Effects of Right-Hemisphere Stroke Therapies

on Symptoms of Autism Spectrum Disorder

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Author Note

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Abstract

There are many similarities between Right-Hemisphere Stroke (RHS) and Autism Spectrum Disorder (ASD), including deficits in global processing, impaired face recognition, linguistic and social understanding difficulties, theory of mind and motor skills impairment, impulsivity, executive function problems, aphasia, aprosodia, short-term memory problems, vision aberrations, anxiety and depression. Although RHS and ASD have different etiologies, imaging studies have indicated that there is decreased right-hemisphere function in both. This study examines what, if any, effects Right-Hemisphere Stroke therapies have in ameliorating symptoms of Autism Spectrum Disorder.

*Keywords:* Right-Hemisphere Stroke, Autism Spectrum Disorder, therapies, neuroplasticity, stroke rehabilitation, white matter

Effects of Right-Hemisphere Stroke Therapies on Symptoms of Autism Spectrum Disorder

Autism is a spectrum of neurological difficulties. Recent brain imaging technology of individuals with ASD has shown a lack of normal processing in specific regions of the brain, including parts in the right hemisphere. Research has indicated left-hemisphere predominance (also called extreme male brain) is common in ASD (Auyeung et al., 2009; Beacher, et al., 2012; Chapman et al., 2006). Neural imaging studies have indicated atypical brain function compared to neurotypical controls (Baron-Cohen, et al., 1999). By predominant function of the left side of the brain, functions of the right-hemisphere are under-utilized, which include: face recognition, global processing, and understanding non-verbal aspects of speech of others, which include emotion and gestures.

In cases of Right-Hemisphere Stroke, lesions from the stroke affect right hemisphere function (Dewarrat et al., 2009). Therapies for RHS were shown to increase function even years after the event of the stroke, due to brain plasticity (Meinzer et al., 2004). For both stroke (Brier et al., 2011; Sharma, Baron & Rowe, 2009) and Autism Spectrum Disorder (Pardini et al., 2012), therapies have been indicated as a factor in growing white brain tissue in areas of the brain where function has been hindered. The hypothesis of this study is that using therapies developed for individuals with RHS may be a viable option to increase right-hemisphere brain function for children with ASD by increasing white matter in under-functioning areas.

There have been more imaging studies of individuals with stroke than ASD, most likely due to stroke patients typically being older and able to lie still for the imaging process, as opposed to

children with ASD, who tend to be hyperactive and would most likely be difficult to measure through any means of neuroimaging. However, in addition to brain imaging studies, improvement of brain function can also be assessed by improvement of affected abilities, which is the method I will use to test the usefulness of the therapy.

Therapies considered most effective for stroke which do not require professional oversight or medical intervention will be designed into learning modules. Neurologists who are expert in Stroke rehabilitation and therapists who are expert in Autism Spectrum Disorder will be asked to review the modules for general review and any safety concerns. The learning modules will then be distributed to parents through mobile technology (designed as an application) which teaches parents how to incorporate RHS stroke therapies in play and activities of daily living of their children with ASD. It will include modules the children can watch independently, such as imbedded videos of an actor throwing a baseball, which in a study for stroke rehabilitation suggested that observing sport performance increases brain activation. (Sangburn, Taeho, Dukchan & Mihyun, 2011). Access to these learning modules will increase available therapies for the children, which is of immediate practical importance; increased therapies have been reported to have better outcomes in improvement of ASD symptoms (Mazurek, Kanne & Miles, 2012).

A randomized-to-groups posttest only quantitative study of 1,000 randomly selected parents of children ages 4-11 (who were previously diagnosed ASD by a qualified professional) will be asked to participate. Out of the 1,000, half will be randomly chosen to use the learning modules,

and then all participants will be asked to respond to the Functional Emotional Development Questionnaire (FEDQ) (Greenspan and Greenspan, 2002) and the Child Autism Spectrum Quotient Short (AQ-Short) (Hoekstra et al, 2011) to evaluate any changes that may be due to the RHS therapy modules. Both of these instruments are considered reliable and valid rating scales that rate autistic symptoms. These were chosen because they have been used in other research which evaluates therapies and the effects will be easier to compare with other interventions by using these pre-validated instruments. Written informed consent will be obtained from parents or guardians before the child will be able to participate in the study.

A concern for parents of children with autism is that a lack of medical coverage and uneven degrees of assistance (depending on the state in which the family resides) can cause delays in available therapies, further hindering development of the child. In addition, often parents have to rely on trained professionals for any interventional therapies, if they are even able to confer with any, since not much information is readily available to parents regarding what they can do to help their child therapeutically, even though research has shown that parents trained to do therapies at home can make significant gains with their children in reducing symptom severity (Pajareya & Nopmaneejumruslers, 2011). Although stroke and autism act upon the brain in complex ways, and different therapies have been shown useful in each, this study will be the first to examine the use of Right-hemisphere Stroke therapies for Autism Spectrum Disorder.

Definitions:

ABA Therapy: Applied Behavior Analysis therapy, which requires individualized behavioral interactions of a trained therapist with the child, which are used to increase communication and socialization skills.

Aphasia: impaired language ability, ranging from being unable to speak, read and write to having difficulty remembering words for speaking.

Aprosodia: Inability to infer the emotional state of a speaker by voice or gesture of others, a function of the right hemisphere of the brain.

Autism Spectrum Disorder (ASD): A brain developmental disorder which causes deficits in communication and social interaction skills, sensory issues and repetitive behaviors, perseveration (gets stuck on an action or task), preference for solitude, anxiety, and need for sameness, autism has a wide range of abilities and disabilities from child to child, which cause it to be called a “spectrum” disorder.

Global processing: Ability to put together parts of a whole to understand the “big picture” of a situation.

Neuroplasticity: The ability of the brain to re-grow or recreate connections.

Right-Hemisphere Stroke (RHS): A traumatic brain injury caused by lack of blood flow to the right side of the brain which results in deficits of right-hemisphere function.

Theory of mind: The ability to understand that others have thought and perceptions apart from your own.

**Literature Review**

Auyeung et al. (2009) found a significant positive relationship between fetal testosterone levels and autistic traits being exhibited by the children later through tests for autism characteristics. (No relationships were found between IQ and fetal testosterone (fT).) There was a significant negative correlation in Chapman et al. (2006) between fT and ability to empathize, as well as understand emotional affect by ‘reading eyes’ of the other person. Ethically, both studies could only get one fT reading, as it is not safe to get more for the purposes of a study, and the fT reading were obtained by amniocentesis voluntarily by women concerned about genetic abnormalities in their developing child. It is also not ethical to manipulate fT. This causes limitations in that hormones vary in individuals, including fetuses, from day to day, so we have to rely on just the one reading in both studies. Neither study can rule out post-natal environment or experience either, but the results are interesting in that testosterone is linked in other studies to over-reliance on the left hemisphere, known as extreme male brain (EMB). The right hemisphere is normally implicated in social and emotional intelligence and empathy, which is typically impaired in subjects with ASD.

The amygdala is another part of the brain normally activated in social-intelligence-required situations; in subjects with ASD, the amygdala was not activated (Baron-Cohen, et al., 1999). This shows another area of atypical brain function in ASD, and is also indicative that brain function is complex and the issue is not clear-cut and associated purely with right-hemisphere function. Here also is a major limitation: the complexity and depth of information related to brain imaging is a topic requiring specialized training and in-depth investigation; this experimental study does not attempt to cover every aspect of neurological difference between individuals with ASD, and those who have experienced a stroke. (Even between individuals with the same diagnosis there is variation, so to attempt to do so with different diagnoses would be foolhardy. These limitations I acknowledge without reservation.)

Research done on right-hemisphere stroke patients has shown comprehension and repetition impairments were caused by right-hemisphere damage, especially to the frontal gyrus of the brain. Fluency impairment was related to the temporal area in RHS. Seen in Dewarrat et al. (2009), lesion volume was measured by computed tomography (CT) and magnetic resonance imaging (MRI). Typically, patients diagnosed with stroke are older than children with autism spectrum disorder, and are aware that something is happening in their brain at the time of the stroke because they have previously not had the impairments they experience from the stroke. Similar comparisons cannot be made by children with autism, because typically the child has symptoms of ASD quite young; they may not have experienced a different way of perceiving things, or understanding and relating to people, so we have to rely on imaging techniques and outward assessments instead of the individual’s self-reporting, which we can sometimes do with adult stroke patients. It would also be impracticable and unfair to attempt to compel a child with

ASD who may have sensory difficulties to lie still inside a noisy imaging machine. Many adults without any sensory problems are not able to submit to these imaging tests without a sedative. It would be unethical and unnecessary to ask children to submit to imaging studies at this time. Quantitative parent responses on validated instruments will be used to assess changes in the child’s symptoms due to this study’s learning modules.

To regain function after stroke, research that shows efficacious therapy can increase connections in the brain tissue not near the damage (Sharma, Baron & Rowe, 2009) and Breier, Juranek and Papanicolaou (2011) showed bilateral increased white matter in areas of language function after therapy for stroke. Growth or increase of white matter, integrity and connectivity is called neuroplasticity - the ability of the brain to heal, or rewire itself after damage. Even years after a stroke, intensive language training improved language function and slow wave activity (which indicates a damaged area) in areas where the stroke lesions were located (Meinzer, et al, 2004), as measured by magnetencephalography (MEG).

The training in that study involved intensive language and speech training in concert with intentional restraint of other non-verbal forms of communication. This would not be ethically recommended for application in a study which may have children with ASD who may be nonverbal. However, the important aspect with the stroke therapy in that case, was that therapy was able to have an effect on the areas of stroke impairment indicated the neuroplasticity of the brain in adults; it is possible that children have even greater neuroplasticity, as their brains are in a natural state of growth daily. This study does not have the means to investigate or analyze these questions, but they are a potential future study when less overwhelming means of imaging are available for children.

Studies that have used imaging to view brain volume and integrity are available, although not as voluminous as stroke imaging studies for reasons mentioned above. Beacher et al. (2011) found white matter and gray matter volume atypical in areas in people with ASD; Pardini et al. (2012) explored white matter structure and increase/changes in subjects with ASD.

Pardini used Diffusion Tensor Imaging to determine if long-term augmentative and alternative communication therapy changed either clinical outcome or white matter modifications, and found that the therapy did both. In that study, where augmentative and alternative communication therapy was used, and indicated white brain matter growth, as alternative means to communicate was a means of therapy, it would not only be unethical to limit non-verbal communication in individuals with ASD who have no other form of communication, it would be counter-productive, as it was the non-verbal communication therapies in this study which improved the clinical outcome.

The difference between the two diagnoses (RHS and ASD) is not lightly being glossed over; the above cases are examples where some respective therpaies cannot be remotely considered alike in usefulness. For this reason it is imperative that any learning module that is delivered to parents of children with ASD is checked by experts before dissemination. It is not the intent of this study to do any harm or cause any further frustration for the parents of the children with ASD, and any learning modules will be cross-checked by medical experts in both RHS and ASD before being made available.

Although the specific content of the learning modules (and mobile application platform) will not be elaborated on here, an example of a potential useful therapy segment is to have an animated or

video of an actor performing a variety of sports activities. Sangbum et al. (2011) observed sports modeling an efficacious cognitive therapy option for stroke patients. The videos, which were of a baseball being thrown, activated regions of the brain which would have been involved in the actual performance of the action. Electroencephalogram (EEG) was used to observe activation of the brain areas during the viewing of the video. This particular video was taken of a university baseball player (so ideally it is best to have someone who can do an accurate representation of good form) and a high-resolution camcorder was used. The quality of the video and the ability of the athlete should be kept high also in this study’s learning modules. We do not know how much mirror neurons are active in children with ASD, but the intention is to increase all brain functions, so the learning modules will be designed as if everything were an actual coaching activity. For this reason, both right- and left-handed athletes will demonstrate a variety of sports actions in the module.

A logical reason to train parents as therapists is simply to meet the child’s need. Greater intensity (time) of therapies have been shown to increase improvement in outcome (Mazurek et al., 2012). A particular therapy that is suitable for parents to use at any time is Developmental, Individual-Difference, Relationship-Based/Floortime (DIR/Floortime). Increased use of this therapy by the parent at home, interacting with the child, showed significant gains in overall autism severity improvement as compared to the control group (Pajareya & Nopmaneejumruslers, 2011). After the parents were trained, they were then able to apply the principles of Floortime in interacting with their child without having to go anywhere or have an additional cost.

Existing research investigates the function of various therapies specific to stroke or autism. Although both conditions have been studied separately in depth, and gains in neuroplasticity

have been implicated in efficacious therapies for both, previous research has not sought to cross-check stroke therapies for ASD. This gap in research which checks for a valid therapy for autism, from the research in therapies for stroke, justifies the proposed study.

**Research Purpose and Questions**

The purpose of this quantitative experimental study is to examine the effectiveness of learning modules which have been based on right-hemisphere stroke therapies, and are used by parents in daily activities with their child diagnosed with ASD.

Research questions:

1.) Have there been any improvements (as rated by the parents with the rating instruments) in the child’s symptoms since the study began?

2.) Does the number of hours per week the parent/s apply the intervention affect the outcome?

3.) What variables have an effect on the outcome, and is there any relationship between any of the variables?

**Phase I**

**Participants**

1,000 parents of children (ages 4-11) who have been professionally diagnosed with ASD previous to the study will be randomly selected from a larger pool of 2,000 parents recruited through Occupational Therapy clinics in thirty states by pamphlets and posters in the clinics. Half (n=500) will be the control group, called the “waiting” group, which will not be permitted to try the intervention learning modules until the other group’s three month trial is over. (After

the first group uses the learning modules and both groups are tested, the second “waiting” group will be able to use the learning modules also.)

The other half of the participating parents (n=500) who will be randomly assigned from the 1,000 to use the learning modules, will be asked not to discuss them at all with other parents until after the study, to avoid other parents’ impressions becoming a confounding variable. Siblings will have to be able to take the learning modules together. Written informed consent will be obtained from all participants.

**Setting**

The setting will be the homes of the children and natural environment, whether it is outside in the yard, in the car, or visiting relatives. The module is designed for mobile phones so that it can be taken wherever the family goes. The goal is to incorporate the activities into the fabric of family life with as little disruption as possible.

**Variable/Data Sources/Measures**

Dependent variables include: age of children and parents, demographic information of children and parents, marriage and educational status, child and sibling sex and birth order, language(s)

spoken in the home, family members living with the family, family and any helpers listed. Parents will be asked to supply this information.

Names will not be used. Numbers will be assigned throughout so family confidentiality can be maintained. All 1,000 parents will be asked to fill out a survey for this information after the first random selection. The independent variable is the use of the RHS therapies learning module intervention, which half of the participants will then use for three months.

**Instruments/Materials**

The learning modules, designed to instruct parents of simple ways to incorporate RHS therapies into daily activities with their children, will be delivered via a mobile application to the intervention group. The modules will be animated and have videos, and if the participants have questions, a researcher will be available to answer any questions through email, and research assistants will be available for answering questions by phone. Parents will be able to maintain anonymity throughout, and do not need to answer any questions that would identify them specifically either initially or through email communications. No photos o videos will be taken.

**Researcher's Identity**

The researcher is the grandmother of a child with autism spectrum disorder.

**Validity and Reliability**

Experts in both fields of stroke and autism will be consulted for the safety and any concerns about the modules as they are designed and before dissemination to participants. Peer review by therapists in both fields will also be consulted for cross-checking the modules for any input regarding the modules.

**Data Collection Procedures**

In addition to the learning modules, and answers to questions through email or phone calls, every attempt will be made to give parents multiple ways to give input regarding the modules. Part of the application will include a way to leave voice messages or emailed comments from the parents for the researchers. The comments will not be visible to other participants.

**Proposed Data Analysis**

In this phase, only the intervention (the RHS therapy learning modules) will be given; there will be no data analysis in this phase.

**Phase II**

**Participants**

In this phase, After three months of use of the intervention, all 1,000 parents of children ages 4-11 who were randomly selected to participate will be asked to fill out both instruments: the Functional Emotional Development Questionnaire (FEDQ) (Greenspan and Greenspan, 2002), and the Child Autism Spectrum Quotient Short (AQ-Short) (Hoekstra et al, 2011). These are validated instruments that have been used for parent assessment of children’s autism symptoms and are designed to be used to both accurately assess the child’s interaction and levels of cognition/emotional responses at the time, but also they were designed to be used easily by parents and for self-report (parents will answer for younger children). They have been used previously as standard tests of function with regards to ASD. The FEDQ is related to developmental levels of 1) shared attention and regulation 2) engagement and relating 3) purposeful emotional interaction 4) social problem solving 5) creating ideas, and 6) thinking logically. The AQ-Short is a 28-item validated development instrument which correlates very highly with the full-length (50-item) AQ (r between .93 and .95). The shorter version is being used to ease the burden on parents to keep down attrition by using the briefest instrument possible.

**Setting**

The setting will again be the homes and natural environment of the family. Parents will have a choice of postage-paid paper versions of the instruments, online versions, or email versions they can fill out and save and email later as PDFs.

This is to retain as many participants as possible, as is the choice of assessment tools (above).

**Variable/Data Sources/Measures**

Dependent variables include: age of children and parents, demographic information of children and parents, marriage and educational status, child and sibling sex and birth order, language(s)

spoken in the home, family members living with the family, family and any helpers listed. Parents will be asked to supply this information at the beginning of their participation, and numbers will be used throughout. Unless a change of status of one of the demographics occurs, parents will not need to provide any other data in this respect. The independent variable, the intervention (the RHS-based learning modules) will have already been used for three months at this time.

**Instruments/Materials**

Instruments are the Functional Emotional Development Questionnaire (FEDQ) (Greenspan and Greenspan, 2002), and the Child Autism Spectrum Quotient Short (AQ-Short) (Hoekstra et al, 2011).

**Researcher's Identity**

Researcher is the same as phase 1. Research assistants TBD.

**Validity and Reliability**

These instruments (listed above) have already been validated by experts and checked for reliability.

**Data Collection Procedures**

Parents will be asked to fill out responses to the instruments, or if the children are older they can answer the questions to the AQ-Short, as it is designed to be self-report. Parents will answer for the younger children or nonverbal children. Paper versions will be postage-paid, with an envelope available to make response as easy as possible for parents. They will also be able to

Email a PDF version or answer within a dedicated area of the learning application. Parents will be identified by number only to maintain confidentiality throughout. They will be able to call or email comments or questions regarding completing the instruments at the same email address and phone number as for the learning modules. If parents or children would like to leave voice notes to the researchers for any suggestions, they will be able to do so through part of the mobile application. All information will be collected and recorded by graduate students and the researcher, and the information cross-checked by peer-review and archived for future evaluation.

**Proposed Data Analysis**

Using the data from the instruments, a specialist with s PhD in analytical methods will be asked to independently check the variables to distill any and all results. They will then be cross-checked by other professors in another department. Variables will be assessed based on their rate of occurrence their relationship to any improvement or decline in autism outcomes or symptoms indicated by the parents. ANCOVA will be used to compare variables within the study, and chi-square for comparison of sets of responses to check for any patterns not readily seen in the data.

Depending on the results of the data, if there is significant potential for the learning modules for future use, we will incorporate suggestions by parents and children, have experts check them again before launch, and then disseminate the modules to parents. My hope is to design and freely disseminate a mobile application that helps parents be involved in the therapeutic care of their children with ASD.

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