Background & Efficacy of the MOVIA Robotics, Inc. Robot-Assisted Instruction (RAI) System

Over the past 10 years, MOVIA Robotics, Inc. (MOVIA) has successfully deployed patented[1] RAI systems in dozens of schools and homes, measurably improving learning and therapeutic outcomes for children with Autism Spectrum Disorder (ASD). Students interacting with the RAI system demonstrated attainment and generalization of targeted skills including attention, literacy skills, reading comprehension, interpersonal coordination, improved motor coordination, coping, articulation, spontaneous and appropriate verbalizations, and reciprocal communication. Teachers piloting the MOVIA RAI system frequently report improvements in joint attention, turn taking, patience, following directions, social skills, pragmatic language, and skills maintenance. Data collected during the MOVIA in-home pilot program show dramatic improvement in therapeutic and educational skills including peer-bond, self-esteem, verbalization, functional vocabulary, responding to name, eye contact, sibling socialization, and sibling empathy. Children demonstrate improved learning readiness and self-regulation during the majority of the RAI sessions. Parents and teachers indicate no concerns of novelty effect, observing children's sustained interest and engagement following over many months of using the RAI system.

The Science and Research Behind RAI

MOVIA clients report the same breakthrough results for children with ASD that have been seen in labs and clinics around the world. Over the past three decades, top universities including Yale, MIT, and USC have published studies showing the deep science and evidence of RAI effectiveness at improving social and cognitive skills among children with ASD. General awareness of the RAI impact has been limited because it has been cost-prohibitive, limiting access…until now. MOVIA is the first company to bring the benefits of RAI to the lives of the general public by creating a hardware agnostic system that is affordable, accessible to both families and schools, and can be operated independently by a non-technical teacher or caregiver. MOVIA has built a product that is aligned with scientific data and evidence-based practices. At MOVIA, child development specialists and roboticists collaborate closely to create personalized and effective solutions for our clients. Below is an overview of the exciting research and evidence that drive our solutions.

Why Robots? *Robots scaffold social skills and learning gains.*

Robots have proven to be ideal teaching tools, able to serve as embodied instructional peers for children with ASD, providing non-judgmental, patient encouragement. Years of research utilizing robots in education and therapy have shown improved engagement[2], compliance[3], retention[4] and learning outcomes[5]. The unique relationship a robot provides offers scaffolding for social skills and engagement[6] [7] which children with ASD are able to generalize to their person to person interactions.[8] [9] [10] [11] Neurologically, robots are perceived similarly to humans, stimulating mirror neurons which contribute to the generalization of social skills.[12] Research has also shown that ASD children have increased engagement and learning opportunities with fewer disruptive behaviors when working with robots.[13] [14]

Are Robots Therapy? *Robots are a social tool to connect with ASD children in an easier way.*

Socially assistive robots are already being used in mental healthcare applications. MOVIA and other experts agree that RAI is <u>not a replacement</u> for specially trained and knowledgeable professionals. Rather, robots can serve as <u>clinical tools</u> or assistants in a wide range of settings.[15] Robots have served in three primary roles: companion, coach, and play partner. Additionally, robots have a wide range of potential applications in mental healthcare. The essential feature of RAI is the social and peer-like component of the interaction as a means of helping a human user (e.g., through coaching, education, and motivation).[16] Children often perform better with a robot partner as opposed to a human partner.[17] The children interact with the robots on a social level without dealing with many of the nonverbal cues present when interacting with a person that they normally find off putting or distracting.[18] [19] During their sessions with the robots, children show reduced repetitive and stereotypical behaviors,[20] and, social robots help to improve children's spontaneous language during therapy sessions.[21] These new RAI tools provide therapists and researchers with a means to connect with children on the autism spectrum in a unique and easier way.[22] Finally, the use of robotics can improve access to consistent

support, deliver consistent intervention, and promote adherence to another type of intervention or provide meaningful engagement.[23] Children reliably demonstrate generalization of the skills learned with the robot in circumstances where the robot is not present.[24] [25] [26]

Why Robots in the Home? *Robots provide consistency of intervention.*

Personalized RAI interventions are effective in providing long-term, in-home developmental support for children with diverse learning needs.[27] Children show improvements in targeted skills with long-term retention of content and no novelty effect. Parents have reported that their children have progressed more quickly towards their Individualized Education Plan (IEP) goals with the use of RAI at home. Additionally, families report the use of in-home RAI to be convenient and adaptable.[28]

Overview of MOVIA Methodology

Techniques foundational to RAI interactions include Applied Behavioral Analysis (ABA), movement-based therapies of embodied cognition and Gradual Release of Responsibility (GRR), and Discrete Trial Instruction (DTI). These methods are combined and applied by the robot to script appropriate behaviors needed for the student to make academic and social progress, devolving responsibility within the learning process from the teacher to the eventual independence of the learner. DTI, a validated intervention used in ABA, is a key approach to measure student performance; this data helps the system and the teacher determine when to introduce additional concepts or move on to an entirely new material.

MOVIA's Evidence-Based Approach

MOVIA's RAI system has been designed utilizing Evidence Based Practices (EBPs) and incorporates multiple therapeutic techniques and pedagogies to create a broadly applicable and successful teaching tool for children with ASD. The techniques have been validated by research conducted by the MOVIA founder, Timothy D. Gifford, his colleagues, and multiple researchers at institutions around the world. Gifford's initial research was conducted in collaboration with the University of Connecticut through a National Institute of Mental Health (NIMH) grant. This project demonstrated the efficacy of movement-based interventions to improve interpersonal coordination as well as improving spontaneous verbalization.[29] [30] [31] The work resulted in a patent that is part of the intellectual property that MOVIA uses in its approach and RAI systems. *A list of EBPs used in MOVIA's RAI systems is provided in Figure 1.*

All of the EBPs listed in Figure 1 are implemented via a multi-sensory approach where the student is able to hear, see, and touch the RAI system in a positive manner that is non-threatening and safe. This helps to keep a student's anxiety level low and allows for the brain to be able to process the information being taught, further internalizing the skills taught. Eventually, integration into the classroom and participation with typically developing peers in academic and social-emotional lessons is achieved.

How the MOVIA RAI System incorporates EBPs for Individualized Learning

The patient, nonjudgmental, and predictable nature of the robots provides a structured environment that allows a student to expressively take chances that he or she would not normally take in a traditional classroom. Anxiety is decreased in this approach to building social and emotional understanding. The robot has the ability to adjust the pacing of the curriculum to allow students more processing time to comprehend and respond to questions.

Child Data Privacy

The MOVIA RAI system meets all U.S. federal regulations, is HIPAA[32], COPPA[33], and FERPA[34] compliant and has no cameras recording the child or environment. Individualized instructional content is delivered via multi-layered RAI software driven by child-tablet interactions and facilitators adjusting sessions.

Naturalistic Intervention	Technology Aided Instruction and Intervention	Core Applications of Interventions
Self-Management	Reinforcement	Social and Emotional Understanding
Social Narratives	Functional Communication Training	Communicational Dynamics
Social Skills Training	Response Interruption Redirection	Self-Regulation
Structure Play w/Robot	Modeling	Executive Functioning
Task Analysis	Scripting	Learning Readiness
Prompting	Visual Supports	Activities of Daily Living

Figure 1

[1]Patent No.: US 9.478,147 B2, Gifford et al. (45) Date of Patent: Oct. 25, 2016, Methods and Apparatus for Interpersonal Coordination Analysis and Training.

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[32] HIPAA - The Health Insurance Portability and Accountability Act of 1996 (HIPAA or the Kennedy–Kassebaum Act).

[33] COPPA - Children's Online Privacy Protection Act of 1998 (COPPA) is a United States federal law, located at 15 U.S.C. §§ 6501–6506 (Pub. L. 105–277, 112 Stat. 2681-728, enacted October 21, 1998).

[34] FERPA - Family Educational Rights and Privacy Act of 1974 (FERPA or the Buckley Amendment).