

Social robots for creativity stimulation in children

Patrícia Alves-Oliveira

ISCTE-Instituto Universitário de Lisboa, CIS-IUL,
GAIPS/INESC-ID and Cornell University
Lisbon, Portugal and Ithaca, NY, USA
patricia_alves_oliveira@iscte-iul.pt

Patrícia Arriaga

ISCTE-Instituto Universitario de Lisboa, CIS-IUL, Lisbon, Portugal
patricia.arriaga@iscte-iul.pt

Guy Hoffman

Sibley School of Mechanical and Aerospace Engineering,
Cornell University
Ithaca, NY, USA
hoffman@cornell.edu

Ana Paiva

Instituto Superior Técnico, Universidade de Lisboa,
GAIPS/INESC-ID
Lisbon, Portugal
ana.paiva@inesc-id.pt

I. INTRODUCTION AND BACKGROUND

Creativity is one of today's most sought-after abilities, related with personal and professional benefits. It favors social and economic innovations as well as promotes individuals' well-being, self-expression, and a sense of identity [28, 6]. The importance of creative abilities has been recognized in developed societies [19] with innovation, collaboration, and creative problem-solving being valued over standardized knowledge and procedures memorization [8, 2]. This resulted in a change from industrial towards creative economies [24, 17, 4]. One of the most important drivers for this change has been the technological development, including emerging technologies such as social robotics [1].

Despite the fact that creativity is an important skill to have, a so-called "creative crisis" is reported to exist in the literature [14]. This crisis is defined as a tendency for creativity levels to decrease during some stages of development starting at elementary school years [14]. Research has shown that creativity is a skill that can be developed, if trained and stimulated, with interventions for creativity presenting encouraging levels of success [16, 30, 33, 15, 3]. Efforts to harness creative potential have been conducted in the field of education (focusing on the development of curricular content and a change on teaching approaches that now that embrace creativity [7, 11]), and in technology-related fields with emerging technologies having crucial contributions. For example, Scratch, a widely used programming language for children adopted by schools and whose roots are based on Papert's work [22], can be applied to stimulate creative and critical thinking by encouraging independence, exploration, and playful learning [29, 27, 32]. Furthermore, creativity-support tools are technological tools that enable new forms of self-expression and are especially effective in supporting group collaboration and social creativity [34], with interventions showing positive effects on children creative thinking [5, 26, 25, 21]. Beyond the virtual ambiance, social robots have also been used to stimulate creative behaviors either in

adults [13, 12] and in children [10]. This body of work shows the promise and potential of technological artifacts in fostering a higher cognitive ability to be creative.

Given the potential that social robots have shown in creativity, the present work aims to contribute to the field of human-robot interaction (HRI) by targeting creativity decline with the usage of social robots to stimulate creativity in children. More specifically, we this robot is loaded with creativity techniques and during interactive play moments with children it can foster their creativity. Despite the developments in other fields outside robotics, the inclusion of technology to increase creativity has been sparse. Additionally, this project sets a novel use-case for robots given that they are traditionally used as programming tools for children.

II. THE ROBOT-CREATIVITY PROJECT

This project is grounded in the field of HRI in which robots are developed to be social actors that can interact with humans.

A. Problem statement

Creativity is an important ability to have. However, due to various factors (e.g., developmental changes in creative thinking [36, 37, 23], socialization and conformity [35, 20, 9], school restrictions [31], etc), creativity levels tend to decrease. We aim to contribute towards the described "creative crisis" by designing, building, and programming a robot focused at stimulating creativity in children from 7-9 years old.

B. Research questions

- 1) *Effectiveness* – Can robots be used as tools that influence the creative abilities of children?
- 2) *Process and Product* – Does the intervention for creativity using robots influences both the creative process and the creative product?
- 3) *Domain* – Which creativity domains (verbal and figural) are most influenced by the intervention with a robot?
- 4) *Group Size* – Is the intervention for creativity more successful if performed in groups or individually?

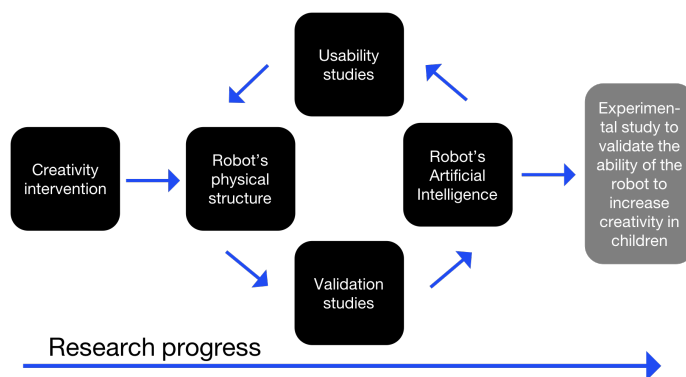


Fig. 1. Milestones and research progress for this Ph.D. project. Milestones represented in black squares show the work that was already performed, while milestones in grey squares are part of the future work.

C. Methodologies and approaches

This project is anchored in multidisciplinary research approaches and methodologies from the fields of psychology, computer science, mechanical engineering, and design. The inherent multidisciplinary of the research methods and approaches used enabled the successful development of our robot, called YOLO¹. A visual representation of the project milestones and research progress is present in Figure 1 and is explained below.

The initial stage of this work concerned the design of a creativity intervention between children and YOLO. To investigate the most suitable scenario, a systematic review of the literature about creativity interventions was conducted. This systematic review included a survey of 2247 scientific articles from 1961 to 2018, filtered down to a full analysis of 49 papers using the PRISMA method [18]. From this review, we concluded that a playful activity would be a promising scenario to stimulate creativity. Specifically, a storytelling activity was chosen in which YOLO would be used as a character in children’s stories.

The second and third stages of this research concern design through research to develop the physical body and the artificial intelligence (AI) of YOLO. We aimed at designing appearances and behaviors that facilitate story creation. Prototyping techniques (e.g., 3D printing, laser cutting) were used for the iterative process of designing and fabricating the robot. This was a joint process with children where we have relied on design methodologies, such as co-design and participatory design approaches to create a robot that would act as an autonomous animated toy, both reacting to the plot that children create and being proactive in giving ideas for storylines. This resulted in a robot with an abstract and minimal shape. The AI of the robot is comprised of two main modules: the robots’ social behaviors and the robot’s creative behaviors. The robot’s social AI module served to create behaviors for the robot to act socially and engage children in story creation. The creative AI module enables YOLO to display validated techniques for creativity stimulation (selected from

the systematic review literature) to trigger creativity in children during play. A total of 132 children participated in different usability and validation studies of the robot’s embodiment and AI development.

The third stage concerns experimental studies that validate the use of YOLO in creativity augmentation. We will investigate the effectiveness of the intervention with a study design in which YOLO is loaded with the creativity techniques compared to a condition with random behaviors and with no behaviors (YOLO is turned off to mimic a traditional toy). Additionally, we aim to investigate if creativity levels increase more when groups of children play with the robot (social creativity condition) compared to just one child (individual creativity condition). We envision a large scale study to evaluate the creative process of children (how children create a story and select ideas), the creative product (the final story created by children), and the person (creative abilities of each child stimulated by the interaction with YOLO and assessed using validated measures as pre- and post-tests).

III. IMPACT

This project has the potential of showcasing how autonomous robotic technologies can be used to perform tasks that go beyond function to increase innate human qualities, such as being creative. YOLO was developed especially for and with children, having a child-proof design that enables free and unrestricted play due to its small size, lightweight, and portability. This project has the potential to influence policy-making for child-robot interaction as it introduces a new generation of technological toys that children can use, both outdoors and indoors, that not only stimulate traditional play dynamics (such as physical play) as it also nurtures social connection, imagination, and fun.

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¹YOLO, short for Your Own Living Object.

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