THE UNDERGRADUATE RESEARCH JOURNAL OF PSYCHOLOGY

AT UCLA | 2014-2015

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Journal Staff

Acknowledgements

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Note from the Editors-in-Chief

In 2013, The Undergraduate Research Journal of Psychology at UCLA was founded with the goal of empowering the next generation of psychology scholars to pursue and share their research endeavors with the larger academic community. Through the collaborative efforts of our undergraduate staff, graduate student advisers, and undergraduate authors, The URJP met this goal in its inaugural year and again this year. We continue to be encouraged and driven by the ever-growing interest that we receive from undergraduate students worldwide.

The response to our organization has been large and overwhelmingly positive, especially considering how new we are to the scene. While working to secure recognition on and off campus, we have continued to build upon the vision of our founders by prioritizing the success of our undergraduate staff and authors before all else. Our aim is that all undergraduate students in psychology and related fields will be inspired by research - both to conduct research and apply it. Research is an integral part of success in academia, especially for those who want to pursue a doctorate degree. It has been our experience that research is often intimidating and abstract to undergrads - a realm seemingly reserved for professors and graduate students. But everyone starts somewhere, and we believe that the sooner one becomes involved in research, the better they will become at asking questions and exploring the innumerable inquiries that are possible in a dynamic field like psychology.

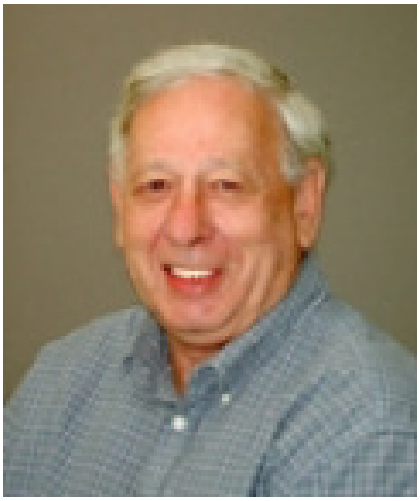
With that said, we feel that we have managed to make our second year a successful one, and we have the numbers to back it up. This year we received 109 submissions from 57 different colleges and universities across the globe and raised over $2,100 in donations from faculty, alumni, and peers. Out of the vast pool of submissions, we are proud to share four of those articles with you here.

First and foremost these accomplishments would not have been possible without the commendable efforts of our undergraduate staff and the expertise and guidance of our graduate student advisers. In particular we would like to extend a special thank you to Brianna Goodale and the Underrepresented Graduate Students in Psychology for hosting several academic workshops that provided our staff with valuable knowledge and skills that they will take with them in their graduate school endeavors.

Thank you to all the faculty at UCLA who have expressed support for our organization; your words of encouragement motivate us to continue to produce great work and represent our university. Last but not least, thank you to the graduate students who took the time to write advice articles for this year's issue - there is no better source for advice than the experiences of those who have already made it to where you want to be.

Anthony Osuna, Alisa Muñoz, & Vincent Nguyen

Preface



Howard S. Adelman

Professor and Co-director, School Mental Health Project & Center for MH in Schools

The second volume of The Undergraduate Research Journal of Psychology at UCLA is here and once again provides an exciting platform for undergraduates to join in the scientific conversation.

Undergraduate involvement in research, of course, contributes not only to the advancement of scientific knowledge but to the personal development of those who participate. Each year, more and more undergrads are taking advantage of the special opportunities available to them to extend what they learn in lectures and the type of interactions they have with faculty, graduate students, and other undergrads.

Some students have used the opportunities to translate their work into an article for this journal and to present a poster session on campus and elsewhere, and some have contributed enough to be credited in published work by a faculty member and/or graduate student. As rewarding as all this is, the fundamental benefits of participating in research activities derive from how the experiences shape one's future.

Here is what two undergrads working in our Center for Mental Health in Schools at UCLA had to say about their experiences:

"My involvement has helped me value knowledge and the content of new information being produced. It has become both a process of personal development and of self realization. The funnest part is that it's a continuous challenge that is exciting! It has definitely been a hallmark of my time at UCLA and has helped me come closer to my career goals."

"I learned that research is a fundamental tool for acquiring knowledge and expanding the mind, ideas, and interests. It can take you into a new path of innovated thinking and new discoveries of infinite and diverse topics."

What I see everyday is that participating students develop knowledge, skills, and attitudes that pay immediate dividends for them and ultimately will benefit our rapidly changing world.

The great baseball personality, Yogi Berra, once said, "If you don't know where you are going, you might end up someplace else." We mean for undergrads to use their research experiences to help crystalize where they want to go. And wherever the path leads them, we want it to be someplace they want to be. In the process, we want their curiosity, creativity, critical sensitivity, and truth seeking to blossom.

On behalf of faculty and graduate students, let me express appreciation for all that undergrads contribute when they participate in our research activities. And to those who are making this undergraduate journal so successful, congratulations on Volume 2. Your continuing efforts are contributing to a new tradition and are providing an important and empowering vehicle for those seeking to share their scholarly efforts.

Faculty Endorsements

Thomas Bradbury, Ph. D "Even in times of remarkable technological achievements, the essence of the scientific process remains unchanged: ask a vital question, employ rigorous methods to differentiate among possible answers to that question, and communicate the results with clarity. As young scholars, undergraduates bring needed passion, curiosity, and fresh ideas to this age-old process. I am delighted that the URJP at UCLA provides these scholars with an outlet for their contributions, and I will read their papers with great interest."

Gennady Erlikhman, Ph. D "I have been fortunate to work with many talented UCLA undergraduate RAs. Many projects would not have been completed without their help. Their effort, enthusiasm, and intelligence are reflected in the many presentations and papers on which their names appear. This journal is a fantastic opportunity to showcase the excellent work that they do, communicated in their own words. It is the most rewarding experience to discover and then tell others about the answer to a question or the solution of a mystery after many hard-fought months or years of research. I am thrilled that undergraduates have the opportunity to have that experience with this journal."

Patricia Greenfield, Ph. D "I congratulate the editors and authors of the Undergraduate Research Journal of Psychology at UCLA! Since this online journal was founded only two years ago, it has received almost 250 submissions from about 100 different universities located in 7 different countries. In this issue, you will read four empirical and review articles the editorial staff has selected in a highly competitive process. The journal's dedicated editors are providing important exposure to the publishing process for undergraduate researchers all over the country and all over the world. Through these efforts, they are furthering the UCLA Psychology Department's mission of developing the next generation of psychology researchers."

Benjamin Karney, Ph. D "My advice to anyone interested in understanding modern life is: do research. Volunteer in a lab. Help out conducting a study. Learn what it is like to pose a question about how people act, and then to gather data that answers that question. Even if you do not proceed to a career in research, you will never ask questions the same way again, and never read headlines about research the same way either. The Undergraduate Research Journal of Psychology at UCLA provides students with the platform to explore and share these questions with the larger research community."

Zili Liu, Ph. D "I am very pleased to learn that UCLA provides this opportunity for undergraduate students to publish their research in this journal. Going through the entire research and publication process will be great experience for the students down the road in their careers."

Catherine Sandhofer, Ph. D "Some of the best college experiences take place in a laboratory. Participating in research allows students opportunities to learn new skills, to make significant discoveries, and to contribute to a body of knowledge. Moreover, participating in research allows students to gain the types of experiences that employers are looking for."

Ladan Shams, Ph. D "Undergraduate researchers have been essential to the productivity and creativity in my lab, and I believe this is the case in most Psychology laboratories. Research experience is also a critical component of science education for undergrads, in my opinion. Students learn first-hand how science really works. Exposure to science through lectures and textbooks is insufficient in conveying the dynamic and tentative nature of scientific progress. These and other important aspects of science can only be learned by hands-on and first-hand experience.The Undergraduate Research Journal of Psychology at UCLA allows undergrads to take their research a step further, to engage in the publication process which is just as pertinent to academic development and success as the research itself."

Advice From A Grad

Brianna Mae Goodale, MA
Graduate Student, Social Psychology
Department of Psychology, UCLA

How to Ensure Quality Letters of Recommendation

"I'm sorry… do I know you?" He tilted his head to the side, the journal on his desk that he was reading forgotten. I blushed and stammered, "Oh right, sorry, I took your class a year ago. I really enjoyed it, and I need a letter of rec from a Professor since I'm applying for grad school in the Fall. Could you write me one?" Richard's eyes widened further. "I'm really sorry," he added, "But I don't remember you." He stood up from behind his desk and walked around me to the couch where he sat down, kicking his shoes off and sprawling back. My heart sank and I fumbled for words. Richard smiled at me and added, "So why don't you tell me a little about yourself then."

Well over six feet tall, Richard Hackman was a giant in person and in the field of Organizational Psychology. His contributions to team management and job motivation had earned him tenure as a Harvard professor and a fifteenth-floor corner office that overlooked all of Boston. He later confessed to me that he did remember me, since I had done so well in his class, but that when I barged in unannounced, he was inclined to think me demandingly rude. Over the course of our conversation, in which I revealed my dad was a mailman and I came from rural New England, he changed his appraisal of me to well-intentioned but incredibly naïve. He eventually offered to write me a letter on the condition that I volunteered in his psychology lab that summer.

I love this story because it exemplifies exactly what NOT to do when asking for a letter of recommendation. Firstly, if you're going to ask a professor for a letter, you want to make sure the professor knows who you are. Beyond enrolling in his or her class, you need to attend lecture and do well on all assignments. Teaching several hundred students at a time, most professors don't know everyone's name. To change this, go to the professor's office hours and ask thought-provoking questions that demonstrate you have done the readings or explored beyond the required material. You want the professor to know who you are and furthermore, to know how much you care about psychology.

Secondly, you want to stay in touch with the professor. When I asked Richard for a letter of recommendation, I hadn't spoken to him in over a year. He had no idea what was going on in my life or what my ambitions were. In part, he offered me the volunteer position so he could get to know me better and write a more informed letter. While some professors may express regret upfront if they feel they do not know you well enough to write a recommendation letter, not all will. Instead, some may write you sub-par or template letters that any admissions committee will instantly see through. You want to be sure that the professor writing your letter knows you and believes in your ability to succeed in graduate school. An occasional email checking in with the professor or taking them out for coffee to catch up will go a long way towards making your request for a letter seem less out of the blue and less of a hassle.

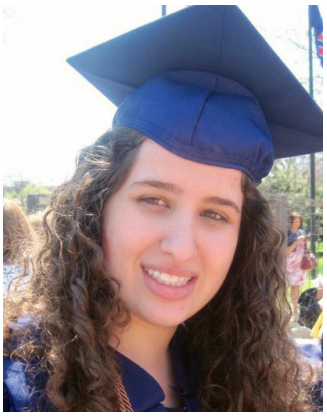
Another way to ensure a great letter of recommendation, volunteering in a professor's lab enables them to comment on your ability to conduct research. Psychology graduate schools want to admit students who will be productive researchers; your ability to do well in classes matters, but significantly less than your potential to think and run studies independently. At least one of your letters of recommendation should speak to your ability to conduct research. Ask your favorite professors if their labs are hiring and try to get involved early.

Advice From A Grad

Finally, in terms of application deadlines, make sure you help your letter writers as much as possible. Compile a document to share with them that outlines every school you will apply to, who you want to work with there, the specific due dates of each letter and whether the professor needs to email, submit online or mail in their letter. Including the individuals you would like to work with in the compiled spreadsheet may be helpful, as some professors have extensive professional networks and may know those individuals personally. In these cases, they can speak directly in their letter about why you would be a good fit for that lab. This spreadsheet should also include a column where you can note anything in particular that you would like the professor to highlight. Most letter writers will write only one letter to send to all graduate programs, changing the graduate school's name each time. Do not expect to see your letter of recommendation, as most schools make you sign away that right and asking your professor for a copy creates an awkward situation. As the deadlines for filing letters approach, feel free to send friendly, gentle reminders to your professors but be wary of making unrealistic demands on their time.

Once all the deadlines have passed and your letters of recommendation are in, consider hand-writing thank you notes to each professor. Further, you might get them a small token of appreciation, like a bag of their favorite coffee. Isaac Newton said it best when he attributed his success to "standing on ye shoulders of Giants." You cannot get into graduate school without good letters of recommendation; I have, in a very large part, my letter writers to thank for my graduate school achievements. In particular, I would not be where I am without the tallest Giant of them all, Richard. It is in his memory that I wish to dedicate this column and hope that you all may find your Giant letter writers who believe in you too.

Advice From A Grad



Kasiani Michalopoulos, MA

Graduate Student, Clinial Psychology

California School of Professional Psychology, San Diego

PsyD vs PhD

You have your Bachelor's degree, but now what? One of the major questions students have who are interested to pursue a degree in psychology is whether to get a Doctorate of Philosophy (Ph.D.) or Doctorate of Psychology (Psy.D.). What are the differences? How will the degree you choose impact your future? These are some factors to consider when deciding between a Ph.D and a Psy.D.

As a starting point, finding an APA-accredited doctoral program may be a crucial factor due to the field gravitating towards American Psychological Association (APA) standards, including pre- and post-doctoral internships which often require training from an APA-accredited program. There are several programs accredited that offer both Ph.D. and Psy.D. However, programs will provide different training models depending on whether it is Ph.D. or Psy.D. Ph.D. programs will heavily concentrate on research, whereas Psy.D. programs will concentrate more on clinical application.

Almost every APA-accredited program will require completion of a dissertation, or dissertation-like project, regardless of the specific degree. Many Ph.D. programs require completion of a quantitative dissertation, whereas Psy.D. programs often will be more flexible with quantitative or qualitative design being acceptable. With the consideration that the Ph.D. focuses more on research, classes will focus more on research design and statistics. On the contrary, Psy.D. classes will focus less on research and more on theory and treatment planning. Generally, Ph.D. programs will require more years to graduate than Psy.D. programs, averaging 5-6 years versus 4-5 years, respectively. Both programs offer specializations, although it is recommended to explore what different graduate programs have to offer because they may not all offer the same specializations.

Additional factors to consider are the chances of getting admitted to each program, with higher acceptance rates being shown amongst Psy.D. programs versus Ph.D. programs. There are typically less slots offered into Ph.D. programs, but usually greater funding including grants, fellowships, and other training opportunities that may greatly reduce the debt accrued during graduate training if seeking a Ph.D.

Besides the difference in focus, time to completion, and possible debt, how does each degree affect your career opportunities? With the focus in Ph.D. being research, this may open up greater opportunities to teach at universities or work in parts of the private sector where your expertise as a researcher are highly utilized. You can also teach at universities with a Psy.D., though this is not as common since the emphasis in Psy.D programs is in clinical application. This emphasis however, may be an advantage in certain settings due to your expertise in face-to-face interactions with clients. Despite the degree, you still have the opportunity to work in various settings and wear many different hats, which is so wonderful about being a psychologist.

The importance of science and research in our field is essential, but an important question to ask yourself is, do I want to be a producer of research (Ph.D.) or a consumer of research (Psy.D.)? In sum, there are several factors to consider when choosing which degree to pursue and various programs with different training models. You may have already come across various opinions regarding which degree is "better," but I believe it is finding the program that is a "better" fit for you.

Advice From A Grad

Christina Schonberg, MA

Graduate Student, Developmental Psychology
Department of Psychology, UCLA

A Day in the Life of a Grad

Although attending a graduate program technically still falls under "being in school," one of the first things that I found out was that the expectations and the way I'd spend my time would be very different from college. At the beginning of my first year, my advisor recommended that I try to think of grad school like a job: work very hard for 40 hours/week, and try to have a life outside of that. Unlike college, grad school really does feel more like a job than an all-encompassing experience (at least, most of the time). Maintaining a balance between work and the rest of your life is key in avoiding burnout.

As a graduate student, I generally spend my time working on things in four major areas: research, teaching, coursework, and mentoring/service. This will differ for everyone, of course – your teaching load will vary depending on your year in the program, as will coursework. Now that I've finished my course requirements, my time is pretty evenly divided between the other three categories.

When I spend time on research, that includes things like training research assistants, designing studies and making stimuli, collecting data, and analyzing and presenting my results. Depending on the week, I spend anywhere from 12-18 hours/week on research-related activities. This also includes holding individual meetings with my primary advisor, attending my advisors' lab meetings, and writing grants for research funding.

Teaching typically takes about 15-20 hours/week, depending on the course I'm teaching. This mainly includes teaching sections, holding office hours, and attending lecture. I also grade exams and course assignments, write exam questions, meet with the professor and other TAs as needed, and may give a guest lecture or two in class.

Finally, I spend about 7-10 hours/week in various mentoring and service activities. This includes working with another grad student in my lab to hold a weekly journal article discussion group for our lab's undergraduate RAs, helping out with university-wide graduate student groups, and planning my area's interview weekend for prospective graduate students. This year, I am an officer in the Psychology Graduate Student Association (PGSA), co-organize a weekly colloquium series in my department, help to coordinate undergraduate outreach events through the Underrepresented Graduate Students in Psychology (UGSP), and am on the planning committee for the Psychology Interdisciplinary Events spring symposium. In addition to these larger departmental activities, I also mentor individual students in my lab who are RAs, PROPS students, and honors students.

On any given day, my schedule might look something like this:
8:45am: Leave home to drive to campus*
9:30-11:00am: Arrive on campus a little early to prep. Teach a discussion section I'm TAing this quarter.
11:00am-12:30pm: Lab meeting with my secondary advisor. Each week, a different graduate student gives a presentation about a project they're currently working on.
1:00-2:00pm: Meet with my primary advisor to discuss research, progress on requirements, and/or career.
2:00-3:30pm: Data collection with participants who have been scheduled for this day/time.
3:30-4:30pm: Meet with two of my research assistants about the poster they're putting together for conferences.
4:30-5:30pm: Attend a PGSA meeting.
6:15pm: Arrive back at home. Cook dinner and decompress for a bit.
7:30-10:00pm: Catch up on writing or presentations if there are upcoming deadlines; otherwise, you can find me hanging out with friends, climbing with my roommates, or at community choir rehearsal.

*Another big difference between college and grad school is that it's very likely that you won't live within walking distance of campus anymore. Some people do, but most of my colleagues prefer to have some physical separation between work and home.

Advice From A Grad

Aleksandra Petkova, BA

Graduate Student, Clinical-Developmental Psychology
Department of Psychology, University of Pittsburgh

I Got into a PhD Program, What Happens Next?

This is probably a question that, for many of us, follows immediately after receiving the good news of being accepted into a PhD graduate program in psychology. Once you have gone through the application process, the interviews, and finally received a yes answer, you finally start to think about the journey that is yet to begin. So, what comes next and how is your life going be different as a PhD student?

I decided to pursue a PhD in Clinical Psychology while I was still completing my undergraduate degree in psychology and mathematics. My natural curiosity and passion for research kept me firmly grounded in the academic world. While completing my undergraduate psychology thesis, I longed for even more time to ask questions, collect data, read, and write. I was particularly interested in the clinical field because I was hoping to find a way of integrating my interest in scientific research with my desire to be a clinician. Although I felt prepared to embark on the PhD journey, there were certain aspects of it I wish I had known more about in advance.

The graduate student life is quite dynamic, things keep happening around the clock. If you have chosen to enter a PhD program, the odds of you maintaining a busy schedule and a fast-paced lifestyle are probably pretty high! The ways in which you spend your time will, to a large extent, be driven by your classes and lab meetings. You might find yourself going to multiple lectures and meetings a day, perhaps having to hold office hours and doing some grading if you are a TA, and then going home only to do more work that involves completing your class assignments or working on research projects. While I can't speak to all programs, this is certainly the case with clinical programs – among your research endeavors you are also tackling classes, lab tasks, and clinic duties.

However, unlike when you are in college or working for somebody, you still have a lot more freedom in building and managing your schedule. You might find that some days your meetings and classes for the day don't start until the afternoon, on other days you might have to be in your office with the crack of dawn, yet you can take the afternoon to do groceries or to exercise. While it is certainly great to have flexibility in terms of when, where, and how you get things done, one challenge is to learn how to use your time wisely. It is easy, for example, to put off reading recent literature or writing when you have no pending due date for a submission, or when you feel like you did a lot of work for your classes. Thus, I find that the careful monitoring of your time and what you focus your efforts on, is crucial for success in academia. A more concrete piece of advice when it comes to being productive in your research would be to schedule time for writing, just as if you would have to be in class or attend a meeting. While you might not be able to write up a study within a day, try using an hour or two in the morning to come up with a draft – this would already be a good start.

Additionally, you will have to prepare yourself for approaching big and challenging tasks frequently. Sometimes you might be asked to do things in your lab that you have no idea how to do, or you might feel intimidated by the thought of proposing and implementing a Master's study on your own. This is when being a graduate student might feel scary, lonely, and isolating. To which I say – you are not alone! Personally, I think the most important lesson I learned during my first year was to learn how to ask for help. Asking questions, as many as you need to ask, is a good skill to have! Remember, it is okay to say that you are not sure how to run a certain type of statistical analysis, how to work with data that somebody else from your lab has collected, how to approach a homework problem, or that, to put it simply, you feel directionless. This does not mean that you are incompetent of getting the work done; rather, it means that you are in the process of learning new information and techniques! This is why you are still a student. While it might be intimidating to ask your advisor or older graduate students for help with certain tasks (probably because you feel like you should know how to do things by now), don't forget that they were in shoes, maybe even not too long ago.

As a PhD student in psychology you will be busy and challenged frequently; however, don't forget that what brought you to a PhD program was, among other things, your intellect, curiosity, and good work ethics. When in doubt, go back to the basics – ask questions, set manageable goals, and don't fear the unknown. Keep an open mind to the possibilities that research opens for you and work through difficult tasks with persistence, courage, and dedication.

Brett Bankson

University of Portland
University of South Carolina

Brett Bankson graduated from the University of Portland in 2014 where he studied psychology, French, and neuroscience. His past research experience has included time spent studying motor speech disorders, speech and gesture integration, and artificial grammar learning in people with aphasia. He most recently worked in the Neurolinguistics Lab at the University of South Carolina with Dr. Dirk den Ouden, where they focused on developing a novel aphasia treatment and identifying how complex verb structures are processed in the brain. In particular, Brett is interested in studying how language use reflects perceptual capabilities and how perceptual information can be recruited for high-level, goal-directed cognition. Brett will be working as a postbaccalaureate research trainee in the fall and intends to continue on to his doctoral studies in cognitive neuroscience. He enjoys cooking, reading, and exploring the Pacific Northwest whenever he can.

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Different Neural Mechanisms For Causal Processing In Language and Perception: An fMRI Study

Brett B. Bankson[1, 2], Dirk den Ouden[2]

[1] Department of Psychological Sciences, University of Portland

[2] Department of Communication Sciences and Disorders, University of South Carolina

Information that is used to establish and evaluate causal relationships between objects and events can be gleaned from many sources, especially those that rely on language and perception. For example, sentences with a verb structure using change of state verbs such as "to break" or "to freeze" imply sequential events that express understood causal relationships. At this time, little research has examined the neural correlates of causal verb processing or has compared them to the more well researched brain activity involved in perceptual causal processing. This study investigated the extent to which the evaluation of causal verbs and causal image pairs recruits brain areas distinct from non-causal verbs and non-causal image pairs. The authors administered a lexical task and a separate perceptual task involving causal judgments to 6 participants in an MRI scanner. Data analysis yielded no activation differences for the linguistic task conditions, suggesting that there was no difference in causal processing between the change of state and non-change of state verbs used in the current study. In the perceptual task, the activation peaks that were found for the causal image pairs in the inferior parietal lobule and supramarginal gyrus, rather than the expected frontal areas, suggest that perceptual causality is evaluated based on modality-specific qualities such as spatial change and implied motion. The depiction of sequential events and before-after states in the causal image stimuli provide a new context for perceptual processing in parietal and temporal cortices. Further analysis and additional research that utilizes a more explicit linguistic task will focus on the role language plays in encoding causality based on perceptual information so as to further clarify neural recruitment during causal processing.

Beginning centuries ago with the seminal work of Hume and Kant, questions have arisen regarding the ability to understand causal events and relations. A central inquiry focuses on the problem of whether causality can be understood as an a priori concept, or if one requires a concrete understanding that originates in personal, lived experience (Hume, 1738). Stemming from this fundamental question, modern lines of research have explored how causality is represented and processed over linguistic and perceptual means in order to clarify how causal information supports higher-level cognitive functions such as planning, predicting, and categorizing (Fenker, Waldmann, & Holyoak, 2005; Fonlupt, 2003).

In language, different types of verb structures are used to categorize whether a causal relationship is perceived as direct or indirect. For example, participants viewing causally related animated events have demonstrated a preference for one-word verb constructions such as "move" or "push" when describing direct causation (i.e. an interaction lacking any mediating events), while demonstrating a preference for phrases with two verbs such as "cause to move" or "make shatter" when describing indirect causal events with intervening steps (Wolff, 2003).

Perceptual causality, or the identification of causal events based on the observation of interactions, has primarily been investigated using visual animations such as the Michottean launch paradigm (Michotte, 1963). In this paradigm, one object moves towards another object until contact occurs and the second object moves. Object size, speed, resulting motion, and motion delay are among those characteristics typically manipulated to investigate causal attributions; these animations demonstrate how the qualities of proximity (the temporal distance between two events), exclusivity (the presence of a necessary causal source), and

priority (the cause precedes the result) are used to judge the relatedness of two events.

Neural Signature of Linguistic Causal Processing

The neural representation of causal processing in a linguistic context appears to differ from other types of semantic analysis, primarily association judgments. In tasks where participants both viewed and produced causal or associative word pairs, causal processing with asymmetric word pairs elicited significant activation of the left middle frontal gyrus (MFG) that was not seen during associative processing with symmetric word pairs (Satpute et al., 2005; Wende et al., 2012). Causal asymmetry refers to relationships that demonstrate a necessary temporal order seen in cause-effect events, such as 'wind-erosion' and 'spark-fire' (Fenker et al., 2009). This type of relationship contrasts with associative word-pairs that are symmetric, such as 'emerald-ring' and 'fruit-vegetable' that do not necessitate a certain order of presentation. The activation in the MFG results from the increased demands of semantic causal inference because the MFG, as well as the dorsolateral prefrontal cortex (DLPFC), are implicated in higher-level working memory tasks such as the storage and evaluation of object and event relations (Satpute et al., 2005). The retrieval of sequential, causal relations from semantic memory induces activity in the left middle and superior frontal gyri when compared to the retrieval of taxonomic, or associative, relations (Kuchinke, van der Meer, & Krueger, 2009). The predominant activation of the frontal cortex for tasks of linguistic causal judgments indicates that such procedures require more complex cognitive processes than other aspects of semantic processing.

To date, few studies in neurolinguistics have examined the representation of causality by investigating the lexical semantics of verb classes. By examining how the brain encodes certain verbs as causal events, one can begin to clarify how linguistic causal processing is facilitated by the lexical semantic information presented by verbs, and how this compares to non-causal or associative processing in language.

Neural Signature of Perceptual Causal Processing

The increased neural activation that is displayed during complex semantic processing has also been demonstrated with tasks of perceptual causality. The judgment of physical causality in billiard ball collision events, more so than the passive viewing of the same physical events, results in increased activity of the medial and dorsal superior frontal gyrus (Fonlupt, 2003). Studies have shown that the spatial and temporal qualities of such related events influence whether individuals identify them as causal or non-causal, and that such decisions are instantiated in particular brain areas. (Buehner, 2012; Fugelsang, Roser, Corballis, Gazzaniga, & Dunbar, 2005; Hecht, 1996). Specifically regarding spatial characteristics, the left inferior parietal lobule has been implicated in processing spatial relations during billiard ball style launch events with variations in the launch angle (Woods et al., 2014). This parietal activity can also be modulated by the contextual complexity of observable physical events (Han, Gin, Mao, Friederici, & Ge, 2012).

Present Study

The present study used functional magnetic resonance imaging (fMRI) to examine where processing of linguistic and perceptual causality occurs in the brain. Specifically, linguistic and perceptual causal processing were compared to clarify which, if any, overlapping brain regions facilitated causal processing over both modalities. This was done by investigating how the processing of causal information from lexical semantics in a verb task and perceptual stimuli in an image task compared to the processing of non-causal information over the same modalities, respectively. In both cases, the causal attribution depended on the qualitatively different "before" and "after" event states that are demonstrated explicitly in the perceptual task and implicitly through the semantics of the lexical task.

To examine causality in language, the authors focused on "change of state" verbs (Levin 1993). Previous research has suggested that judgments of semantic similarity regarding change of state verbs correspond with specific activity in the ventral temporal cortex (Kemmerer, Castillo, Talavage, Patterson, & Wiley, 2008). These results emerged when compared to other semantically defined classes, including "running" and "contact" verb classes (Levin, 1993). The specific neural signature of the change of state verb class suggests that a qualitative semantic difference exists between these and other "non-change of state" verbs. The authors anticipated that the neural activity that corresponds with encoding causal relations would differ between semantically- and syntactically-defined classes of change of state verbs and non-change of state verbs.

In order to expand upon previous studies that used a visual launch paradigm, this study examined higher-level processing of sequential, static images with causal relationships in a variety of life-like and relevant contexts.

The causal images used here demonstrated the necessary qualities of proximity, exclusivity, and priority as found in the visual launch paradigms. The experimental paradigm included two tasks: first, a lexical task for which participants rated the pleasantness of various verbs; and second, an image task in which participants monitored the actors or order of events depicted in pairs of line drawings.

We hypothesized that the brain areas activated by the causal conditions in both the verb task and perceptual task would be distinct from the areas activated by the non-causal conditions due to the unique demands of causal, hierarchical processing. The neural correlates of causal processing across modalities were also compared.

Method

Participants

Six right-handed, native English-speaking individuals (two female, age $M = 21.2$ years, $SD = 0.6$) participated in the experiment. Participants reported normal or corrected-to-normal vision and no history of neurological or psychiatric impairment during MRI session prescreening, briefing, and informed written consent.

Lexical Task: Pleasantness Rating

While in the scanner, participants indicated the pleasantness of each verb through a three-button press paradigm. They used their left ring finger, left middle finger, and left index finger to indicate unpleasant, neutral, and pleasant. The pleasantness rating was included rather than a more traditional lexical decision test, in which an individual decides whether or not a word is real, in order to allow participants to access the verb meaning on a deeper semantic level.

One goal of this study was to explore specifically how single verbs convey implicit causal relationships. A linguistic task necessitating explicit judgments of sequence or causality would require a paradigm employing contrasting adjective pairs (i.e. cooked – burnt, empty – full) or complete sentences (i.e. the woman jumped from the diving board into the pool). An adjective pair task would entail the processing of discrete conceptual representations of different states, and the causal sentence paradigm would require additional balancing of sentence length, word types, and construction types; thus, the single verb pleasantness rating proved to be the most feasible and relevant to the study, and avoided alerting participants to the study's goal of examining causal processing.

The pleasantness rating task contained verbs of two different classes. The first class contained 40 verbs that belong to the Change of State, Carve, Poison, and Destroy verb classes following Levin's (1993) categorization. Forty verbs were selected based on their opposite relation to the Change of State verbs, namely non-change of state verbs that do not imply any event realization or causal relationship. These verbs included Hold, Characterize, Masquerade, See, Sight, Admire, Marvel, Judgment, Assessment, Search, Correspond, Meet, Manner of Speaking, Say, and Complain verb classes as outlined by Levin (1993). Only verbs with a legal transitive usage were selected. Verbs were presented in the infinitive form, such as "to stiffen" or "to admire." By presenting only the verbs in their infinitive form, any difference in behavioral or imaging results between the change of state and non-change of state verbs can be attributed to the verb semantics.

The verb classes were balanced with regards to lexical frequency ($Mlog = 1.29$, $SD = 0.42$, $p = 0.48$; frequency data drawn from Web Celex, http://celex.mpi.nl/), character count ($M = 5.6$, SD = 1.45, $p = 0.94$), imageability ($M = 434.86$, $SD = 76.12$, $p = 0.62$; data drawn from NWatch, download at http://www.pc.rhul.ac.uk/staff/c.davis/Utilities/), phoneme count ($M = 4.42$, $SD = 1.3$, $p = 1$), syllable count ($M = 1.49$, $SD = 0.61$, $p = 0.46$), and concreteness ($M = 3.3$, $SD = 0.65$, $p = 0.28$; data drawn from Brysbaert et al., 2013). The verbs are displayed in Table 1.

Table 1
Verb Classes for Pleasantness Rating

Change of State Verbs		Non-Change of State Verbs	
break	crush	treat	grasp
fill	shrink	check	assess
close	chop	shout	taste
destroy	crash	fear	roar
burn	pop	examine	yell
shoot	dissolve	sing	clutch
stretch	poison	announce	mumble
divide	soak	hurt	grip
freeze	contract	propose	moan
boil	multiply	note	clasp
burst	enlarge	complain	adore
split	chill	scream	debate
snap	harden	smell	boast
heat	soften	search	cite
strengthen	roast	whisper	groan
double	decay	greet	insult
ruin	wither	remark	mock
smash	deepen	view	portray
bake	evaporate	pose	thrill
evolve	mature	weep	hiss

Image Task: Order Versus Actor Judgments

The image task used 90 distinct pairs of line drawings from 120 images, some of which were used twice to minimize systematic differences in stimuli between conditions. These pairs were selected from a set of 265 images normalized for processing of temporal and causal order information (Denkinger & Koutstaal, 2014). This static image set was included in the present study, rather than animations, in order to mirror more closely the semantic qualities of the linguistic task than would be possible with visual launch animations. Additionally, this image set had not yet been used in a neuroimaging study to the best of the authors' knowledge, and this preliminary application may allow for a larger stimulus set available for cognitive neuroscience research in the future.

For pairs in the first condition, participants decided whether or not the same actor appeared in both pictures. Thirty pairs demonstrated congruent actors, and 15 pairs showed different actors. The number of trials was determined based on available time in the scanner, minimum stimulus presentation time, and optimal time in between stimuli. The images included in this condition had been judged and normed to have little causal association or inherent sequence, and thus would invoke associative processing and more basic perceptual processes (Denkinger & Koutstaal, 2014). With the cue of "Actor?" before each of these image pairs, participants were primed to search primarily for similarity between critical visual characteristics. This condition was included in order to provide a perceptual control and contrast to the second condition, where participants decided whether or not the image pair demonstrated the correct event order; the cue "Order?" in this condition directed participants to pay attention to the key characteristics of a causal progression. In this second condition, 30 image pairs demonstrated a causal, sequentially correct relationship, and 15 pairs showed a non-sequential set. The 30 critical image pairs demonstrate asymmetric relationships (such as a woman in the sun followed by the same woman with darker skin), so as to model the nature of causal relationships.

The two tasks that make up this diverse paradigm can allow further understanding into the basic information needed to comprehend causal relationships over several modalities, because causal processing in everyday life does not occur in isolation of visual or linguistic capabilities.

Procedure

Verbal stimuli were presented in an event-related design. Word presentation order and inter-stimulus interval were determined using OptSeq (download http://surfer.nmr.mgh.harvard.edu/optseq/). OptSeq produces an optimal stimuli presentation order and inter-stimulus interval based on the known hemodynamic response function (HRF) and number of total trials, so as to produce the most distinct fMRI signal. This maximizes experimental power and reduces noise in imaging data. For the verbal task, each word was displayed on a monitor (aspect ratio 16:9) behind the scanner and mirrored upon a display approximately 10 cm from the subject in the MRI scanner. After instruction presentation, each word appeared in 36-point Arial font for 1500 ms and was followed by a screen with a fixation cross lasting 1700 ms to 8900 ms. Participants used a response glove on their left hand to rate the pleasantness of each verb before the presentation of the next verb. Each response corresponded with a numerical value from 7-9 based on the specific finger of the response glove, with the possible responses of unpleasant (7), neutral (8), and pleasant (9). Thus, results from this task were reported on a scale of 7-9. Because language processes are generally lateralized to the left hemisphere of the brain, participants used their left hand to induce motor activity on the right hemisphere to prevent overlap between task demands and motor response. Jitter times allowing for variable inter-stimulus intervals between each verb ranged from 1700 ms to 8900 ms. Participants practiced with ten words before entering the scanner. Total run time for the verb paradigm lasted 361.15 seconds. Figure 1 displays the verb procedure.

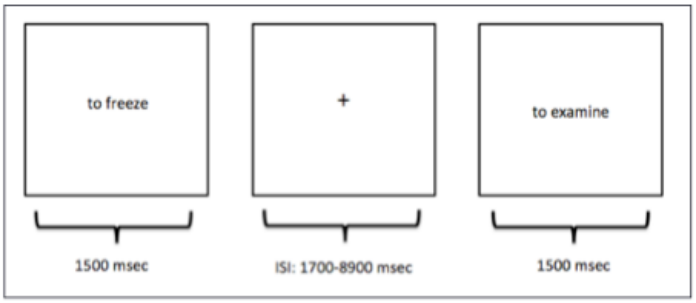

Figure 1. Verb Paradigm

The image stimuli appeared in a block design. Again, OptSeq was used to determine the optimal presentation order based on the canonical hemodynamic response that matched our blood-oxygen-level-dependent (BOLD) response model. After reading the instructions, participants responded to ten different blocks that each contained nine image pairs. The odd blocks (1, 3, 5, 7, and 9) instructed participants to make judgments regarding the similarity of actors as outlined above. The actor blocks displayed the cue

word "Actor?" in 36-point Arial font during the entire block.

The even blocks (2, 4, 6, 8, and 10) instructed participants to make judgments regarding the order of the images as outlined above. The order trials displayed the cue word "Order?" in 36-point Arial font during the entire block. The actor and order blocks were not counterbalanced, in order to maintain the optimal presentation sequence determined by OptSeq. Each pair of images appeared for 2500 ms, during which the participants responded with the appropriate button press. Half of the participants used their left middle finger in the response glove to respond "yes" and the other half used their left index finger to respond "yes," and vice versa for the "no" response. The responses were recorded as correct or incorrect, with correct responses assigned a numerical value of "1" and incorrect responses assigned a numerical value of "0." In the results section, these data points are reported on a scale of 0-1. Between each image pair, participants saw the block cue word and a blank screen for 500 ms. A fixation cross appeared for 15005 ms between each block, and the image paradigm lasted 420.05 seconds in total. Participants practiced with 8 trials before entering the scanner. Figure 2 demonstrates the procedure of the image task.

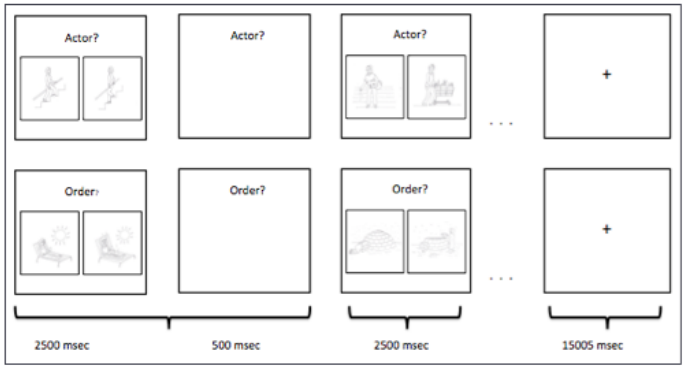

Figure 2. Image Paradigm

After completing both the lexical and image tasks, participants were removed from the MRI scanner and debriefed on the procedure. The order of the lexical and image task was not counterbalanced, such that all participants completed the lexical task before beginning the image task. The order remained static to accommodate other imaging procedures occurring before the current paradigm.

Scanning Protocol and Preprocessing

Imaging was conducted with a Siemens 3.0 TIM Trio full-body scanner. Scanning began with structural acquisition of a T1 image for anatomic normalization and alignment with the following parameters: TR = 1550 ms; TE = 4.52 ms; flip angle = 9°; image matrix = 176 x 256; FOV = 256; voxel size = 1 x 1 x 1 mm3. During the experimental runs, functional volumes with BOLD contrast were obtained using gradient echo-planar imaging sequences (TR = 1550 ms; TE = 30 ms; flip angle = 80°; matrix size = 64 x 64 x 64; FOV = 220; voxel size = 3.44 x 3.44 x 3.44 mm3; 42 slices). This process took about eight minutes. During the functional session, stimuli were presented with E-Prime software (Psychology Software Tools Inc.).

Data pre-processing was performed with SPM8 (http://www.fil.ion.ucl.ac.uk/spm). Functional scans were corrected for slice-acquisition timing and then realigned to a mean functional volume that was registered with the anatomical volume. After the anatomical image was spatially normed to the Montreal Neurological Institute (MNI) 152-subject template brain (ICBM, NIH P-20 project), the co-registered functional volumes were normalized with the same transformation parameters and re-sliced at a resolution of 3x3x3 cubic mm. Spatial smoothing was performed with a 6 mm (full-width, half-maximum) isotropic Gaussian kernel. Behavioral data was taken for accuracy and reaction time on a button press paradigm, and analyzed using Excel (Microsoft).

Results

Behavioral Analyses

Reaction time and subjective rating were collected for the lexical task; reaction time and accuracy were collected for the image task. Performance was compared using paired t-tests between conditions for each measurement.

The results of the behavioral data here provide a context from which to interpret the fMRI data, which were the focus of the hypothesis. In the lexical task, there was no significant difference of pleasantness ratings between the "change of state" verb (M=7.98, SD=1.00) and the "non-change of state" verb (M=7.99, SD=0.35) conditions; $t(5)$= -0.18, p=0.85. There was no significant difference of reaction time in milliseconds between the change of state verb (M=679.82, SD=406.57) and the non-change of state verb (M=662.7, SD=385.03) conditions; $t(5)$= -0.49, p=0.63. In the image task, there was a significant difference for accuracy by condition, such that participants were less accurate for the causal Order (M=0.88, SD=0.32) than the non-causal Actor (M=0.96, SD=0.19) condition; $t(5)$= 3.55, p=0.0004. Also, there was a significant difference for reaction time in milliseconds based on condition, such that participants responded more slowly for the causal

Order (*M*=1468.9, *SD*=451.77) than the non-causal Actor (*M*=1222.74, *SD*=395.25) condition; *t*(5)= -7.21, *p*=0.00003. These differences will be discussed later in the section entitled Perceptual Processing of Causality.

fMRI Analyses

In the analysis of the lexical and image data, the data of individual participants were convolved with the canonical HRF, with the event-times modeled as the word presentation onset. We added 11 regressors, namely the two conditions in each task, two time derivatives, six motion regressors, and one constant regressor. First-level analysis included developing models for the two main effects and two-condition contrasts.

To conduct the group analysis, we used a one-way ANOVA to compare the selected contrasts. Mapping and localization of regions that showed significant activation differences were performed in SPM with AAL (download http://www.fil.ion.ucl.ac.uk/spm/ext/), and results were displayed in MRICron (download http://www.mccauslandcenter.sc.edu/mricro/mricron/). Contrasts were conducted with a significance level of *p*=0.001, uncorrected, with a minimal cluster threshold k of 3 contiguous voxels.

Analysis of the lexical task with a one-way ANOVA with unequal variance did not yield a significant main effect of verb type. The contrast of causal > non-causal verbs yielded no contiguous voxel clusters greater than *k*=3 at a significance level of *p*=0.001. This supports the null hypothesis and demonstrates that the brain areas active during causal verb processing were not distinct from those areas active while processing the non-causal verbs in the current paradigm. The baseline activations for each condition in the lexical task are displayed in Figure 3.

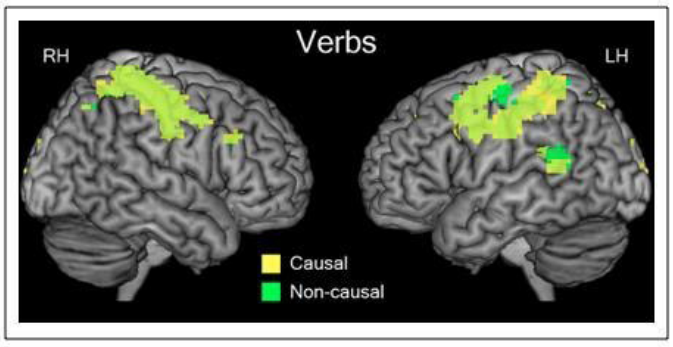

Figure 3. Main effect for the causal verb trials shown here in yellow, and the main effect for the non-causal verb trials shown in green. These main effects are FDR corrected for multiple comparisons, with p<.05 in order to demonstrate the range of activations for both conditions. None of the main effects or contrasts reported here were significant at the optimal threshold of p=.001, uncorrected.

Analysis of the image task did reveal a significant main effect for image type with the same cluster size threshold as above. The effect was driven by the contrast of Order > Actor trials, which allowed a comparison between brain activity during causal perception and processing in the Order condition and brain activity during more basic perceptual processing in the Actor condition. This contrast yielded peak activations centered in both the left inferior parietal lobule (IPL) and left supramarginal gyrus (SMG) with a cluster of 19 voxels [(MNI coordinates: -54, -37, -37), *t*=6.37], left middle temporal gyrus (MTG) with a cluster of 16 voxels [(-54, -55, -55), *t*=4.81], left superior precentral gyrus (PCG) with a cluster of 8 voxels [(-33, -1, -1), *t*=4.47], and an independent peak in the IPL with a cluster of 5 voxels [(-42, -40, -46), *t*=4.39] (See Table 2 and Figure 4). The opposite contrast of Actor > Order yielded no significant difference in activation.

Table 2
Activation Clusters for Order > Actor Contrast

Activation Peak (left hemisphere)	Brodmann Areas	x coordinate	y coordinate	z coordinate	Cluster size (*k*)	t-Max
IPL, SMG	39	-54	-37	-37	19	6.37
MTG	21	-54	-55	-55	16	4.81
PCG	4	-33	-1	-1	8	4.47
IPL	7	-42	-40	46	5	4.39

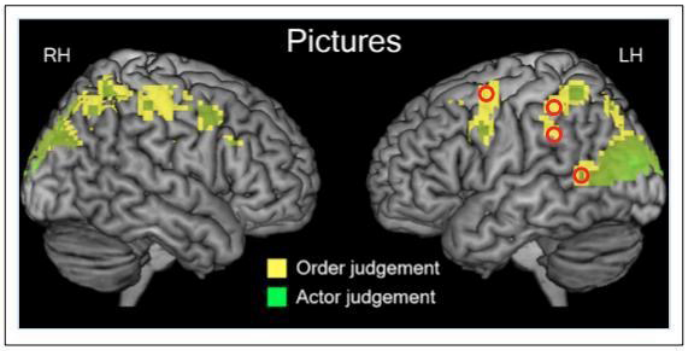

Figure 4. Main effect for the order (causal) trials shown here in yellow, and main effect for the actor (non-causal) trials shown in green. These main effects are FDR (false discovery rate) corrected for multiple comparisons, with p<.05 in order to visually demonstrate the range of activations. The suprathreshold activations for the order>actor contrast that yielded significant results at p=.001, uncorrected, are outlined in red; these mirror the imaging analysis results reported in Table 2.

Discussion

Perceptual Processing of Causality

The results in the image task support the hypothesis, demonstrating that the brain areas active during the causal (Order) condition were distinct from those areas active while processing the non-causal (Actor) image pairs. The pattern of activation for the Order > Actor contrast,

namely the activation peaks for the causal condition seen in the left inferior parietal lobule and left middle temporal gyrus, suggests a role of these areas in addressing salient spatial information. As related to the order judgment task, the activity in the IPL indicates the importance of spatial relationship monitoring in order to establish an asymmetric, causal relationship between the images in each pair (Kemmerer et al., 2008). The MTG activity reported during the current image task may be indicative of related-event processing. This particular activation in the MTG has previously been associated with the basic detection of implied motion and action processing in other paradigms utilizing a succession of related static images (Smith, Greenlee, Singh, Kraemer, & Hennig, 1998).

The behavioral finding in the image task that participants responded to the causal Order trials significantly slower and less accurately than the non-causal Actor trials indicates that the causal judgments were significantly more difficult than the non-causal judgments. The type of judgment being made for the causal trials required information regarding the sequence and intentionality of the images depicted, in addition to comparing the present actors or scenes in the non-causal judgments. Taken together, the significant behavioral difference by condition and corresponding brain activity in the perceptual task provides evidence that judgments of perceptual causality, more so than non-causal judgments, require complex spatial monitoring and wide recruitment of visual processing mechanisms.

Linguistic Processing of Causality

The results in the lexical task do not support the hypothesis, indicating that the neural substantiation of causal versus non-causal verbs based on the current paradigm does not yield any significantly different brain activation. This suggests that the current methodology may not target the semantic and syntactic differences between the two classes, that these distinctions may not be neurologically valid, or that the current experiment did not have sufficient power to identify any differential activation patterns. Potential improvements to the paradigm and applications of further data analysis will be discussed in the final section.

Causal Processing Across Modalities

Considered alongside the lack of significantly distinct neural activity from the current lexical task, the activity in the left IPL and left MTG suggests that there is no one universal structure or mechanism of causality detection, but rather a set of discrete mechanisms that function selectively based on present modality and task demands. Brain activity centralized in the left MTG has been reported during the assessment of conceptual aspects of motion attributes in both linguistic and perceptual tasks; the occurrence of this activity during tasks of different modalities suggests that the domains of language and perception may interact to process specific spatial information during causal processing (Kable, Kan, Wilson, Thompson-Schill, & Chatterjee, 2005).

Future Directions

Although this current research suggests that causal verb processing and non-causal verb processing do not result in significantly different brain activity, there are several ways to move forward with the current data and a refined paradigm that will allow beneficial insight into the basic neural mechanism of causal linguistic processing. Future analyses can address any systematic covariation between pleasantness rating and reaction time, with the intention of identifying whether only the verbs that were rated as pleasant or unpleasant (rather than neutral) were considered on a deep enough semantic level to adequately access the corresponding lemma. Additionally, region-of-interest (ROI) analyses could be used to identify any possible linguistic roles of areas sensitive to perceptual causal processing, as well as pertinent activation in the dorsolateral/medial prefrontal cortex and along the ventral occipitotemporal stream of visual processing.

With regards to the methodology, a more complex lexical paradigm with full sentence presentation would allow individuals to access the meaningful change of state semantics and shed light on how verbs are encoded to represent information unique from that which is conveyed by other lexical components. Adding EEG measurements to this expanded lexical paradigm in order to provide information on the time course of causal event processing would help clarify which lexical components guide causal linguistic processing on a sentence level. Furthermore, contrasting a receptive task (sentence viewing) with a productive language task, wherein participants describe causal events based on an image cue, would elucidate the perceptual and linguistic processes that allow the integration of visual information and language productivity.

Based on the current findings that localize aspects of perceptual causal processing in parietal and middle temporal areas, it is plausible that the reported brain activity reflects the processing of salient spatial and temporal qualities conveyed by the static line drawings. Another line of research would seek to understand which of these spatial

and temporal characteristics of discrete events are encoded in language to express asymmetric, causal relationships. The conceptual inference of motion and spatial change as demonstrated in these line drawings suggests that humans judge unnatural stimuli (static images) based on their real-world substantiation; perhaps the same can be argued for the conceptual expression of causality in language. With further clarification of the parietal and temporal activation seen in this study, and corresponding neural areas for language processing, advances can be made in characterizing how the brain utilizes low-level processing as a basis for resulting causal inferences and other aspects of complex cognition.

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The Effects of Masked Priming on Lexical Ambiguity Resolution

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Lexical ambiguity resolution refers to our ability to select the correct meaning for words that look or sound the same but have different interpretations. There is debate, however, as to how lexical ambiguity is resolved: whether all meanings of an ambiguous word are accessed automatically before context is used at the next level of processing to select the correct meaning (modular interpretation), or whether context (such as sentential information) plays a part much earlier, due to interaction from other levels of processing (interactive interpretation). Evidence exists for both accounts; however there is little research that compares automatic versus controlled lexical access. This study therefore used a within-participants design to compare automatic versus controlled processing of ambiguous words, using word-target pairs that either represented the dominant (most common), subordinate (less common), or unrelated, meanings. Masked priming was used to induce automatic, subconscious processing, and overt priming to make comparisons with controlled, conscious processing. A marginally significant interaction was found, whereby reaction times to a lexical decision task were faster to dominant targets and slower to subordinate and unrelated targets in masked conditions (in overt conditions reaction times were similar for all conditions). This suggested that the automatic processing of ambiguous words might be selective for the dominant response only. If so, then a modular account of lexical ambiguity resolution would be insufficient, and access to multiple meanings of ambiguous words might depend on controlled, interactive processes.

Lexical Ambiguity Resolution

There has been much interest in understanding how our cognitive architecture processes language, as this has relevance to understanding cognitive processing more generally and has the potential to inform the fields of neuropsychology, psycholinguistics and artificial intelligence (Small, Cottrell, & Tanenhaus, 1987; Frankish & Ramsey, 2014). An important feature of efficient language processing is lexical ambiguity resolution, which refers to our ability to select the correct meaning of ambiguous words (homonyms or homographs) that look or sound the same but have different meanings depending on context (e.g., 'bank' as in money, or 'bank' as in riverbank) (Gaskell, 2010). Without lexical ambiguity resolution, we would be unable to understand contextually specific remarks or respond to alerts swiftly. For example 'Bank to the left!' could mean different things depending on whether you needed to withdraw money or whether you were piloting a boat.

The Modular versus Interactive Debate

There is, however, debate regarding the cognitive mechanisms underlying lexical ambiguity resolution. For example, modular accounts propose that we evolved to have discrete modules, which carry out their jobs (such as language processing) in isolation before feeding forward the results to other levels of processing (Gaskell, 2010). With regards to lexical ambiguity resolution, proponents of the modular account would argue that one module accesses all possible meanings of a word automatically, before context is integrated at the next level of processing to select the appropriate meaning (so a modular account implies multiple access of word meanings). The interactive view, however, holds that different levels of processing communicate rather than operating in isolation, with one level inhibiting or informing the other level, and hence context can be used to rule out inappropriate meanings before they have been fully accessed (so access for word meanings can be selective) (Gaskell, 2010).

Evidence from Semantic Priming Experiments

A method often used to examine language processing is 'semantic priming', whereby participants are exposed to a stimulus word followed by a target word, and where the speed with which a response is made to the target is faster if there is a known relationship between the two. For example, if a participant sees the word 'bank', then they should be quicker to respond to the target word 'money' than an unrelated word, because they have accessed information within the mental lexicon about the possible meanings of the word 'bank'. To test the effect of priming, experimenters often use a lexical decision task, in which a participant must decide whether a target is a genuine word or a made up non-word (and so where priming has occurred this decision should be faster) (Naish, 2010). This technique is traditionally used to study lexical ambiguity resolution because if multiple meanings have been accessed then there should be a priming effect for those meanings; if only one meaning is primed then lexical access has been selective.

Evidence from semantic priming experiments supports both modular and interactive accounts. Manipulating the time between the beginning of the presentation of the stimulus and the beginning of the presentation of the target, known as the stimulus onset asynchrony (SOA), appears to determine which mechanism is at work. For example, Swinney (1979) used auditory sentences as context, and found that when targets were shown at the offset of ambiguous words, both meanings were primed regardless of the context. When the target was presented three syllables later however (roughly 750-1000ms SOA) only the contextually appropriate meaning was primed, which supports the modular stance that there is a limited window in which all meanings are accessed before contextual information is employed.

Simpson and Burgess (1985) varied both the timing of SOAs and homonym meaning frequencies in order to examine not only the time course of lexical access but also whether there are differences dependent on how familiar meanings are to us (dominant meanings are the most frequently used, such as money for bank, whilst subordinate meanings are less frequently used, such as river for bank). They found that dominant meanings were primed first (from 16ms SOA), followed by both meanings (at around 300ms SOA), then dominant again (750ms SOA). They claim that this supports a modular account, where 'ordered access' occurs. For example, through a process of 'automatic spreading activation' (with no need for context) dominant meanings are accessed first, then both meanings, and then in the absence of disambiguating context the most likely dominant option is again settled for in what they term a post-lexical reallocation of attention (after meanings have been accessed).

Tabossi and Zardon (1993) extended this by using auditory sentential context and presenting the target 100ms before the offset of the homonym, to examine early selection processes (average SOA of 387ms). They found that dominant meanings only were primed in dominant-biased contexts, however both meanings were primed in subordinate-biased contexts. They interpreted this in terms of an interactive account, whereby dominant meanings are always accessed, however contextual information was also necessary for the retrieval of other meanings (as opposed to all meanings being accessed automatically as per a modular account).

Automatic versus Controlled Processing

The Tabossi and Zardon (1993) study raises an interesting question about automatic versus controlled access to the lexicon. For example, the modular perspective states that lexical access is bottom up and automatic (Gaskell, 2010), and hence multiple meanings of a word are accessed automatically regardless of context. However Tabossi and Zardon suggested that multiple meanings are only accessed where context has been used, which requires interaction from conscious, controlled processes (1993). Indeed most studies do not control for the effects of conscious processing and thus perhaps also reflect top down controlled, task-specific strategies.

Although in everyday situations we would use context from various sources, it is necessary to isolate such context under experimental conditions in order to separate and test the effects of automatic and controlled processing. One way to achieve this is to compare overt and masked semantic priming. Masked priming involves presenting the stimulus word followed very quickly by a mask, so that participants cannot consciously process the word, and hence any priming observed must be the result of automatic processes. Overt priming simply refers to the standard presentation of the stimulus without a mask, and hence conscious controlled processing is possible. Indeed Eckstein, Kubat and Perrig (2011) used overt and masked priming with homonyms to distinguish between automatic and controlled lexical access. They found that whilst overt conditions supported previous findings of access for both meanings at approximately 300ms SOA, in masked conditions access was fast and selective for the dominant meaning only at any SOA;

further, subordinate meanings were inhibited.

The focus of Eckstein et al.'s (2011) paper was on understanding early automatic lexical selection processes, and their interpretation focused on how subliminal/ automatic processing is selective and fast. However it follows that accessing additional multiple meanings of a word might depend on an interaction between automatic and controlled conscious processes. This concurs with what is currently understood about automatic processes as being fast and inflexible, while controlled processes have been associated with slower but more flexible responding (Andrade, 2010). For example, Baddeley's 'central executive' model describes how automatic activations of established schemas are combined with a supervisory attentional error-checking system (SAS) to allow for novel responses (as cited in Andrade, 2010). In relation to lexical ambiguity resolution, dominant meanings may therefore be activated automatically, before an interactive error checking system would allow for the consideration of alternative meanings. This would be problematic for a modular account which argues that multiple meanings are accessed automatically.

Eckstein et al.'s (2011) study was in German, however there is a hypothesis that lexical access may be language-driven, where different countries are considered relatively more or less context heavy, and this may influence how dependent on context lexical access is (Ahrens, 1998). It was therefore important for the present study to replicate Eckstein et al.'s procedure using English participants. It was also considered important to focus on the SOA of 300ms, as consistent findings of access for both dominant and subordinate meanings of ambiguous words at this SOA means that potential patterns of spreading activation should not be precluded (i.e., this interval between primes and target words allows spreading activation to occur, but prevents processing from the next level).

Present Study

Due to Eckstein et al.'s (2011) findings that automatic access to the lexicon is fast and selective for dominant meanings only, the research question posed was "Is there an effect of overt and masked priming on the selective or multiple access of ambiguous word meanings?" A main effect of dominance was predicted, such that mean reaction times (RTs) in a priming task should be faster overall to dominant targets than subordinate or unrelated targets. A main effect of prime awareness was not predicted, because RTs to dominant and subordinate targets should be similar in overt conditions but should vary in opposite directions in masked, and hence overall means should be similar. An interaction was expected, whereby in masked conditions, RTs to dominant targets should be faster and RTs to subordinate targets should be slower (Eckstein et al., 2011).

Method

Participants

Participants were Open University cognitive psychology students (N = 40, 31 female, M age = 38 years). Only native English speakers were allowed to participate, so that priming would affect lexical decisions (Elston-Guttler & Friederici, 2005).

Design

A 2 x 3 repeated-measures design was used: there were two independent variables and participants experienced all possible conditions. The first variable was 'Prime Awareness' with two levels 'Overt' and 'Masked', and refers to whether or not the homonym was presented subliminally or not. The second variable 'Dominance' had three levels: 'Dominant', 'Subordinate' and 'Unrelated' and refers to the frequency of use of the target words. There were therefore six conditions: overt homonyms paired with dominant, subordinate or unrelated targets, and masked homonyms paired with dominant, subordinate or unrelated targets (for example: BANK, with Money, River or Clamp).

The dependent variable was RTs to a lexical decision task, where participants had to press a key to indicate whether they believed the target was a real word or not. The task included an equal number of real words and non-words, to prevent automatic responses regardless of priming. Stimuli were counterbalanced between four stimulus pools such that although all homonyms occurred equally often across participants, the same stimulus-target pair was never seen more than once, to avoid cumulative priming. To reduce task confusion, half of the participants saw overt conditions first, whereas the other half saw masked conditions first, rather than having overt and masked conditions mixed up within a single block. Further, homonyms were presented in lowercase whilst targets were in upper case. Order effects were also controlled by fully randomising presentations within each overt and masked block.

Materials

Stimuli consisted of homonym-target word pairs, with dominant and subordinate meanings taken from Twilley, Dixon, Taylor and Clark (1994). Unrelated controls were taken from an online random word list (Optusnet, 2012) and were balanced with experimental words as far as possible for form and frequency. The mask consisted of a hash pattern.

E-Prime software (version 1.2, 2004) was used to record data and present the stimuli, which were black letters on a white background in bold 18 point Courier New font; a data sheet was used to record whether or not participants had noticed the subliminal primes.

Procedure

Participants were seated at a computer and age and gender data were recorded. An instruction screen explained the process, then the participants practiced with three trials each of overt and masked conditions. For the experimental trials, participants saw one of four stimulus lists consisting of 120 homonym-target pairs, 60 of which were overt and 60 masked. Within each overt and masked block 10 pairings were dominant, 10 subordinate, 10 unrelated and 30 consisted of non-words. In overt conditions, the homonym was displayed for 300ms followed by the target, which remained on screen until a lexical decision was made (with a 500ms delay between trials). In masked conditions, the homonym was displayed for 50ms, followed by a hash mask for 250ms before the target was presented. When both the overt and masked blocks were completed a thank you screen appeared, and participants were asked if they had managed to read any of the 'subliminal' words.

Results

Data from one participant was removed as an outlier as their scores fell outside the accepted statistical range for the population.

N39		Prime Awareness		Sub-Row Means for Dominance
		Overt	**Masked**	
Dominance	**Dominant**	710.91 (157.47)	694.03 (126.79)	**702.47**
	Subordinate	695.66 (147.03)	735.79 (165.15)	**715.73**
	Unrelated	712.12 (159.91)	746.55 (174.86)	**729.34**
Sub-Column Means for Prime Awareness		**706.23**	**725.46**	Grand Mean: 715.85

Table 1. Mean Reaction Times (and Standard Deviations) in Milliseconds

Results of a two-way repeated-measures analysis of variance (ANOVA, PASW 18.0) showed that there was not a significant effect of Prime Awareness ($F(1,38) = 1.32$, $p = .259$), but RTs for overt conditions (M=706.23ms) were faster than for masked conditions (M=725.46ms).

The main effect of Dominance was also not significant ($F(2, 76) = 1.91$, $p = .155$), although RTs to dominant targets (M=702.47ms) were faster than to subordinate (M=715.73ms) or unrelated targets (M=729.34ms).

There was a marginally significant interaction however ($F(2,76) = 2.83$, $p = .065$). Figure 1 (below) illustrates a trend whereby RTs to both dominant (M=710.91ms; SD=157.47) and subordinate targets (M=695.66ms; SD=147.03) were similar in overt conditions; however in masked conditions RTs to dominant targets (M=694.03ms; SD=126.79) were faster than to subordinate (M=735.79ms; SD=165.15) and unrelated (M=746.55ms; SD=174.86) targets.

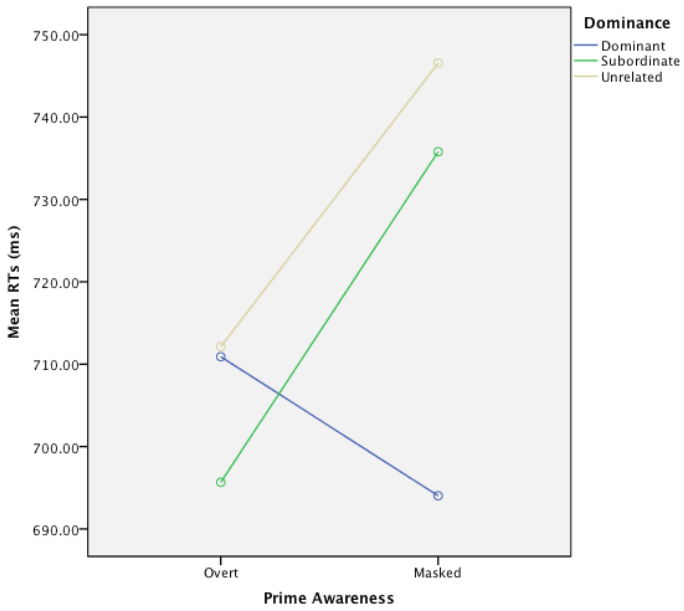

Figure 1. Mean Reaction Times for Prime Awareness and Dominance

The marginally significant interaction warranted further investigation so pairwise comparisons were made using Bonferroni correction. A marginally significant difference was found in masked conditions between dominant and subordinate targets (p=0.069), with mean RTs being 41.76ms faster to dominant than subordinate targets. A significant difference was found between dominant and unrelated targets (p=0.032), with mean RTs being 52.52ms faster to dominant than unrelated targets.

Discussion

The predictions of this study were that RTs would be faster overall to dominant targets than to subordinate

or unrelated targets, however this was not significant. Similarly an interaction was predicted whereby, in masked conditions, RTs to dominant targets would be faster and RTs to subordinate targets would be slower. Again, however, significance was not achieved and hence the null hypotheses could not be rejected.

Although the interaction did not reach significance, it is however interesting that a marginally significant trend was found, in line with the study by Eckstein et al. (2011). In overt conditions, which allowed for conscious processing, both dominant, subordinate and unrelated meanings were primed to a similar extent. However, in masked conditions, when subconscious or automatic processing was employed, there was a trend which indicated that lexical access was selective for the dominant meaning only, because subordinate meanings were not primed much more than unrelated controls. It is therefore considered useful to explore an alternative perspective on the modular-interactive debate: if automatic processing is selective for the dominant meaning only, then a modular automatic 'spreading activation' account would be insufficient, as it is claimed that all meanings are accessed automatically. The retrieval of multiple meanings in order to resolve lexical ambiguity might, therefore, depend on conscious and controlled processes.

Whilst this proposal is in conflict with the modular interpretations in the literature, it could accommodate the findings, and it is worth considering the possible mechanisms behind this. For example, it is possible that Swinney's (1979) findings of multiple access could be reinterpreted in terms of an error checking of the automatic response by controlled processes (followed by the inhibition of incorrect responses based on context as in their study). Simpson and Burgess (1985) made not only the 'ordered access' distinction, but also described a reallocation of attention once meanings had been accessed, which, in the absence of context, settles for the dominant meaning. The trend found in the current study is in line with Eckstein et al. (2011), and could indicate that an allocation of attention might be important even earlier than Simpson and Burgess suggest, for the retrieval of non-dominant meanings (e.g. in order for multiple meanings to be accessed). Indeed, the findings of Tabossi and Zardon (1993) indicated that if context strongly biased the dominant meaning, then access was selective, however if it biased the subordinate meaning, then access was multiple. This, too, concurs with an account in which automatic selection for the dominant response is combined with controlled processes such as error checking attentional components.

Whilst these interpretations are speculative and based on marginally significant results, several limiting factors were acknowledged which might be addressed in the future. The primary issue was monitor refresh rates, which limited masked presentations to 50ms. Ideally a pilot should have been used to determine the speed at which primes were perceived at no better than chance, however the current study did not have the time or technology to achieve this. This meant that primes were not truly subliminal (indeed a few participants reported being aware of words before the hash mask), and hence there could have been some influence of controlled processing in masked conditions (thus affecting reaction times and hence significance levels). The word list from Twilley et al. (1994) was chosen over more recent ones due to the greater choice of true homonyms over polysemous homonyms (where polysemous homonyms can have subtly related meanings rather than separate meanings). However it would be preferable to find lists where only true homonyms are used. Due to time constraints non-words were simple fabrications, however ideally they should be re-ordered versions of existing stimuli to reduce the chance that they are distracting or require lengthier processing. Further, although cumulative priming was controlled for within this experiment, participants were taken from a pool that was also available for other language experiments and they may not have been naïve to the task. Thus, there could have been other cumulative priming effects (from previous experiments) or processing times could have been affected by their understanding of the task. Indeed this could explain why subordinate meanings were primed slightly more than dominant in overt conditions (with participants anticipating the task).

Aside from addressing these limitations, it would also be useful to examine the effects of attention using another paradigm, in case there is something qualitatively different or task specific about the processing induced by masked primes. For example, Baddeley's 'central executive' model might be applied to lexical ambiguity resolution, with the prediction that supervisory attentional error-correction systems are necessary for retrieval of non-dominant meanings (as cited in Andrade, 2010). If so, then varying the amount of resources available for a lexical decision task could have an effect on whether lexical access is selective or multiple (for example, using a distractor task such as looking out for sequences of auditory numbers would

increase cognitive load and reduce the ability of controlled processes to intervene in lexical access).

Conclusion

In sum, if the automatic processing of homonyms is fast and selective for the dominant meaning only, then this offers support for the theory that lexical ambiguity resolution may depend on interactive processes, rather than being strictly modular. These findings compliment previous work in the field and contribute towards the understanding of how we are able to decipher meanings, as well as how human cognitive architecture operates more broadly.

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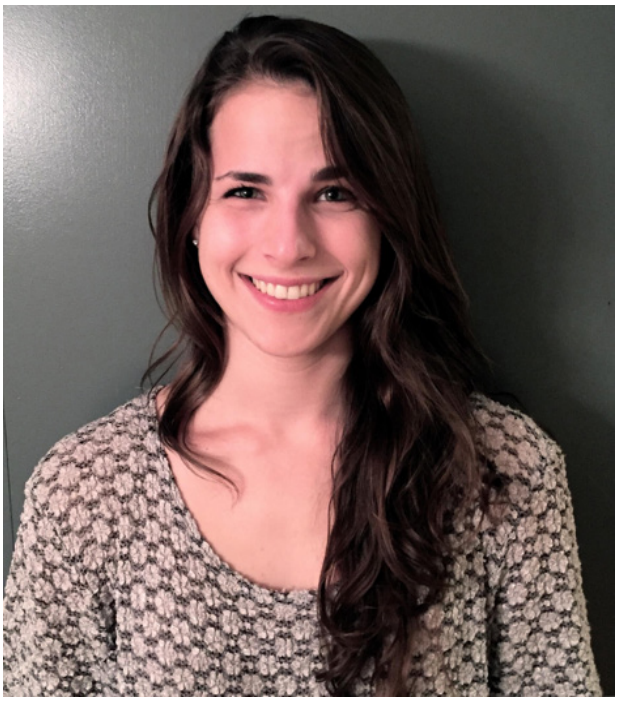

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Children Relating to Each Other as Artists Through Education (CREATE): A Pilot Study on Fine Arts Programs for Children with Autism

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Many families of children with autism spectrum disorder (ASD) rely on community-based services for support and treatment. However, these treatment intervention strategies often lack the efficacy of individualized interpersonal therapy, creating a need to improve on current community-based treatments. Because children spend the majority of their daily lives in the classroom, it is suggested that school-based therapy programs, such as those incorporating the arts, may be a beneficial foundation for providing therapy to children on the autism spectrum. A fifth grade classroom of children with ASD completed a 12-week art-based treatment intervention program to determine the functionality and efficacy of incorporating therapy techniques through fine arts in a classroom setting. Teacher ratings revealed significant improvement in social skills as well as decreases in internalizing and overall behavioral problems from pre-treatment to post-treatment assessment. Based on child and teacher satisfaction reports, the intervention program is supported as being feasible, easily integrated into the classroom curriculum, and beneficial in teaching students social skills that they believed they would use throughout their daily lives.

Autism Spectrum Disorder

Autism spectrum disorder (ASD) is characterized by difficulties in social communication and social interaction, as well as, restricted and repetitive patterns of behavior, interests, or activities (American Psychiatric Association, 2013). These characteristics can be observed in early childhood and persist throughout adulthood (Lord et al., 2000). Children with ASD may have unusual attachment to objects or interactions with others, can be resistant to changes in their daily routines, and are at high risk for having comorbid anxiety disorders and depression (Chalfant, Rapee, & Carroll, 2007). While traits such as these are common, there is substantial heterogeneity within the ASD population meaning that the phenotypic expression of ASD associated behaviors may vary significantly between individuals on the spectrum. Because children with ASD can have varying symptom expression, new treatment options need to continue being developed to target the specific needs of each individual with ASD.

In 2014, the United States' Center for Disease Control (CDC) released new data that 1 in 68 children have ASD and that more than 3.5 million Americans live with ASD. Males are five times more likely to be diagnosed with ASD than females, and the incidence of ASD continues to increase worldwide (Center for Disease Control, 2014). There is a growing field of research that focuses on identifying efficacious treatment interventions for children with ASD with an emphasis on making them readily accessible to families. Early intervention has been associated with better outcomes than interventions started later in life, highlighting the importance of addressing ASD symptoms as soon as possible (Charman, 2010; Matson & Smith, 2008). However, because multiple barriers have limited the accessibility of traditional interventions, it is becoming increasingly important to develop treatment programs that can be successfully implemented in alternative settings, such as the classroom (Odom, Collet-Klingenberg, Rogers & Hatton, 2010).

Group Therapy

Treatment for ASD often involves either individual or group therapy that targets core ASD symptoms (e.g.,

social deficits, restricted interests), as well deficits in emotion regulation and empathy (Chorpita, Yim, & Donkervoet, 2002; Odom et al., 2010; Schreibman, & Ingersoll, 2005; Tsatsanis, 2003). Individual, one-on-one intensive cognitive behavioral therapy (CBT) is arguably the most successful and reliable form of treatment to date for treating social skills deficits and anxiety in children with ASD (Wood et al., 2009). However, this type of treatment often requires a substantial investment of time and resources and is not accessible to many families because of the associated financial cost (American Psychological Association Task Force on Promotion and Dissemination of Psychological Procedures, 1995; Chorpita et al., 2002; Chorpita, & Donkervoet, 2005). As a result of these challenges, it is important to develop forms of treatment that are more accessible to a greater number of children with ASD.

Group therapy is often the alternative to individual therapy and is the standard for community treatment (Wood et al., 2009). Group therapy for children is a form of psychotherapy in which three or more children meet together with a therapist. This type of therapy may include active parent participation and involve parents meeting with the same or a separate therapist as their child. Although children with ASD benefit from group treatment, the outcomes to date are rarely superior to those of individual treatment (Magiati, Charman, & Howlin, 2007, Wood et al., 2010). However, it has been hypothesized that children with ASD may show greater improvements in social skills in response to group, rather than individual, therapy because a group setting can provide greater opportunities to practice these skills with peers (Ozonoff, Dawson & McPartland, 2002). By providing social skills coaching in a group setting, the current study aims provide children receiving community-based treatment with a modified form of group therapy where they can develop and practice these skills with other children.

Art Therapy

Because children spend a significant amount of time in school, it is optimal to consider treatment interventions that can be incorporated into classroom settings. By using the classroom as a foundation, the current study aims to better understand the group therapy dynamic and whether it is feasible to successfully incorporate group therapy treatment techniques into the classroom. State standards dictate strict policies on content of instruction as children progress through elementary, middle and high school; however, therapy techniques could be successfully incorporated into these standards in certain elective areas such as the arts (California State Board of Education, 2013). If successful this would provide an indication of whether or not children could benefit from having therapy techniques incorporated into elective classes.

Art therapy is the use of the creative processes to improve and enhance physical, mental and emotional well-being (Kramer, 1993). It can be used via a variety of subject matter such as painting, sculpture, drawing, dance and music. The goal of art therapy is to use the arts as a means of connecting with patients and helping them develop self-awareness and self-expression (Gold, Wigram, Cochavit & Elefant, 2006). As early as the 1960s and 1970s, practitioners used art therapy for educational and treatment purposes in special schools and social service departments for children with ASD (Malchiodi, 2012). Music-based art therapy, in particular, has been deemed effective in improving self-expression, self-regulation, and communication skills in children with ASD who have intellectual disabilities (Alvin, 1978; Gold et al., 2006; Holck, 2002; Woodward, 2004). However, musical instruments can be expensive and children with ASD who experience sensory-overload and discomfort due to loud noise may not benefit from music programs. A different approach to using art therapy for children with ASD is visual arts, such as drawing and painting. However, relative to music-based therapy, there is limited research examining the effects of visual arts therapy on children with ASD (Epp, 2008; Sandle, 1998).

Creating a piece of visual art often requires a high degree of understanding, thought and risk taking. Children in art therapy are usually instructed to freely draw or paint to demonstrate to the therapist their thoughts and feelings, but are rarely challenged with the task of creating art that is well planned and executed (Matthews, 1984). By age 10 or 11, children are believed to have the cognitive capacity to appreciate and develop well-planned works of art (Deloache, 1992; Harris, 1963). Giving children at this age the opportunity to create works of art that require abstract and complex thinking may have a meaningful impact on their mental health.

While there is a limited amount of literature on the effects of visual arts therapy for the treatment of ASD, extensive research has examined the use of visual arts therapy for treating depression in children and adults. Studies have examined individuals at high risk for depression such as terminally ill patients and prisoners and have found strong correlations between the use of visual art therapy and better mental and physical health outcomes (Slayton, D'Archer,

& Kaplan, 2010). Specifically, visual art therapy has been shown to lessen symptoms of depression, fatigue, and lead to a better quality of life for patients (Bar-Sela, Atid, Danos, Gabay, & Epelbaum, 2007). These gains are attributed to the way that visual-arts therapy approaches depression by giving patients a creative outlet to work through complex emotions (Wallace, 2015). Patients may have an inability to express certain cognitions and emotions, which can greatly hinder the effectiveness of traditional talk therapy sessions. Visual arts therapy provides patients with a means of expressing thoughts and feelings that may be too difficult to articulate verbally to their therapist.

A visual arts-based approach is suggested to be especially successful in treating children with ASD because of how difficult it can be for them to express what they are thinking and feeling. FMRI and observational studies highlight that children with ASD tend to have a severe lack of awareness of their own mental states (Harris & Leevers, 2000; Silani et al., 2015; Williams, & Happe, 2008). Furthermore, internalizing problems, such as depression and anxiety, are especially difficult to treat if children with ASD are unable to accurately communicate how they are feeling. Visual art-based therapy may provide children with ASD a medium to explore and express their internal states. By using visual art therapy as a communication tool, the current study aims to address internalizing problems that are often seen in children with ASD that traditional therapy approaches may struggle to address.

CREATE Intervention Program

The CREATE program provides an art-centered form of group therapy to high functioning children with ASD who, by definition, have average to above average intellectual and language abilities (e.g.,Loveland & Tunali-Kotoski, 2005). The current study aims to determine the feasibility and practicality of a visual art therapy program that is integrated into specialized classrooms for children with high-functioning ASD. The current study focuses on fifth grade students because children begin to develop the capacity to think abstractly and critically by the age of 10 or 11. Furthermore, development of strong social skills by the end of elementary school is incredibly important for creating peer relationships in middle school.

Implementing this treatment intervention in a classroom setting will hopefully provide a better approach to group therapy and lead to better outcomes for children with ASD who depend on community-based treatment. By incorporating low-cost classroom-based interventions into schools, more children will have access to therapy programs in their daily lives. Additionally, providing a group therapy program during the normal art period instead of before or afterschool should lower attrition and not disrupt the children's daily routines. Furthermore, CREATE was developed as a visual arts program specifically because even though art therapy has been supported to be helpful in addressing the needs of other populations (e.g., depressed), it remains understudied in the domain of ASD treatment. We hypothesized that children with ASD who participate in the CREATE intervention program will show increases in appropriate social behaviors as well as decreases in internalizing behavior problems after receiving extensive art instruction. Additionally, it is hypothesized that the CREATE program will be feasible and easily incorporated into classroom art curriculum, as assessed by the classroom art teacher.

Method

Participants

The intent-to-treat sample included six fifth grade students (mean age: 11.7 years) with a primary diagnosis of ASD. The sample included two Caucasian boys, two African-American boys, one Asian boy, and one Caucasian girl. The participants were recruited from a specialized fifth grade classroom of 12 children with ASD at the Help Group Village Glen School in Culver City, California. The Help Group Village Glen School was specifically developed for children with challenges in the areas of socialization, communicative and pragmatic language development and peer relations. All participants had a previous clinical diagnosis of autism, Asperger syndrome, or PDD-NOS and had an IQ at or above 70. Diagnosis and IQ were determined based on the students' individualized education plans (IEP), which specifies the participants' intellectual testing results and references clinical diagnostic history. Informed consent was obtained from parents or legal guardians as well as from the school's administrator, homeroom and art classroom teachers while students completed accent forms.

Measures

The Teacher Report Form (TRF) for Ages 6-18 (Achenbach & Rescorla, 1983). The Teacher Report Form (TRF) is intended to provide a comprehensive assessment of childhood problems across school, home and community settings over the past six months. The TRF is the teacher reported-parallel to the CBCL. The teacher is asked to indicate the extent to which they agree with each statement using a three-point scale, (0) 'not true', (1) 'somewhat true', or (2) 'very or often true'. The total problem score, broadband

externalizing and internalizing scores, and depressed/ anxious and social problems narrowband scales of the TRF were compared at pre-treatment and post-treatment in the present analyses. Reliability and validity of the TRF are excellent (Achenbach, 2000).

Social Responsiveness Scale (SRS) Ages 4-18 (Constantino, 2002). The SRS is a 65-item rating scale that provides a dimensional measure of ASD, with higher scores on the SRS reflecting a greater degree of social impairment and lower scores signifying less impairment. Completed by parents and teachers at pre- and post-treatment, the SRS has been shown to be sensitive to changes in social functioning among children with ASD (Wood et al., 2009). Responses are scored on a scale from (0) 'never true' to (3) 'almost always true', and the measure yields an overall social responsiveness score and four subscales: autistic mannerisms, social cognition problems, social communication problems, and social motivation. Internal consistency on the SRS is well established (Constantino, 2002; Wigham, McConachie, Tandos & Le Couteur, 2012).

CREATE Program Consumer Satisfaction Questionnaire. A 25-item consumer satisfaction questionnaire was used to ascertain the opinions of both child participants and the classroom art teacher regarding the CREATE program. Student participants and the classroom art teacher were asked to rate the quality of different aspects of the program with response options including 'strongly negative', 'negative', 'positive' and 'strongly positive'. Additionally, the classroom art teacher was asked specifically about the incorporation of the program into her classroom and the quality of the therapy provided.

Procedure

This treatment pilot study was conducted in compliance with a university-based IRB. The Help Group - UCLA Autism Research Alliance assisted in recruiting the fifth grade classroom and corresponding homeroom teacher and art classroom teacher to participate in the study. Consent and assent forms were sent home with children. Children of families who did not wish to participate were given the option of working with the homeroom teacher in a different classroom or participating in the intervention program without the assessment portion. All 12 families of children in the class gave consent to participate in the art lessons but only six consented to being part of the study. Measures of social functioning and internalizing behavior were collected at pre- and post-treatment. Participants and the school's art teacher also completed a consumer satisfaction measure at post-treatment. Parents and school administration were informed that the study was an intervention study, but the homeroom teacher was not told in order to reduce bias in her reports.

The 12-week treatment program was initiated after all pre-treatment measures were collected from the homeroom teacher. The post-treatment assessment involved the re-administration of all pre-treatment measures. The homeroom teacher was given the measures and allowed time to complete the teacher report forms during school hours. The treatment program was exclusively provided in the school setting.

The student therapist had been trained in clinical psychology with two years of previous clinical experience and experience working with children with ASD. The student therapist worked with participants once a week for 45 minutes over the course of 12 weeks during the students' scheduled art period. The participants' homeroom teacher was not involved in the intervention program, however the students were under the supervision of the school's art teacher during the program. The intervention program was inspired by the Building Confidence CBT program (Wood & McLeod, 2008) as well as the Super-Kids social skills therapy program (Epp et al., 2008), but was modified for use in a school setting with children with ASD. Enhancements to the inspiring manual were designed to integrate therapy into art lessons. The updated manual addresses poor attention, disruptive behavior, anxiety, poor social skills, hyperactivity, poor self-awareness and internalizing problems.

The program was developed as three modules, with each lasting approximately four weeks in length. The modules were developed to be flexible so that if there were additional time needed for one module it would not interfere with the timeline of the following modules.

Module 1

The first three weeks of the program focused on Module 1: Emotion Regulation. Participants discussed the importance of expressing emotion and recognizing different emotional states by creating sketches of their own face as well as the faces of their classmates. Participants also practiced using and recognizing different tones of voice to convey emotion.

Module 2

The following five weeks focused on Module 2: Self-awareness and Self-expression. Participants created duality papier-mâché masks. One side of the mask was meant

to be a representation of themselves with the other side representing what makes them anxious, their opposite or "alter ego". A discussion focused on the participants' anxiety was also incorporated to address their anxious thoughts and how to combat these thoughts with calm thoughts.

Module 3

The final four weeks focused on Module 3: Social Skills. Participants worked on developing social skills through a group project during which they created a classroom mural together. Participants were given social skills guidance and practice before working on the mural. Throughout the program participants learned how to appropriately comment and critique other students' work as well as their own.

Results

All components of the manual were successfully completed. All participants partook in at least 11 of the 12 sessions. Analysis focused solely on the teacher responses via the TRF and SRS; Paired samples t-tests were used to compare pre- and post-treatment scores (see Table 1).

Variable		Mean	Std. Deviation	*t*
SRS-T social skills total	Pre	58.50	2.43	3.14*
	Post	54.17	4.26	
SRS-T autistic mannerisms	Pre	57.83	3.25	0.69
	Post	56.50	5.08	
SRS-T social communication	Pre	57.33	2.65	3.30*
	Post	53.33	3.61	
SRS-T social cognition	Pre	60.50	2.07	2.20+
	Post	57.50	4.37	
SRS-T social motivation	Pre	58.50	3.01	5.17**
	Post	52.00	5.13	
TRF total problems	Pre	60.50	4.63	2.79*
	Post	56.33	4.13	
TRF internalizing problems	Pre	64.33	4.17	4.80**
	Post	57.16	1.83	
TRF depressed/anxious problems	Pre	67.16	5.38	3.08*
	Post	59.66	2.80	
TRF social problems	Pre	64.33	4.58	3.77*
	Post	58.33	4.93	

Note. + $p < .10$; * $p < .05$;** $p < .01$

Table 1. Comparison of means from outcome variables for treatment group

The SRS results (see Figure 1) yielded significantly lower levels of impairment in the areas of overall social responsiveness (t (5) = 3.14, $p < .05$), social communication (t (5) = 3.3, $p < .05$) and social motivation (t (5) = 5.2, $p < .01$), as well as a trend-level decrease in social cognition (t (5) = 2.2, $p = .08$). There was not significant improvement in the autistic mannerisms subscale. The TRF results (see Figure 2) yielded significant decreases in internalizing problems (t (5) = 4.8, $p < .05$), anxiety and depression (t (5) = 3.1, $p < .05$), social problems (t (5) = 3.8, $p < .05$) and total problems (t (5) = 2.8, $p < .05$).

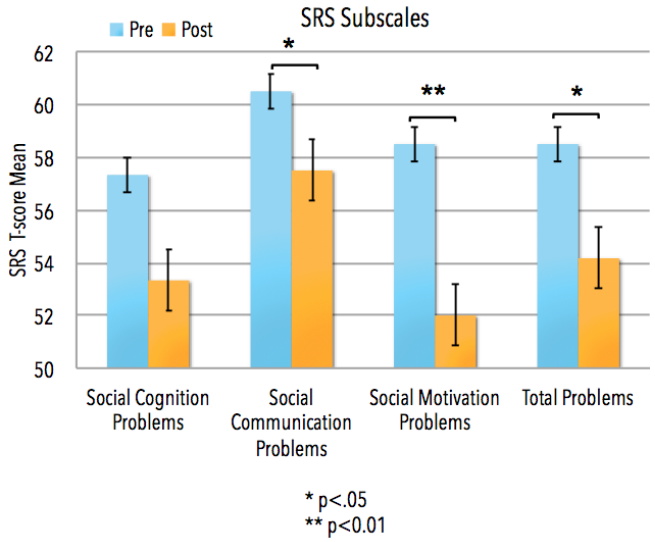

Figure 1. SRS-T Subscales T-score mean comparison pre- and post- treatment.

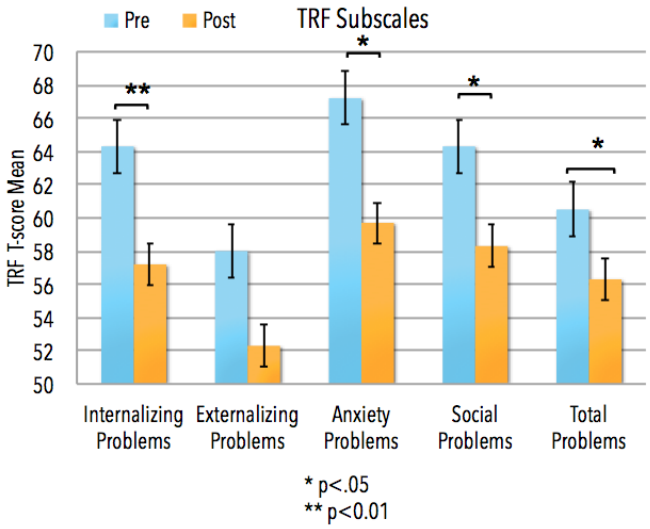

Figure 2. TRF Subscales T-score mean comparison pre- and post- treatment.

All student participants and their art teacher completed consumer satisfaction reports. More than half of the participants (67%) reported that their overall feeling about the CREATE art lessons was 'strongly positive' and the remaining participants (33%) reported 'positive.' All participants reported that they 'agree' that they would recommend the intervention program to other children. All participants also reported that they 'agree' that the intervention program was helpful. More than half of the participants (67%) reported that they 'agree' that after participating in the program, they were better able to manage upsetting feelings. The majority of the participants (83%) reported that they 'agree' the program helped them at school and at home, and all participants reported that they 'strongly agree' that they will continue to use what they learned in the CREATE art lessons in their lives. One participant commented that he "[did not] like the feeling of touching glue and paint but it got easier the more [he] tried." Another participant reported that the most important thing she learned was "nothing is ever perfect, just be you" and another reported, "I learned to slow down and be patient".

The classroom art teacher reported that her overall feeling about the CREATE art lessons was 'strongly positive'. She also reported that she 'strongly agreed' that she would recommend the program to other schools and teachers, that the intervention was helpful to the children, that the student therapist did a good job teaching skills to the children and that she will use techniques that she learned from the intervention program in her classroom. She reported that she 'strongly disagreed' that the program was financially costly or was an imposition on her teaching, and 'strongly agreed' that the program was easy to implement in her classroom. She commented that "the students were able to bring forward their creative voices more fully in ways that incorporated who they are" and that the program "allowed students to problem solve and take risks, which is beneficial for the students and [the program] provided many opportunities to do so". In reference to the integration of the intervention program into her classroom the art teacher commented that the program "provided the students a means of self-expression that aligned with State standards and was adapted to meet the needs and strengths of this population of students on the autism spectrum."

Discussion

The CREATE program was developed to provide children with ASD access to group-based therapy through a visual arts-based approach. The study hypothesized that children who completed the CREATE program would exhibit improvements in social skills as well as decreases in internalizing behavior problems. Additionally, the study aimed to determine if the implementation of art-based therapy programs like the CREATE program would be feasible and easily incorporated into art classroom curriculum.

One of the major components of the CREATE program is the emphasis on social skills. The results of the social skills subscales of the TRF and SRS yielded significant decreases in total social problems of the participants, as well as social communication and social motivation with a trend-level decrease in social cognition. These findings support the hypothesis that children can successfully improve their social skills in a group therapy format. It is, however, difficult to conclude whether or not these gains were due to the social skills coaching, the act of working on a mural project together, or a combination of both.

Another large component of the CREATE program is the emphasis on confronting internalizing problems, such as anxiety and depression. There was a significant reduction in internalizing problems. These results were expected, given the strong focus on building the participants' self-confidence and helping to develop coping strategies for anxious thoughts and feelings. It is possible that the reason why the participants were able to make positive social gains during this intervention was because of reductions in social anxiety. Unfortunately, the current study did not focus on differentiating between the varieties of anxiety problems so the specific mechanism for this change cannot be identified. While the relationship between the social problems and internalizing problems subscales is unclear it is promising that the participants made significant gains in both.

All of the participants reported that they enjoyed the program. They indicated that they felt they would use the skills they learned in the program in their daily lives, which may lead to lasting treatment effects. The classroom art teacher reported that the CREATE intervention program was highly feasible and posed no imposition being integrated into her classroom. The teacher also reported that she believed that the students made substantial social and anxiety-related progress as a result of the student therapist's teaching style and the format of the CREATE program.

Developing interventions that are efficacious for children with ASD is challenging and not all families have access to the forms of treatment that are proven to have the highest outcomes. Lack of access to information and

financial restrictions places a heavy toll on many families of children with ASD seeking treatment. This pilot study was meant to preliminarily assess whether incorporating therapy techniques into visual arts education could be beneficial. Study results suggest that the 12-week CREATE intervention program facilitated the improvement of participants' social responsiveness and decreased problem behaviors. Through the incorporation of therapy techniques in the classroom, programs like CREATE will hopefully provide children with ASD better access to therapy in a practical setting. Art appears to be an appropriate subject to work with children on self-expression, and social communication.

Further studies should expand on these results through randomized control trials that compare classrooms of both children with ASD and typically developing children to assess the efficacy of art-based treatment interventions. Follow-up assessments should be performed to determine if the program has lasting effects. Additionally, while teacher ratings are helpful, future studies should use clinically trained independent evaluators to assess the progress of those receiving art-based treatment. The use of the arts as a platform for incorporating therapy into the classroom appears to be successful but may not be the only possibility. Therapy techniques could be incorporated in youth sports and physical educations classes in addition to core subject areas, such as English and Social Studies.

Although the current study was successful in improving the social skills and reducing the problem behaviors of the fifth grade participants, there are limitations to these findings that must be noted. The results of this study are encouraging, but the lack of a control group is a substantial hindrance. It is impossible to draw confident conclusions from the results of this study given that it did not contain a randomized control group and had such a small sample size. Maturation effects could have had a substantial role in the gains that the current study found. While the limitations of the current study restrict the conclusions that can be drawn about the intervention's impact, the overall trends that were seen encourage the possibility that incorporating therapy programs into the classroom can be highly successful.

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Chantel T. Ebrahimi is a fourth-year psychobiology student at the University of California, Los Angeles. With the goal of contributing to the advancement of health in the future, she plans on attending medical school in the next year with a focus on psychiatry. She is currently working as an undergraduate Research Assistant in Dr. Thomas Minor's learning and behavior lab in the Department of Psychology studying the effects of glucose on PTSD after trauma. Chantel also is a Research Assistant for the Big-C Project at the Tennenbaum Center for the Biology of Creativity and a contributor to the Healthy Campus Initiative (HCI) Sleep Well resources website both under the supervision of Dr. Robert Bilder. Her experiences have developed a passion to learn about the function of the brain and its role in disease. She also works closely with the Junior Youth Spiritual Empowerment Program that aims to guide middle-school aged youth to think about the betterment of their communities and living meaningful lives. In her free time, she enjoys to dance ballet and spend time with her friends and family.

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Neurotransmitter Drug Mediated Treatments for Obsessive Compulsive Disorder

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Obsessive Compulsive Disorder (OCD) is thought to be caused by hyperactivity of the cortico-striato-thalamo-cortical circuitry in the brain altering behavior and cognitive control. Symptoms of OCD include obsessive, persistent, and repetitive thoughts, an inability to resist compulsive behaviors, and an impulsive urge to perform and complete a task. These behavioral impairments reduce an individual's ability to control his/her actions and live a quality life. Many neurotransmitter systems are involved in the pharmacotherapy of OCD. Strong evidence in the past decade supports intervention in the serotonergic neurotransmitter system using SSRIs, selective serotonin reuptake inhibitors, as the first-line drug treatment for OCD. SSRIs and other drugs are frequently used together to reduce OCD-like symptoms in both preclinical and clinical models. Preclinical studies using rodents focus on specific compulsive and impulsive behaviors as determined by marble burying or nestlet shredding behaviors. Drugs mediated by the glutamatergic and dopaminergic systems are also currently being investigated as potential treatment options for OCD. Alleviation of OCD symptoms in clinical subjects often is measured as a decrease in the Yale-Brown Obsessive-Compulsive Scale (Y-BOCS). The serotonin-dopamine hypothesis of OCD requires further research in role of motivation as a cause of compulsive behavior in OCD.

Obsessive Compulsive Disorder (OCD) affects 2-3% of the general population and is a common mental disorder characterized by alterations of serotonin levels in the cortico-striato-thalamo-cortical circuitry (CSTC) (Dougherty et al., 2004; Nakanishi et al, 2014). These neurochemical alterations can cause behavioral impairment and are connected to the dysfunction of the basal ganglia and frontal lobe in the brain. Common OCD-like symptoms include repetitive and persistent thoughts and urges known as obsessions, an inability to resist compulsive actions, and a state of impulsivity causing severe anxiety (Witkin, 2008). It was only after the development of reliable diagnostic criteria in the 1980s that OCD treatment research began with the combination of behavioral therapy and pharmacotherapy operating as the 'gold standard' treatment (Ruscio et al., 2010). There is a large body of data pertaining to drug treatment methods for adults with OCD, but little research in this area has been dedicated to children with OCD because of the rare use of pharmacotherapy for this age population (Abramovitch et al., 2015). This review will focus solely on different neurotransmitter-mediated pharmacotherapies for adults with OCD, with an emphasis on the alleviation of compulsion and impulsivity.

Several concerns and questions remain about the disabling impact of OCD, such as the degree and range to which one's quality of life is diminished and one's ability to enter the workforce. For example, there are concerns regarding the limitations of measuring OCD prevalence in communities. In the past, prevalence estimates have only been reported for the full syndrome and not for obsessive-compulsive personality, a subsyndrome of obsessions and compulsions (Ruscio et al., 2010). This lack of external validity regarding the prevalence estimates and the impact of obsessive compulsiveness severity limits the possibility of comparing estimates across the globe or nation. Also, further research in OCD is needed to solve the disagreement of classifying this mental disorder due to its ranging subtypes. Beginning to answer these questions regarding the disabling impact of OCD on afflicted individuals and communities will help promote future therapies relieving patients of certain symptoms of this disease.

Obsessions are repeated, uncontrollable images or thoughts that occur in the individual's mind causing disturbance, uncomfortable feelings, and distress, which may strongly impair daily function and/or behaviors. Compulsivity, as described by Angoa-Perez et al. (2012),

refers to repetitive, ritualistic behaviors where the individual has little or no control. Impulsivity is a predisposition toward rapid, unplanned reactions to stimuli with decreased inhibitory control and a lack of consideration of negative consequences to the self or others (Angoa-Perez et al., 2012). Generally, OCD is classified as an anxiety disorder, but patients with OCD often also experience co-morbid depression (Witkin, 2008). As a result of this inability to resist thoughts or actions, the social and occupational functioning of OCD patients are impaired (Nakanishi et al., 2014).

Serotonergic System

As stated previously, the 'gold standard' treatment for OCD is the combination of cognitive behavior therapy (CBT) and medication (Koran et al., 2007). The most effective CBT treatment is called the Exposure and Response Prevention (ERP), which has the strongest effect on alleviating OCD-like symptoms when paired with serotonergic-mediated medication. Specifically, the first-line, preferred drug treatment for OCD is selective serotonin reuptake inhibitors (SSRIs) (Dell-Osso et al., 2006). Certain SSRIs used for the pharmacotherapy of OCD are: fluoxetine (Prozac), citalopram (Celexa), escitalopram (Lexapro), and clomipramine, a tricyclic antidepressant with a mechanism of action that primarily involves serotonin reuptake inhibition (Doughtery et al., 2004). Although serotonergic neurotransmission shows beneficial effects, it does not mean that a serotonergic dysregulation causes OCD (Dell-Osso et al., 2006). SSRIs are commonly administered because of the minimal number of side effects, rather high efficacy, and moderate therapeutic effect (Berlin et al., 2011). The therapeutic effect is moderate because about 30-50% of patients on SSRI treatment experience a lack of symptom reductions (Berlin et al., 2011; Nakanishi et al., 2014). Serotonergic reuptake inhibitors are primarily used to decrease the recycling of serotonin back into the pre-synaptic cleft in order to increase the duration and magnitude of serotonin-receptor binding in the post-synaptic terminal (Berlin et al., 2011). Chronic doses of SSRIs, however, result in higher levels of serotonin in the synapse, which cause the presynaptic neuron to modulate the amount of serotonin available through its autoreceptors (Dougherty et al., 2004). Ultimately, this serotonin modulation that occurs causes a downregulation, or decrease, of serotonin 1a-receptors on the postsynaptic membrane, which is associated with an increase in OCD-like symptoms. A continual dose increase of SSRI is needed to counter downregulation of receptors and decrease OCD-like symptoms, further supporting the serotonin hypothesis (Dougherty et al., 2004).

In preclinical studies testing the effect of SSRIs (Angoa-Perez et al., 2012; Andersen et al., 2010; Li et al., 2006), marble burying and nestlet shredding were operationalized as a sign of OCD-like compulsivity, obsessiveness, and anxiety mediated by the serotonin neurotransmitter system. Marble burying measures the tendency of rodents to dig in natural settings and nestlet shredding reflects the natural disposition to build nests to protect themselves and offspring from environmental conditions. Hyper-engagement in these activities reflects anxiety and compulsion. Genetic depletion of serotonin in transgenic mice lacking the gene encoding tryptophan hydroxylase 2 (Tph2) leads to an increased expression of OCD symptoms, especially compulsivity and impulsivity (Angoa-Perez et al., 2012). Interestingly, it has been found that a Tph2-/- genotype does not increase anxiety-like behaviors, which suggests that OCD is not necessarily co-morbid with anxiety contrary to Dougherty and other's findings (2004). An animal with a Tph2-/- genotype is a knockout animal, which means that this gene is inactive and not expressed. These researchers found that Tph2-/- knockout mice shredded significantly more nestlet material and significantly hid more marbles than their wild-type counterparts (Angoa-Perez et al., 2012). To determine if OCD symptoms could be reduced, brain serotonin levels were normalized with injections of tryptophan hydroxylase (5HTP), the immediate precursor to serotonin, in the dorsal raphe before behavioral testing. Results show that 5HTP treatment reduced marble burying and impulsivity, indicating that both the chemical and behavioral restoration in knockout mice was a function of serotonin.

Generally, the dosage of SSRIs is higher to treat OCD than for Major Depressive Disorder, which decreases the margin of safety (Camfield et al., 2011). Another current disadvantage of pharmacotherpy of OCD is that results from antidepressants take several weeks. This lengthy period of no apparent reduction in symptoms between commencement of treatment and onset of noticeable symptoms can induce anxiety in OCD diagnosed patients (Camfield et al., 2011). Also, rapid relapse of symptoms after discontinuation of SSRI treatment suggests that long-term maintenance of the drug is required (Camfield et al., 2011).

Clinical trials of antidepressant clomipramine, a common pharmacotherapeutic agent for OCD, have shown a reduction in obsessive and compulsive behaviors,

confirming the efficacy of clomipramine in the treatment of OCD. Despite the varying degree of response, 40-60% of patients respond to clomipramine with a 20-40% mean decrease in OCD-like symptoms (Doughtery et al 2004; Kellner, 2010). This low decrease in OCD symptomology suggests that patients with OCD cannot be completely alleviated from their symptoms yet (Camfield et al., 2011).

Although clomipramine has shown promise with adults, it has had adverse effects on developing rats. In a preclinical clomipramine model, rats were injected with serotonergic tricyclic clomipramine twice daily between postnatal days 9-16 and their behavior was assessed in adulthood (Andersen et al., 2010). As adults, the rats showed enhanced anxiety, increased marble burying, again a sign of compulsivity, and behavioral inflexibility as determined by impaired reverse learning in a T-maze. They also displayed a delay in working memory-related tasks assessed with a radial arm maze (Andersen et al., 2010). Both the T-maze and radial arm maze tests required the rats to enter certain arm(s) to receive reward and the inability to succeed was attributed to the compulsive behavior of the rats (Andersen et al., 2010). This study suggests early exposure to a pharmacological agent can produce adverse, long-term effects opposite to those generally observed following adult drug exposure proposing the therapeutic effects of anti-compulsive drugs, like clomipramine, in diseased states and not in neonatal stages.

In another study, researchers found that benzodiazepines, an anxiolytic agent (a drug that reduces anxiety), has a more potent effect in reducing marble burying behavior than antipsychotic agents like haloperidol (a psychotic symptom reducing drug), suggesting that marble burying could be associated with OCD because of its anxiety related behaviors (Witkin, 2008). An SSRI and antidepressant fluoxetine was also found to reduce marble burying behaviors, further supporting anxiety as a disorder closely linked to OCD (Li et al., 2006). Researchers conclude that marble burying is actually a better model of OCD than a generalized anxiety disorder because of the different effects of the specific drugs (Li et al., 2006). For example, SSRIs are generally selective for marble burying behaviors and nestlet shredding where GABA-based anxiolytic drugs are not solely selective for this compulsive behavior (Li et al., 2006). Whereas, when the antidepressant fluoxetine and anxiolytic chlordiazepoxide, a benzodiazepine, were co-administered they showed a greater significant decrease in both marble burying and nestlet shredding material in male rats than when administered alone (Li et al., 2006). Although promising, translation of these drugs from rodents to humans may not be an easy feat to accomplish. SSRI treatment is usually given at a low dose, however, as seen in clinical studies derived from preclinical studies of depression, high doses of fluoxetine may be needed for the alleviation of OCD symptoms in humans (Witkins, 2008).

Citalopram is another promising SSRI for treatment of OCD. Citalopram contains both right (R) and left (S) stereoisomers (Hedges & Woon, 2007). Escitalopram, the S-enantiomer of citalopram, inhibits serotonin reuptake by targeting the nervous system directly, whereas the R-enantiomer seems to have no effect on serotonin, suggesting that escitalopram has a higher clinical efficacy compared to its counterpart. Enantiomers are pairs of molecules that are mirror images of each other (Hedges & Woon, 2007). For example, with equal doses, escitalopram has been found to increase frontal extracellular serotonin more than the R-enantiomer of citalopram (Baldwin & Nair, 2005). Positive findings of escitalopram can be attributed to its high potency and efficacy in binding to the serotonin transporter and its longer half-life allowing for single rather than multiple daily doses. Despite these positive findings, little work has been done to determine its efficacy in the treatment of OCD (Hedges & Woon, 2007). One study, however, found that the effectiveness of escitalopram was higher in treating OCD than placebo and diminished compulsive behavior (Stein et al., 2007).

Currently, clomipramine provides the greatest improvement in OCD symptoms. Researchers are exploring drug-combination treatment like the co-administration of SSRIs and clomipramine. A study examined the drug combination therapy of clomipramine and fluoxetine (Simeon et al., 1990). Improvements appeared when fluoxetine was added to clomipramine treatment, both at low daily doses. Because of the lower dosage of drugs, this drug combination was well tolerated and proved effective, with no adverse side effects.

Other combination treatments use SSRIs and antipsychotics. In one study, a 26 year-old white man with OCD and no other comorbid diseases was prescribed escitalopram and low-dose risperidone, a dopamine antagonist, and in two weeks there was a noticeable 50% decrease in OCD-like symptoms (Dougherty et al., 2007). A double-blind, placebo-controlled study examined the addition of palperidone, an antipsychotic, to SSRI-resistant individuals for OCD treatment meaning that these patients were not experiencing any reductions in OCD-related symptoms with SSRIs determined by the Yale-Brown Obsessive-Compulsive Scale (Y-BOCS) (Storch et al., 2013). The Y-BOCS is rated on a 10-item scale questionnaire

assessing the individual's time spent on obsessions and compulsions, the impairment or distress experienced, and perceived resistance or control over obsessive, compulsive thoughts. Those who received combination drug therapy reduced their Y-BOCS score by 8 points suggesting the potential efficacy of antipsychotics to those individuals with SSRI-resistant OCD (Storch et al., 2013). The combination of antipsychotics and SSRIs was found helpful when a single SSRI only produces a partially favorable or no response. In another double-blind, placebo-controlled trial, researchers and colleagues determined that low-dose risperidone was effective in reducing OCD features when co-administered with an SSRI (McDougle et al., 2000).

In summary, the first line drug treatment for OCD is the administration of SSRIs because of the minimal side effects and high efficacy (Berlin et al., 2011). Also, research has found that a long-term maintenance of SSRI is needed for symptom reduction (Dougherty et al., 2004; Camfield et al., 2011). The preclinical Tph knockout mouse model has confirmed that injection of serotonin decreases OCD-like symptoms, as determined in marble burying and nestlet-shredding behaviors further supporting the role of serotonin in OCD (Angoa-Perez et al., 2012). In the adult clinical population, common drugs to reduce symptoms are clomipramine and citalopram, both serotonergic agonists; clomipramine is more widely used than citalopram, however (Doughtery et al 2004; Kellner, 2010). More recently, combination therapies, SSRIs and clomipramine or SSRIs and antipsychotics, are widely used because of the greater symptom reductions than SSRIs alone (Simeon et al., 1990; Dougherty et al., 2007; Storch et al., 2013; McDougle et al., 2000).

Glutamatergic System

Recent work has been focusing on the role of glutamate, especially on the primary glutamate receptor called NMDA, in repetitive OCD behavior. The NMDA receptor is primarily involved in synaptic plasticity through the flow of positively charged ions activating the neuron (Kariuki-Nyuthe et al., 2014). Many NMDA receptor antagonists and specific anticonvulsants with glutamatergic properties, like D-cycloserine (DCS), are being used as agents to decrease symptoms of OCD (Kariuki-Nyuthe et al., 2014). An agonist binds to receptors to activate and increase receptor-binding functioning and antagonists, on the other hand, bind to the receptor to block activation or functioning. First, preclinical studies on the mouse model tested the expression of cholera toxin promoted by cyclin D1 (D1CT-7) in the glutamatergic system within the CSTC circuitry (Kariuki-Nyuthe et al., 2014). Cholera toxin promotes signal transduction of G-protein and cyclic adenosine monophosphate (cAMP) synthesis facilitating activation of NMDA glutamate receptors. Activating the corticolimbic glutamatergic neurons in transgenic mice, cholera toxin was found to cause more OCD-like tics suggesting that the stimulation of glutamate plays a factor in expressing OCD compulsive behaviors (Kariuki-Nyuthe et al., 2014). Playing important roles in executive function and habitual behaviors, abnormalities in the dorsal and ventral striatum promote an excessive release of procedural strategies, closely resembling OCD-like repetitive behaviors (Kariuki-Nyuthe et al., 2014).

Marble burying and repetitive digging in rats can also be used to understand the glutamatergic system in OCD and related symptoms. An NMDA receptor antagonist, memantin, commonly used to moderate Alzheimer's dementia, is now being examined to study its effect on the alleviation of OCD symptoms (Egashira et al., 2008). A study indicates that NMDA antagonists' amantadine and memantine significantly inhibit marble burying behavior without affecting motor movement (Egashira et al., 2008). On the other hand NBQX, an AMPA receptor antagonist, and riluzole, a glutamate release inhibitor, display no significant effects on marble burying behavior and hinder locomotor activity (Egashira et al., 2008). Another model studied in rats is the signal attenuation model and efficacy of NMDA antagonists. Based on classical conditioning principles, it focuses on rat lever pressing for food reward. To determine compulsive rat lever pressing, a light stimulus is introduced to encourage extinction, or elimination of learned behavior, of the stimulus-food correlation. Those who continue lever-pressing compulsively are then treated with DCS, a partial NMDA receptor agonist that acts as an anticonvulsant. Compared to the control group, those rats administered DCS showed reduced compulsive behavior further suggesting glutamate's role in OCD (Albelda et al., 2010).

Several more recent studies focus on the dysfunction in glutamate neurotransmission, like increased glutamate concentrations in the CTSC network, which contributes to the pathophysiology of OCD. Generally, after SSRI exposure, a decrease in glutamatergic concentrations and a reduction in OCD symptoms are found (Berlin et al., 2011). A preliminary study suggests that glutamate-modulating drugs, such as topiramate, are effective psychotherapeutic drugs for OCD (Berlin et al., 2011).

Topiramate is an anticonvulsant with inhibitory effects on glutamatergic neurotransmission (Berlin et al., 2011). Typically, at the clinical level, both severity of OCD-like symptoms and improvement due to treatment is measured using Y-BOCS. Through a double-blind, placebo controlled experiment, researchers found that topiramate administered patients had a significant decrease in their Y-BOCS compulsion score in comparison to the placebo group, but there was no significant difference in the Y-BOCS obsession score between the topiramate and the placebo group (Berlin et al., 2011). These findings suggest that topiramate may be useful in the treatment of compulsions, but not obsessions. Despite these positive findings, topiramate was associated with adverse side effects, such as urinary bleeding, numbness, and agitation, which caused a 28% decrease in the number of patients completing the study (Berlin et al., 2011). Further research is needed on the effect of topiramate as a treatment for OCD, but it can be concluded that if patients with OCD inadequately respond to SSRIs, topiramate could reasonably be argued as the next line of treatment, despite the present side effects.

Another potential glutamatergic agent is riluzole. A trial using riluzole, a calcium and sodium-channel blocker, has shown a reduction in OCD symptoms in more than 50% of adult and pediatric patients by reducing glutamatergic release in the CSTC network (Coric et al., 2005). Further clinical studies need to examine the effect of memantin, other NMDA receptor antagonists, and DCS on alleviation of OCD symptoms.

Dopaminergic System

The dopaminergic system in the striatal region of the brain system, the basal ganglia, functions primarily in the role of learning and decision-making. Research on the dopamine system began because of the habitually indecisive nature of compulsive behaviors in OCD individuals (Westenberg et al., 2007). Compulsive checking in rats can be used as an endophenotype, indicator, to determine compulsive behavior performance mediated by the dopamine pathway only. Future research is needed in the interaction of the dopaminergic and serotonergic system in OCD, because of the hypothesis stating that both these neurotransmitter systems function in the start and maintenance of obsessive-compulsive symptoms (Westenberg et al., 2007).

Tucci and colleagues (2014) studied the dopamine-serotonin hypothesis in treatment of OCD by examining whether a serotonergic agonist, mCPP, in combination with a dopaminergic agonist, quinpirole, blocks the development of compulsive behavior in rats. More specifically, researchers aimed to understand if mCPP inhibition is present during induction or expression of compulsive checking in rats with injections of quinpirole (Tucci et al., 2014). Quinpirole was used to induce symptoms of OCD by driving the dopamine receptors of the CSTC circuit and overriding any negative feedback signals that terminate behavior (Tucci et al., 2014). Using mCPP, quinpirole, and saline, researchers concluded that the stimulation of the serotonin (5HT) receptors with mCPP inhibits the performance of quinpirole-induced compulsive checking, supporting the dopamine-serotonin hypothesis in the expression of compulsive checking and how compulsive checking behavior is not a direct function of motor habits (Tucci et al., 2014). Rather, the development of this OCD-like phenotype more likely reflects the neuroplastic changes produced by stimulation of the dopaminergic system with quinpirole inducing compulsive-like behavior in rats (Tucci et al., 2014). With quinpirole alone, rats showed fully developed compulsive checking behavior and co-administration of mCPP resulted in no diminished motor activity suggesting that the serotonergic system does not affect the induction of this OCD-like phenotype (Tucci et al., 2014). These findings suggest that 5HT receptors play a role in the serotonergic negative feedback signal that shuts down the motor output of activating dopaminergic stimulations in the expression, but not induction of compulsive checking. Further research is needed to explore whether the receptors stimulated by mCPP play a role in satiety signal, which deactivates the actual motivation to engage in checking behavior.

Future Directions in Research

Certain combination studies have shown adverse effects when SSRIs and clomipramine, an antidepressant, are administered together in high doses (Andrade, 2011). This suggests that both drugs need to be prescribed in lower rather than higher doses because as the dose increases, the adverse risks of pharmacodynamic and pharmacokinetic interactions also increase (Andrade, 2011).

Previous preclinical studies show that a Tph2 knockout mice shows evidence of OCD symptoms because of the depleted serotonin levels in the CSTC network. Future studies could explore if administration of serotonin, through 5HTP, in the neonatal model prevents the presentation of the OCD-phenotype as the mice ages. On a synaptic level, upregulation of serotonin receptors with a neonatal exogenous exposure may cause the phenotype to surpass the genotypic restrictions. Angoa-Perez and others (2012)

mention that forebrain 5HT switches from an exogenous to an endogenous source around embryonic day 16.5. The question of plasticity in terms of development can be explored if tryptophan hydroxylase is injected exogenously before embryonic day 16.5 and continued after expecting a decrease in OCD phenotypic symptoms.

Li, Andrade, and others (2006; 2011) studied certain combination treatments for OCD in rats and human subjects. Andrade, for example, administered an SSRI with clomipramine in human subjects and Li studied the combination of antidepressants and anxiolytics on rats in the alleviation of marble burying and nestlet shredding behaviors. Although Li specifically used anxiolytics because marble burying has been identified as an anxiety marker in rats, future research in this rat model could involve two SSRIs, such as fluoxetine and clomipramine, to see if this combination still reduces compulsive marble burying behavior as a sign of an anxiolytic effect (Li et al., 2006). Although Andrade's study (2011) supports the alleviation of general OCD symptoms with this combination, future research is needed to determine whether this combination is specific to compulsive behavior or OCD general symptoms.

AMPA receptor antagonists and riluzole have shown no significant decrease in marble burying behavior in preclinical subjects; on the other hand, a clinical trial using riluzole showed a reduction in OCD symptoms in more than 50% of adult and pediatric patients (Egashira et al., 2008; Coric et al., 2005). This difference in results could be due to the limitations in dosage on preclinical subjects; findings suggest that higher doses are more efficacious (Camfield et al., 2011; Witkin, 2008). As seen in Witkin (2008), doses generally used on rats are much lower than the doses used on human subjects, which contributes to the varying results. If clomipramine and fluoxetine have shown positive effects on the reduction of OCD symptoms in preclinical subjects (Andersen et al., 2010; Li et al., 2006), a possible future research endeavor could involve a low dose SSRI co-administered with riluzole to determine if a decrease in marble burying behavior occurs.

Overall, future research in the field of this mental disease is required in determining how OCD develops in an individual. The causes vary and the average age of onset is at 19 years of age, with diagnoses starting at age 14. This debilitating disease has prominent effects on adolescents, which require studies that focus on the causes of OCD and possible methods to reduce the age of initial symptoms showing. With an understanding of how OCD began for an individual, psychiatrists can design personal OCD treatments to better suit the disease. Since OCD is characterized primarily by repetitive and compulsive habits, future work on the reward processing and cognitive control of the brain is needed. The prefrontal cortex is the main executive processing structure in the brain and lying within this structure is the dorsomedial and dorsolateral striatum (Westenberg et al., 2007). The dorsomedial striatum is activated during action-oriented, reward behaviors, whereas the dorsolateral striatum is highly activated during habitual or reflexive responses (Westenberg et al., 2007). The principal neurotransmitter within the prefrontal cortex is dopamine, which controls behavior, suggesting the need for future research regarding the role of how dopamine affects the control of decision-making or impulses. If a psychotherapeutic treatment for OCD can be created that reduces the engagement in compulsive, repetitive behaviors, then many patients afflicted with this disease can improve their quality of life by regaining control over their actions and thoughts and thus possibly increasing their quality of life.

Summary

SSRIs and clomipramine, a tricyclic antidepressant, are commonly used as pharmacotherapeutic agents for OCD in adults because of their associated positive findings in both preclinical and clinical studies. Researchers have determined that a greater dosage, a long-term maintenance of drug, and combination drug treatments are methods of decreasing OCD-like symptoms and increasing quality of life. Administration of glutamate will inhibit the repetitive behavior found in OCD and common drugs used in the clinical population are topiramate and riluzole (Berlin et al., 2011; Coric et al., 2005). Lastly, the dopamine-serotonin hypothesis suggests that through a serotonergic negative feedback signal, the motor output of dopamine stimulations is turned off, causing a decrease in compulsive checking behavior and expression of OCD symptomatology, as seen in the interaction of mCPP and quinpirole (Tucci et al., 2014). The dopamine-serotonin hypothesis is not supported in the induction of OCD compulsive checking behavior, as seen in Tucci et al. (2014). This suggests that future manipulations regarding the motor pathway are required in attempts to reduce OCD-like symptoms and enhance an individual's quality of life. The research on OCD has just begun and many future findings will help alleviate, and possibly prevent, many OCD-related behaviors and symptoms.

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