self-evaluation bias was a significant factor in predicting symptoms of depression. We found that negative self-evaluation bias was positively correlated with self-reported rumination and depression and that it was a significant predictor for depression and rumination. Furthermore, we were able to replicate the previously reported relationship between individual differences among distractibility, rumination, and depression. We found that self-reported distractibility was positively correlated with self-reported rumination and depression, whereas objective distractibility was not correlated with self-reported depression. These results suggest that there is a difference between distraction as an active coping method against negative stimuli versus distractibility, or the natural tendency to be distracted.

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# Addressing the Gaps in Mental Health Care for Spanish-Speaking Individuals in Durham, N.C.: A Needs Assessment and Compilation of Relevant Empirical Literature

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**ABSTRACT.** The present report supplies a short historical background of Latino immigration into Durham, NC and incorporates various sources to provide a comprehensive view of Latino immigrant child and adolescent mental health. It addresses the negative impact of acculturation on mental health and outlines documented barriers to obtaining mental health care for Latino immigrants. Noting the repeated references of cost and language as barriers to care, the report presents several strategies, such as task shifting and Health interventions, that can be used to improve access to care. Finally, it connects the presented strategies to existing resources in Durham.

## 1. Introduction to Latino Immigration in Durham, NC

For generations, Latin American immigrants to the United States settled in concentrated areas, the majority of which were in the Southwestern United States. However, in 1990 the Latino immigrant population began to spread across the United States, inhabiting “new destinations” throughout the American Southeast (Flippen & Parrado, 2012). A particularly large number of Latinos immigrated to Durham, NC. The 1990 census registered 2,054 Hispanics in Durham County, representing roughly 1.1 percent of the total population. As Latino immigrants continued to settle in the Southeastern United States, the Hispanic population in Durham grew exponentially in the years that followed, reaching 17,039 in 2000 and 39,332 (13.4 % of the total population) as of the July, 2014 census population estimate.

A number of political and social factors have contributed to the rise of Durham as a “new destination” for Latino immigrants, including recent growth of the city’s technology and research sectors (Flippen & Parrado, 2012). The rapid growth of these sectors has resulted in an increase to commercial and residential construction and a commensurate need for low-skilled laborers. With an initial group of immigrants already established in the area, secondary immigration from outside the state has been ongoing as news of the ample employment opportunities has spread (Flippen & Parrado, 2012). However, as the Latino community has continued to expand, their position

in the labor market has remained largely the same. Roughly a third of Durham’s Latino population lives at or below the poverty line (“From Tobacco to Tortillas,” 2014). Further, the average household income in a typical Latino neighborhood in Durham, NC is \$39,000, less than 70% of the \$56,000 average household income for non-immigrant neighborhoods in Durham. These wealth inequalities are reflected in insurance coverage and health service utilization rates, for which Latino immigrants are more likely to be uninsured and less likely to seek health services than their non-Latino counterparts (NC Minority Health Facts, 2010).

The link between poverty and mental health problems is a well-established one, as is the positive association between poverty and childhood and adolescent mental illness. Poverty increases the likelihood an individual will meet criteria for almost all mental disorders (Lipman & Boyle, 2008), and children from impoverished backgrounds are 2.7 times more likely than non-impoverished children to develop mental health problems, particularly conduct and behavioral disorders (Lipman & Boyle, 2008). Additionally, research has supported the claim that “area-level indicators of less advantaged SES have been associated with mental health even after adjustment for individual-level SES,” suggesting that living in lower-income neighborhoods may have a negative impact on mental health independent of individual socioeconomic status (Lund et al., 2014). These findings highlight the

importance of considering childhood and adolescent mental health within Durham's Hispanic community. The potential negative mental health impacts of this community's high poverty rate, poor health insurance coverage and ethnic minority status are altogether alarming.

## 2. Mental Health in Latino Communities

As the number of Latino immigrants has continued to grow in recent years, there has been a corresponding rise in the number of Spanish-speaking individuals presenting for mental health services in Durham County (Samoff et al., 2014). The rise in individuals seeking services for care has called attention to the psychological well-being of children and adolescents in immigrant communities and has sparked several community-level needs assessments for Latino communities on a local, state, and national level.

One such assessment includes the Surgeon General's supplemental report (2001) on mental health. This report outlined the effect of culture, race and ethnicity on mental health in America. Most notably, the report included a number of epidemiological findings illustrating that Latino youth experience a significant number of mental health problems, including anxiety and substance abuse, and that in most cases, they experience more symptoms of psychological distress than their non-Latino counterparts. However, the majority of supporting data for these claims comes from studies that assess mental health using various problem behavior checklists, rather than formal diagnostic instruments.

Existing research on Latino immigrant child and adolescent mental health has suggested that children and adolescents born outside of the U.S. exhibit higher-than-average levels of anxiety and distress. A 1999 study by Glover and colleagues assessed the anxiety symptoms of Hispanic youth using the Youth Self Report (YSR) version of the Child Behavior Checklist (CBCL), both of which have been cross-culturally validated for Latino samples (Glover et al., 1999). The researchers found that Hispanic students in a Texas middle school exhibited more anxiety-related problem behaviors than non-Latino students and suggested that this could be a result of "either higher risk for anxiety symptomatology or a culturally related bias in the reporting of such symptoms" (Glover et al., 1999).

In addition to anxiety-related problem behaviors, Satcher (2001) reported that Hispanic youth and adolescents exhibit higher levels of distress than their non-Hispanic counterparts. A 1992 study by Roberts and Sobhan found that when controlling for age, gender, perceived health, and socioeconomic status, Mexican-American adolescents exhibited more depressive symptoms than the Anglo-American majority. The elevated levels of anxiety and distress exhibited by children and adolescent-aged Latino immigrants are well documented on a national scale (Polo & López, 2009). These national findings are also reflected in Durham-specific data. Twelve percent of adult respondents in a Durham Latino community health survey said "depression, anxiety, and other mental illnesses" were the most pressing health problem for their community (Samoff et al., 2014).

The cumulative effects of elevated anxiety and distress levels can present in a variety of different ways. Auerbach (2007) suggests that adolescents with both high levels of neuroticism and emotion regulation deficits are more likely to engage in "risky" behaviors (operationalized as criminal behavior, unsafe sexual behavior and illicit drug use in the context of this study), likely as a maladaptive coping strategy. A 1995 study suggested that Latino students, born inside and outside of the United States, engaged in more risk-taking behaviors than their non-Latino peers (Brindis, 1995). In Brindis' study, problem and risk-taking behaviors were classified as substance use, self-violent behaviors, sexual risk behaviors, and acts of violence.

Substance use disorders, considered to be both a mental illness and a risk factor for mental illness, are a particularly relevant problem in Durham's Latino community. Forty-four percent of respondents in a 2014 Latino community health survey endorsed "addiction to alcohol, drugs, or medications" as the most pressing health problem for their community (Samoff et al., 2014). Similar results were found in Durham's Youth Risk Behavior Survey, which showed that 32% of Durham County high school students reported having at least one drink of alcohol in the past 30 days and 35% reported using marijuana one or more times in the past 30 days (Samoff et al., 2014). To provide a national comparison, the 2014 National Survey on Drug Use and Health found that 22.8% of adolescents reported having at least one drink of alcohol in the past 30 days and 9.4% reported us-

ing marijuana one or more times in the past 30 days (Center for Behavioral Health, 2015). The differences in national and Durham-specific data suggest that contextual factors may be associated with drug use in Durham.

A number of researchers have also shown that Latino adolescents may be more predisposed to self-violent behavior. As presented in the Brindis (1995) study, Latino students are more likely to engage in self-violent behaviors than their non-Latino peers. Correspondingly, a national survey of high school students found that adolescent-aged Latino males and females reported more suicidal ideation and specific suicide attempts than their non-Latino peers (Satcher, 2001). This was reflected in a Durham-specific survey as well, which found that 14.7% of Latino high school students had previously made a plan about how to kill themselves, higher than the figure of 10.7% for their white counterparts (Samoff et al., 2014). These findings highlight a concerning rate of depression and suicidal ideation within Latino communities specifically.

A 1992 study by Jeffrey Swanson and colleagues highlighted an alarming trend of increased suicidal ideation among adolescent-aged Latino immigrants. Swanson found that when surveying adolescents on both sides of the Mexican-American border, adolescents living in the United States reported higher scores on the Center for Epidemiologic Studies Depression Scale (CES-D), higher rates of illicit drug use and higher levels of current suicidal ideation (Swanson et al., 1992). Similarly, a cross-national comparison of suicide attempts, drug use, and depressed mood found that immigrants were significantly more likely to report illicit drug use, suicide attempts or depressed mood than their counterparts living in their country of origin (Peña et al., 2015). These findings suggest that Latino immigrant youth living in America are exposed to various social conditions in America, such as racial discrimination and social pressure to conform to cultural norms, that negatively impact their mental health. The process of adjusting to life in a non-native country, conceptualized as “acculturation,” is likely accompanied by a number of significant stressors. Notably, the experience of acculturation has been linked to unfavorable mental health outcomes (Koneru et al., 2007).

### 3. Acculturation and its Impact on Mental Health

“Acculturation” has been defined in various different ways across the existing literature. For the purpose of this paper, acculturation can be understood as the dual process of cultural and psychological change that occurs in times of migration. Acculturation may be associated with positive mental health outcomes when immigrants reconcile their cultural differences and undertake assimilation, adapting to American culture while preserving aspects of their native cultural identity. Though while acculturation may lead to harmonious assimilation into a new culture for some, empirical literature suggests that the stress that accompanies acculturation can also have significant negative impacts on the mental health of immigrants in the United States. Acculturation and accompanying stressors have been associated with poor mental health outcomes among American immigrants, including high rates of substance abuse (Koneru et al., 2007).

The elevated levels of anxiety and distress that accompany acculturation have been conceptualized as “acculturative stress” (Berry, 2005). Dr. John Berry proposed that acculturating individuals must yield and assimilate to the dominant culture in order to resolve the cultural conflict associated with immigration. One example of cultural conflict is the shift in gender roles that is often experienced following immigration. Many Latin American countries have rigid gender roles that promote patriarchal culture, whereas the United States promotes more independence and fluidity in gender roles. This cultural conflict can be amplified when men are unable to find jobs and women become the primary earner (Rees et al., 2015). “Acculturative stress” can emerge when immigrants encounter cultural conflicts that they perceive as “problematic” (Berry, 2005). Although stress generally connotes a negative experience, health psychologists posit that stress can fall along a spectrum that consists of positive and adaptive elements (e.g., adapting to American gender roles while maintaining trust and effective communication in the home) at one end and negative and maladaptive elements at the other extreme (Berry, 2005). Maladaptive acculturative distress is characterized by marked difficulty adapting to novel cultural practices and has been associated with elevated levels of anxiety and distress in



children and adolescents (Polo & López, 2009). While the Durham-specific data does not mention acculturation specifically, acculturative stress could potentially contribute to the various mental health problems evident in the Durham Latino community (Samoff et al., 2014).

While there is a dearth of research supporting acculturative stress and specific mental health outcomes, existing studies have found associations between acculturation and depression (Hovey & King, 1996; Koneru et al., 2007; (Lorenzo-Blanco & Unger, 2015). Mikolajczyk and colleagues (2007) analyzed data from the adolescent sample of the 2003 California Health Interview Survey and compared findings across immigrant and non-immigrant groups to determine the relationship between acculturation and mental health. The survey collected demographic information and measured depressive symptomology with a reduced version of the Center for Epidemiologic Studies Depression Scale (CES-D). The CES-D includes acculturation-specific items and had been validated within immigrant communities prior to this study. "Acculturation" was operationalized into an interval variable, including the language that the interview was conducted in, the language spoken in the home, the number of years residing in the United States and citizenship status (Mikolajczyk et al., 2007). Overall, the researchers found significant differences between Latino and non-Latino white adolescents, with Latino adolescents reporting higher levels of poverty and lower levels of social support. After adjusting for socioeconomic status and social support, the researchers identified a significant correlation between acculturation and depressive symptomology. Low levels of acculturation were associated with higher levels of depressive symptoms (Mikolajczyk et al., 2007). Again, despite the lack of acculturation data for Durham, this association between acculturative stress and depressive symptoms could help explain the large number of Latino immigrants that cited "depression, anxiety, and other mental illnesses" as a pressing community health problem (Samoff et al., 2014).

A number of studies have also linked acculturation to elevated rates of suicidality in Latino adolescents (Cespedes, 2009; Lipsicas & Mäkinen, 2010; Swanson et al., 1992). Lipsicas and Mäkinen (2010)

completed an empirical review and concluded that immigrant status influences suicide risk. Specifically, these researchers found that acculturative stress was a significant and independent predictor of suicidal ideation in adolescent-aged Latino immigrants across the United States (Lipsicas & Mäkinen, 2010). Another cross-sectional study conducted to "determine the relationship between acculturative stress, depressive symptoms, and suicidal ideation in a sample of immigrant and second-generation Latino-American adolescents" found that acculturative stress, depressive symptoms, and suicidal ideation were highly inter-correlated, with acculturative stress and depression serving as significant and independent predictors of suicidal ideation (Hovey & King, 1996). The demonstrated inter-correlation between acculturative stress, depression and suicidal ideation suggests that many of the 14.7% of Latino high school students in the Durham area that had previously made a suicide plan (Samoff et al., 2014) may also have been experiencing acculturative stress at the time that they made such plans.

A number of national studies have linked acculturation to substance use in Latino adolescents (Carvajal et al., 2002; Goldbach et al., 2015; Lorenzo-Blanco & Unger, 2015). Goldbach and colleagues surveyed Latino adolescents across four American cities and found that acculturative stress was associated with a heightened risk of alcohol use. The data also suggested that acculturative stress was a "salient mechanism related to alcohol use" in Latino populations (Goldbach et al., 2015). Similarly, a 2015 study by Lorenzo-Blanco and Unger indicated that acculturative stress was correlated with cigarette smoking in Latino youth. Again, there is no Durham-specific data on acculturative stress and its relationship to substance use. However, national data suggests the

#### 4. Barriers to Care

The probable impact of acculturative stress and existing mental health problems point to a major need for mental health services within the Durham Latino community. However, there are several systematic barriers standing in the way of Latinos accessing mental health care. Most notably, the cost associated with mental health care poses a significant barrier for many Latino families, as indicated by a 2014 commu-

nity health survey (Samoff et al., 2014). Additionally, Durham County lacks providers that are able to provide culturally competent care to Latino children and adolescents, given that few clinicians employed by the county identify as Latino or possess Spanish-language skills (Community Needs, 2014). While the barriers listed above are not comprehensive, they represent large hindrances to accessing mental health care for the Latino community.

In examining mental health needs and service utilization by Hispanic immigrants across the Mid-Southern United States, Bridges and colleagues (2012) found that the most common barrier to service utilization was cost, with 59% of survey respondents reporting it as the reason that they did not seek mental health care. This was reflected in a 2014 Durham County community needs assessment, in which 45% of Latino respondents indicated a need for more affordable healthcare (Samoff et al., 2014). With roughly a third of Durham's Latino population living beneath the poverty line (Samoff et al., 2014), it is reasonable to assume there would be significant financial barriers to accessing mental health care. The majority of Durham County Latinos surveyed they would turn to safety-net clinics; however, these clinics are often over-crowded and do not provide specialty care to Spanish-speaking residents (Samoff et al., 2014). There are several agencies that link low-income and uninsured residents to specialty care, such as Project Access of Durham County and Duke University's Local Access to Coordinated Healthcare (LATCH) program, but their resources are limited and Spanish-specialty care can be difficult to access (Samoff et al., 2014).

Similarly, lack of insurance can pose a large barrier to accessing care, specifically for Latino immigrants (Bridges et al., 2012; Samoff et al., 2014). The Bridges survey (2012) of Hispanic immigrants across the Mid-Southern United States found that 35% of respondents lacked insurance, citing this problem as the main reason why they did not use mental health services. In 2014, the median household income for an immigrant neighborhood in Durham was \$39,000, less than 70% of the \$56,000 median household income for non-immigrant neighborhoods (Samoff et al., 2014). It is therefore not surprising that the majority of Latino immigrants in Durham County cannot afford private insurance plans (Samoff et al., 2014). For non-immigrant individuals who cannot afford private

health insurance, plans are subsidized by the government; however, immigrants face significant barriers in signing up for government-subsidized plans, ranging from lack of credit history to mixed immigration status and fear of deportation (Samoff et al., 2014). Lack of health insurance within Durham's immigrant communities has resulted in an uninsured rate among foreign-born Hispanic children that is more than four times greater than the uninsured rate among native-born Hispanic children (Samoff et al., 2014).

Bridges and colleagues (2012) also found that language posed a major barrier to service utilization, with 31% of survey respondents reporting lack of Spanish-language services as a barrier to their accessing mental health care. For Durham County, an Alliance Behavioral Healthcare community needs assessment found that only 20 behavioral health care providers reported offering Spanish-specialty services (Community Needs, 2014). This number is drastically lower than the suggested number of 72 providers for a population of 39,332 individuals (Community Needs, 2014). However, increasing the number of Spanish-speaking providers alone may not be sufficient to overcome the cultural barriers faced by Latino immigrant communities in seeking mental health care. Indeed, the Surgeon General's report on mental health outlined the need for not only bilingual but also bicultural providers (Satcher, 2001). When mental health patients and providers are "ethnically matched" treatment adherence and outcomes can be improved (Satcher, 2001). There is currently no data on the ethnicity of mental health providers in Durham County; it is worth keeping in mind, however, that not being paired with an ethnically-matched provider could pose a barrier to care for some individuals.

## 5. Implications for Practice Potential Strategies

The pervasive mental health problems and barriers to care that many Latinos in Durham face suggest a need to scale up affordable and culturally competent mental health care. Mental health care in the United States generally encompasses the counseling and medication regimens that are provided by highly-trained professionals such as psychologists, psychiatrists, licensed clinical social workers and licensed counselors. However, the resources needed

to implement this quality of care in Spanish-speaking and immigrant communities are still lacking. The need for Spanish-specialized care coupled with the lack of providers who can supply this care indicates a need for more creative solutions. Some ways in which Spanish-specialized care could be improved have already been suggested in the treatment literature for other, similarly low-resourced communities.

Task Shifting is an innovative approach to mental health care in which counseling responsibilities are shifted to individuals with narrowly-tailored training, commonly referred to as “lay-providers.” Under this approach, respected community members or existing spiritual providers can be given evidence-based training and begin to deliver mental health care under the supervision of a licensed practitioner (Kakuma et al., 2011). This approach is particularly useful because it is implementable even for a community with limited resources, and typically costs very little for the patients. Another positive aspect to this approach is that the lay-providers are generally respected community members, potentially facilitating trust between providers and patients (Kakuma et al., 2011). Task shifting also opens the door for intersectoral collaborations such as partnerships with schools or churches to increase mental health awareness, detection of mental health disorders, referrals and service delivery (Kakuma et al., 2011). Task shifting has been proven to improve access to and quality of care in a number of low-resource settings (Kakuma et al., 2011; Tran et al., 2014) and could be a unique and promising avenue for intervention in Durham’s Latino communities.

The majority of task shifting evidence has been collected from low- and middle-income countries; however, pilot programs have already taken place in Central North Carolina (Tran et al., 2014). In 2013, a team from Duke University and the University of North Carolina at Chapel Hill piloted “Amigas Latinas Motivando el Alma (ALMA), a promotora (Hispanic/Latino community member with specialized training in health education and promotion) intervention designed to reduce stress and promote coping skills among recently-immigrated Latinas” (Tran et al., 2014). The researchers identified potential promotoras through established community contacts, including church leaders, community activists, and other agencies already serving the communities (Tran et

al., 2014). With training in social network building and effective coping, participants in the ALMA program showed a significant decrease in depressive symptoms and increases in productive coping strategies and perceived social support (Tran et al., 2014). Overall, the results from ALMA program suggest that task shifting interventions could potentially be effective in the Durham Latino community. Task-shifting interventions are of little to no cost for the patient, eliminating the financial barrier to accessing mental health services, and can be altered and generalized to fit a multitude of different populations.

Telecounseling interventions utilize telecommunications technologies to provide behavioral health care from a distance. It has emerged as a promising intervention for racial and ethnic minorities, as it has the ability to connect patients with ethnically matched providers in remote locations (Jang et al., 2014). Telecounseling has been shown to produce significant short-term effects in ethnic minority communities, including “large improvements across measures of depression, anxiety, quality of life and psychosocial functioning” (Dorstyn et al., 2013). Still, the emerging nature of telecounseling technologies has limited long-term data collection (Dorstyn et al., 2013). Despite telecounseling’s proven effectiveness in ethnic minority communities, there have been relatively few studies of its effectiveness in linguistically isolated communities (Jang et al., 2014). Jang and colleagues (2014) examined the effect of video counseling sessions between linguistically isolated Korean-American patients and Korean-American providers in other parts of the country. They reported an 86% completion rate and significant reductions in depressive symptomologies both following treatment completion and after a 3-month follow-up (Jang et al., 2014). The above findings suggest that telecounseling interventions could be utilized in Durham to improve access to Spanish-specialty care and subsequently improve mental health care within Latino communities.

Health Promotion Programs can be delivered by specialists or trained community members and are particularly powerful tools for intervention, as they seek to educate communities of individuals about how to have better control over their own health and wellbeing (WHO, n.d). They can be introduced in various settings but are most commonly implemented in

schools and faith-based communities. A 2015 study introduced a mental health promotion and prevention program in an urban elementary school and found considerable improvements to both functioning and academic achievement among Latino students (Montañez et al., 2015). The study was limited in its collection of mental-health specific findings, but the program's results included increases to pro-social behavior and classroom compliance, as well as improved academic achievement (Montañez et al., 2015). A similar program targeted domestic violence prevention and self-esteem improvement in Latina women (Fuchsel, 2014). Implementing an empowerment-based psychoeducation curriculum, the participants reported improved self-esteem levels and knowledge of healthy relationship dynamics (Fuchsel, 2014). Both of the above interventions illustrate the effectiveness of education- and promotion-based interventions in Latino communities. Their ability to impact large groups of people and target clinical and sub-clinical levels of dysfunction make them a particularly promising strategy for the Durham Latino community.

#### 6. Existing Community Resources and Opportunities for Intervention

The presentation of mental health problems and barriers to care within the Durham Latino community does little to accurately represent the strength of the community and its existing resources. Despite pervasive mental health problems, Durham's Latino population encompasses several robust religious communities, has implemented an expansive English as a Second Language (ESL) program in Durham Public Schools (DPS) and has founded several limited but efficacious non-profit health centers. It is important to operate within these existing structures in order to effectively and efficiently address mental health with Durham's Latino community.

**Religious Communities:** The vast majority of Latinos living in the United States are affiliated with religious communities and seek out religious leaders for mental health care ("The Shifting Religious Identity of Latinos in the United States," 2014), making these leaders a potentially fruitful avenue for intervention. In Durham specifically, Immaculate Conception Catholic Church serves as a religious center for many Latinos and offers Spanish-language services, connections to various Latino outreach groups and

partnerships with a number of social justice organizations that focus on Durham's Latino population. Religious partnerships utilize religion "as a means of connecting to the target community's cultural values and traditions... thereby increasing the impact of the health-related content" (Schwingel & Gálvez, 2015). Thus, working alongside Immaculate Conception could increase the impact of a mental health intervention while simultaneously strengthening the community's existing resources. Similarly, Latinos most often seek mental health services from religious leaders. A 2012 study found that religious leaders are the leading provider of mental health services for Latino immigrants (Bridges et al., 2012). A partnership with local religious communities would allow for these services to be improved, studied and expanded. Health promotion programs could be particularly effective in this context, as they can be delivered to a large number of individuals at once. The benefits of partnering with a religious community are multi-faceted. Religious organizations provide established community connections, are tightly associated with cultural and community values and have the potential to strengthen and expand existent mental health services.

Durham Public Schools offers a substantial ESL program which employs approximately 79 ESL instructors throughout Durham County's public schools ("Durham Public Schools," n.d.). Instituting a program in collaboration with DPS's ESL would provide access to care for a large number of children and adolescents, given that federal law mandates school attendance. Additionally, ESL instructors have Spanish language training, eliminating the language barrier. Successful community-based interventions work within existing sectors (in this case parents, families, school counselors, teachers, and administrators) to establish common goals and decide the best way to achieve them (Kakuma et al., 2011). ESL teachers could be trained to identify acculturative stress and ask students how they are coping with it, participating in both initial evaluation and referral. Subsequently, school psychologists could be trained to identify and adapt to the needs of acculturating students. A 2015 report addressed the need to provide culturally competent care to immigrant families and offered suggestions for developing these competencies in school psychologists (Garcia-Joslin et al., 2015). The



authors highlighted the importance of understanding the “cultural context of social, emotional, behavioral, and/or academic concerns,” educating school personnel about the language acquisition process, and involving the family in the intervention process (Garcia-Joslin et al., 2015). Partnering with school systems allows for broader outreach within a network of Spanish-speaking professionals and certified school psychologists.

Existing Health Centers: Recognizing the need for affordable Spanish-specialty care, a number of nonprofit health centers and various institutional collaborations have been founded in the Durham area. Most notably, El Futuro was founded in 2004 in an attempt to address the growing need for culturally competent mental health and substance abuse care for central North Carolina’s growing Latino population (“About Us,” n.d.). They provide services in exchange for a nominal fee “in order to promote personal responsibility.” Each year, more than 1,600 adults and children present to El Futuro for services, with 82% of individuals served showing clinical improvement and 96% of individuals served reporting “feeling helped” (“About Us,” n.d.). El Futuro has had a tremendous impact on the mental health of Durham’s Latino community; unfortunately, their influence is limited by funding and staffing. A partnership with El Futuro could be established to provide valuable resources in exchange for community connections and knowledge on existing clinical interventions. This partnership would enable expansion and support of existing mental health services.

## 7. Gaps in Existing Literature

Several gaps in existing literature were identified throughout the process of completing this project. It is notably difficult to find mental health prevalence data for children and adolescents. There is no Durham-specific data for this population and national data is sparse. Increasing research with an aim to cross-culturally validate diagnostic measures would improve the clinical significance of findings in ethnic minority psychology.

There is currently little to no research identifying specific causal pathways between acculturation and mental health problems. Existing research is limited to correlational studies, which are useful but unable to establish causality. Increasing research ac-

tivities with an aim to study the specific causal pathways behind acculturative stress could be useful, as it has the potential to shape our understanding of the acculturation process and future interventions. Additionally, the influences of both acculturation and religion on mental health have both been studied in detail, but very little work has been done regarding the impact of religion as a mediator in the acculturation process. It is well documented that Latino immigrants seek out religious communities; however, there is very little data on the effect of religious community membership on acculturation and acculturative stress.

The most notable research gap pertains to which types of specific interventions are most efficacious in low-income immigrant communities. Task-sharing has been proven effective in many low- and middle-income countries, yet there is a dearth of data regarding task-shifting in low-income communities within higher-income countries. Research should be expanded to further explore the implications of task-shifting in these communities. These interventions are particularly valuable on account of their ability to reduce language and cultural barriers. Similarly, there is as of yet no data on the efficacy of telecounseling for Latino communities. Existing research has assessed the feasibility of telecounseling, but has not examined its ability to connect culturally and linguistically isolated individuals via comprehensive mental health care. All in all, more research is needed to assess the relative efficacy of different forms of Spanish-specialty interventions.

## 8. Conclusion

The recent rise in Durham, North Carolina’s Latino population calls attention to the need to expand Spanish-specialty mental health care in the city. A number of needs assessments have documented the mental health of Latino communities and found alarming rates of mental illness (Samoff et al., 2014; Auerbach et al., 2007). The acculturative distress that can often be a result of immigration and living in non-native countries further compounds the mental health problems of many Latino immigrants (Polo & López, 2009). However, when assessing access to mental health care, it is clear that there are several systematic barriers impacting Latino immigrants, particularly high cost and lack of bilingual providers

(Samoff et al., 2014). Elevated levels of mental illness and systematic barriers to care suggest a need to present creative and cost-effective solutions, much like those that have been implemented in lower- and middle-income countries. Task-shifting, telecounseling, and health promotion programs have the ability to connect Latino immigrants to culturally competent care for free or at a reduced cost. There are a number of community resources that could be used as a starting point for these interventions, including religious communities, Durham's public school system and existing safety-net clinics. This paper took an equally creative approach in referencing multiple different types of literature, which ranged from empirical articles and book chapters to census data and news stories. Several gaps in this literature were also noted. In particular, little data currently exists regarding how to implement creative care solutions within Latino communities, and specific causal pathways between acculturative stress and mental health disorders have not yet been identified.

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