# Creative Coding for Dance Movement Therapy in Children with Autism

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Abstract: People diagnosed with an Autism Spectrum Disorder (ASD) have deficits in social interaction, communication and cognitive development. Children with ASD may also present motor difficulties growing up, which motivates interventions of Dance Movement Therapy (DMT) that helps them to develop social skills and integrate in society. Current technological advances have integrated into DMT interventions, enriched with virtual scenarios, projections, sensors and robot partners. These works have positive outcomes in social skills development and motor skills refinement, even though, due to confinement for COVID-19, online DMT has yet to be further explored. We propose a research methodology for the development of a tool that aims to develop self expression for ASD youth, with the creation of an artistic image based on dance and body movements. Our initial study case is Movarte, a web based tool that creates graphic pieces based on body movement and proxemic areas. 15 users evaluated the application, showing positive outcomes in terms of engagement and novelty, though it was not considered so clear and limited in terms of parameter control. Future research will provide more insight to adapt an interface for DMT in self expression for people with ASD.

## 1 INTRODUCTION

Autism Spectrum Disorder (ASD) is a family of disorders at a social, communicative and behavioral level (Association, 2013). This neurodevelopmental disorder is detectable from a very early age and today has a prevalence of 1 in 100 children diagnosed annually (Zeidan et al., 2022).

Commonly, this group of people present deficits in the development of social and motor skills and the expression of emotions. In addition, impairments in motor development, movements and speech are included. That is why, depending on the severity of their diagnosis, they may require therapeutic support in the initial stages or even for life (Lord et al., 2018).

Art therapy serves to give a free expression of the deepest emotions and expressions, through the creation of an artistic piece that reflects an internal state. It is an alternative for people who cannot communicate verbally and provides a space for personal expression.

Dance Movement Therapy combines the creative and expressive aspects of dance with psychotherapy, using both verbal and non-verbal means to help clients achieve a more realistic body image and experience relief, pleasure, and integration (Weitz, 2018). Movement therapy can help children with behavioral disorders express memories stored in their bodies from pre-verbal periods, and Dance Movement Therapy has been developed through the collaboration of professionals from the fields of psychiatry, psychology, and dance.

Technologies contribute to the creation of new tools for the development of new visual and creative forms. The contribution in art therapy is favored with new digital possibilities. The confinement caused by the COVID-19 pandemic has led many psychotherapists to move all, or a good part, of their work online, which has been little documented for remote dance music therapy (Garcia-Medrano, 2021).

In this sense, Creative Coding can contribute from the development of code for expression and the visual arts, which is enriched with other areas of Human Computer Interaction, such as affective computing. Likewise, a user-centered methodology can be proposed for the development of a tool that explores corporality and expression in people with ASD.

The present work seeks to present ideas and a first approach towards a tool that allows creating a visual piece in an intervention from dance for children with autism.

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## 2 BACKGROUND

Some works have been studied that apply DMT using technological means to potentiate the abilities of children with autism. These applications have been evaluated in small groups of children with ASD in therapeutic contexts that have had positive results. Some examples are:

1. OSMoSIS is a musical and body game that converts movements into sounds. It uses a Kinect to capture the body movements of the child participating in the game, in order to measure motor and social synchrony (Ragone et al., 2020).
2. DanceCraft is a remote-use system that, through videos of a DMT instructor, allows children to play to imitate their movements. It uses a Kinect sensor and has been well received by family groups that have tried it (Ringland et al., 2019).
3. Choreografish is a virtual reality (VR) video game that simulates choreography for the movement of a school of fish. The objective is to reduce the social anxiety of the participants, by allowing them to control the rhythm and movement of an artistic creation (Jr. et al., 2018).
4. ExpressiveBall is a prototype of a tangible ball that has different sensors to stimulate the stimulation of the senses. The objective is to achieve the expression of children with ASD with low verbal skills, through six body activities (Wilson et al., 2020).

In these works, children with ASD are encouraged to the arts through games on body interfaces and movement. However, the objectives of these studies are to promote certain social skills or autonomy, and few focus on creative expression. Furthermore, the result is often imitation of an instructor to improve the precision of body movements, leaving little room for self expression and exploration.

The present research is motivated by these last aspects to implement a new system that considers the needs of children with ASD, who can explore corporality for the execution of an artistic piece. The process will have more value than the result and will help you communicate in a different way.

Creative Coding is the use of programming in creative applications. In different contexts, user interfaces are enriched with embodied alternatives. This philosophy has a major presence in the Maker movement, where users develop creative technological artifacts, though it has not yet been used for therapy or well being scenarios. In accessibility, the idea is to adapt and develop interfaces for users with special needs, in this case, people with ASD may find an engaging form to develop self expression and creative endeavours through art creation with dance.

DanceON is an educationally-focused programming system that allows users to create visual animations in response to body movement data, with the goal of engaging young women of color in creating artistic computational artifacts within culturally relevant dance learning experiences (Payne et al., 2021).

Children benefit from creation with an increase of self-expression and autonomy development levels. Our goal is to explore how this can be developed through an embodied interface, noting that users are keen on visual and are engaged with virtual worlds and videogames.

Some common tools for creative coding are Processing, a library for graphical creation. The JavaScript language is commonly used for web development, in this case we find p5.js, a library that adapts Processing with WebGL standards. A complementary library is ml5.js, that uses Machine Learning models from Pytorch in JavaScript. TouchDesigner is a software that helps to create graphical, 2D and 3D rendering in creation projects.

In summary, DMT can benefit from the creative currents of programming, to support new tools that stimulate creative development. Recently, as a result of the confinement caused by the COVID-19 pandemic, psychotherapists who practice DMT have had to seek remote and online avenues for their work, demonstrating similar results of empathy and body exploration (Garcia-Medrano, 2021). Currently, it is necessary to continue documenting these processes and propose tools that can adapt to these challenges, in order to achieve a novel and stimulating effect for this group of users.

## 3 METHODOLOGY

A first approach is proposed to evaluate a body interface that allows creating a graphic piece, developed with creative programming tools. This first stage requires validation and further we propose a more complete project, designed with experts in the field.

Movarte emerges as an interactive art proposal that aims to establish links between movement and a dynamic visual image. For the recognition of poses and body movements, a neural network model was used, which was associated with a JavaScript library to produce graphic images within a web browser. Additionally, the concept of proxemics was used to establish imaginary zones that allowed variations to be made when generating the final image. In particular,

it is intended to investigate the use of proxemic zones as a way of generating layers to create an image composed of simple geometric figures.

The web application has six proxemic zones that represent a layer of the image that the user can manipulate. To set a zone, it is necessary to approach until it is indicated to be in the next zone. These are:

**Layer 1.** Choose the background color by varying the vertical position of the elbows and the horizontal position of the waist. The RGB values are chosen, where the right elbow represents the Red channel, the left elbow represents the Green channel, and the right waist represents the Blue channel.

**Layer 2.** Allows the user to choose the position of lines that align with the position of the forearms, measuring from the elbow to the wrist. The colors are triad of the previous color.

**Layer 3.** A triangle is formed whose vertices are the points of each shoulder and the midpoint between the points of each hip. The color is complementary to the background.

**Layer 4.** Allows the user to generate a sequence of circles of different colors and sizes, which follow the position of the wrist and elbow for each arm.

**Layer 5.** Two triangles are formed with each ear, eye and nose as vertices as a common point. The colors are triad of the color of the third zone.

**Layer 6.** Circles of different sizes are formed whose center is the nose. Unlike the third zone, these are created every 2 seconds.

Having completed these areas, you can download the final image, an example is shown in Figure 1.

Figure 1: Example of image generated with Movarte.

In order to gain proof of concept, we developed a web-based tool for interactive art creation based on an embodied interface called Movarte.

The approach is to use proxemic spaces that represent image layers, on which different graphical elements are placed as the user moves closer to the web camera. The main idea is to control basic graphical figures according to the body movements and overall position, so that body movements and dance are enhanced to advance into a final visual product, that can be exported into a 2D image.

It was developed using the p5.js library, which extends Processing in the JavaScript language, and the React framework to integrate to a web based app hosted in Heroku. For body recognition, it uses the PoseNet model integrated with the ml5.js library, a Machine Learning model that collects 17 body and points.

The UEQ is a quick and reliable questionnaire to measure the user experience of interactive products (Laugwitz et al., 2008) . It consists of 26 questions of pairs of opposite words in which the user evaluates the level of identification of an adjective about another, on a seven-point scale. This allows evaluating the scales of: Attraction, Transparency, Efficiency, Controllability, Stimulation and Novelty. Furthermore, it separates the measurement of quality at a pragmatic and hedonic level. The Spanish version was used and the results are processed by the data analysis tool provided on their website.

The evaluation used the User Experience Questionnaire (UEQ) and a set of qualitative questions. The UEQ sets 6 metrics composed of 26 closed questions in a likert scale. Additionally, we added the following open questions:

**Q1.** What contexts do you consider suitable for this application? Options: *Dance, Physical exercise, Performance, Therapy, Artistic creation, Leisure activities, Kinesiology and Other.*

**Q2.** What do you think about this experience?

**Q3.** What aspects would you change for future versions of the application?

Proposals will be reviewed to improve the system and move towards integration in educational or daily use contexts. Changes regarding technological advances and a new review of the literature will be incorporated, as well as proposals from researchers and experts in the area. New case studies will be defined to propose workshops and sessions that promote creativity applied in schools and support centers for children with ASD.

It is planned to have an active group of participants, between 10 and 20 children with ASD. ASD and their families. During a defined time, creative exploration sessions will be developed through the proposed system. The evaluation will correspond to

the complexity of the artistic piece created, as well as your experience and usability with applications of this type. All integration stages will include interviews with experts from centers interested in collaborating.

## 4 A CASE STUDY

As a proof of concept, a study was carried out on the usability and acceptance of Movarte as a tool that contributes to the validity of this research. Initially, it is intended to validate with people who are not experts in the topics addressed in this project, who allow an external view and have different levels of technological or artistic knowledge. To do this, a group of 15 participants between 19 and 52 years, they were sent the link to the project page and some instructions on its use. Users carried out the tests in their homes, with different web cameras, computers, internet browsers, spaces and environmental conditions, to avoid conditioning a response under defined parameters. They were invited to freely explore the tool, to generate at least one image that they could optionally share it in the gallery. At the end, they were asked to respond to the UEQ and the questions posed. The results of the survey for the pairs of items are in Figure 4. A high score can be seen for the characteristics of original, innovative, good, creative and activator. On the other hand, it has been considered unpredictable by a majority of users, and to a lesser extent, confusing, difficult to learn and overloaded.

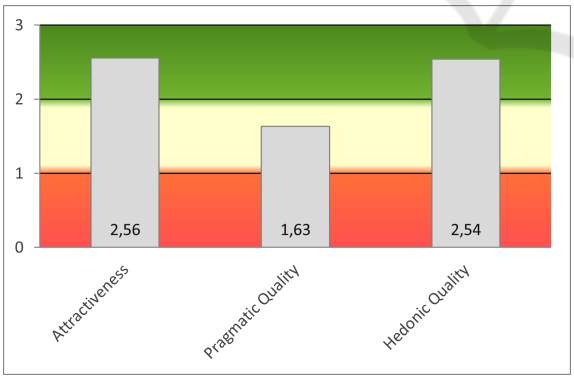


Figure 2: Quality factor in UEQ.

In the quality fields presented in Figure 2, Attractiveness scores the highest with 2.56, close to Hedonic Quality with 2.54. Pragmatic Quality scores lower with 1.63

As noted in Figure 3, Dependability scores only 1.25 which is the lowest overall, given that most users have described the system as more unpredictable, and some of them have classified it as not secure, complicated and confusing, as reflected on answers of Figure 4. Efficiency scores 1.78, followed by Perspicuity with 1.87, noting an experience that is complete but struggles a little to be defined as practical, organized and understandable. Simulation is 2.33.

The UEQ applies a normalization for the questions (or items) into -3 to 3 scale, for each questions field group. In the quality fields presented in Figure 2, Attractiveness scores the highest with 2.56, close to Hedonic Quality with 2.54 and Pragmatic Quality scores the lowest with 1.63.

This is then classified in the UEQ sections noted in Figure 3. Attractiveness and Perspicuity score 2.56 and 1.87, respectively, representing on higher values for the engagement and visual aspects. In Figure 4 the results are presented, noting their relevance with the quality factors, overall the application was found to be quite unpredictable and sometime hard to understand, but showed a great visual impact and was also valued for entertainment.

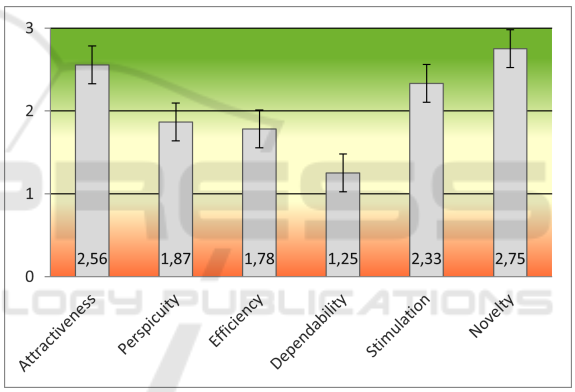


Figure 3: Mean of UEQ sections.

As for the qualitative questions, users in general though that Movarte had value for DMT interventions. The most important aspects of Q1 is that users found this useful for artistic creation with 14 out of 15 answers, and Therapy with two thirds of the votes, other relevant topics where Therapy, dance, physical exercise and leisure activities, as noted in Figure 5.

Users responded to Q2 to have an overall entertaining experience, where they felt present in the dance and art creation, some even played music while they were dancing to increase their creative patterns. They felt their well-being increased and felt more relaxed after the experience.

For Q3, users think the idea is good but still find it limited. They propose new graphic figures, the use of 3D graphics, Virtual or Augmented Reality, as well as being able to control the parameters such as colour, size of images and image format.

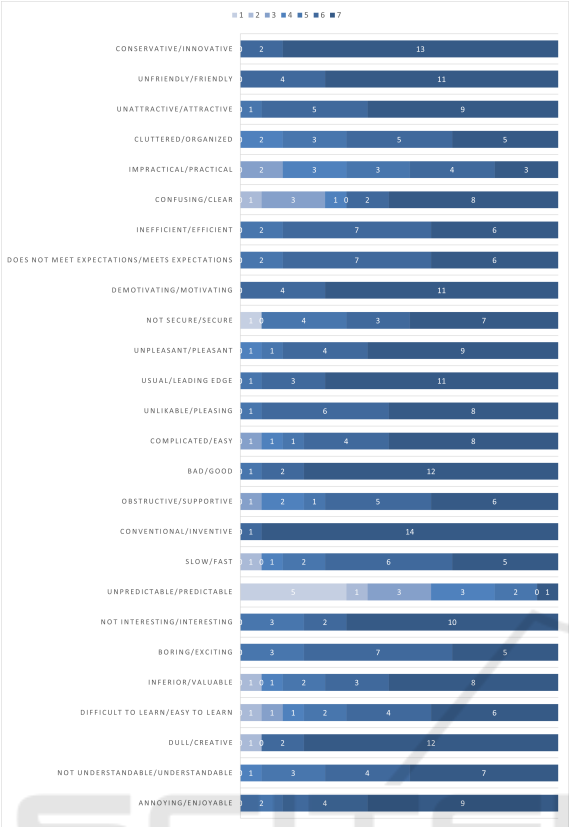


Figure 4: Answers per item.

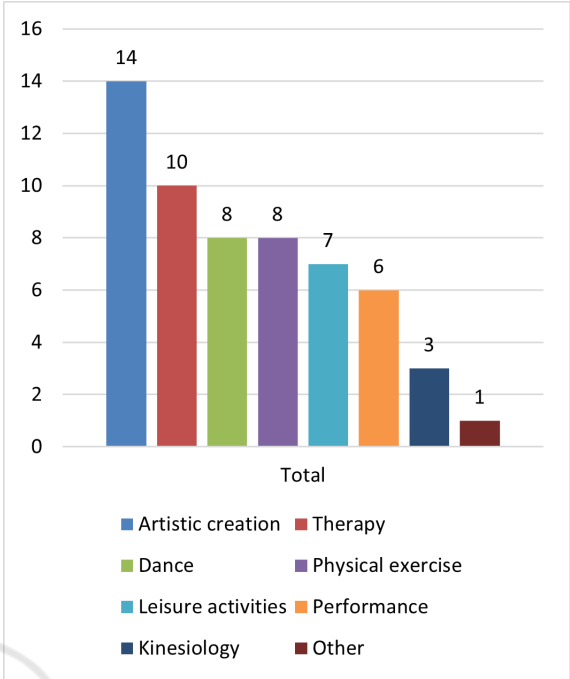


Figure 5: Answers for Q1.

## 5 DISCUSSION

Movarte overall showed positive outcomes with high levels in terms of novelty, attraction and engagement, they feel this tool can help to increase interaction for creative and self expression.

Users assured they need more control on parameters such as colour and size, more diversity in the displayed figures, explore 3D graphics. Instructions were not clear for many, people took some time to understand application.

Users see this tool suitable for anxiety and relief, they felt that disconnected from their physical environments and felt an immersive experience they took to their home places. Some included music and enjoyed the exploration that could be made with their bodies with no additional device needed.

General audience and software experts validate the use of this embodiment tool for therapeutic and artistic uses, which gives a direction that DMT can profit form an intervention that uses Movarte for creative expression in an artistic piece with dance movements. The layers are found to be an interesting idea, but is not clear how to use it, people got confused on where to pass from one layer to the other or to revert changes, feeling like they lost their previous image and had to start over again.

As an initial proof of concept, it can be seen that Movarte has generated good acceptance and has given space to discuss possible improvements. At a general level, it proves to be attractive to a non-specialized general public, achieving high levels of hedonistic and attractive quality, based on the positive assessment in terms of novelty, attraction and stimulation. By varying the colors by random levels and according to each base color chosen, the images are unique for each experience, added to the possibility of sharing them in the gallery, invites users to actively participate to explore new results. On the other hand, randomness plays a factor that does not allow controllability, which lowers the levels of predictability and control over the result, reflected in a lower level of pragmatic quality. You must continue exploring to find a way that allows you to control the creative process, but without limiting it so that it loses its novelty or causes frustration.

Additionally, graphic possibilities and audiovisual resources must be increased. The p5.js library allows you to manipulate basic figures although they are limited, 3D can be integrated with three.js or Babylon.js to achieve an immersive vision. Along these lines, the use of virtual or augmented reality can be explored, without its use involving high computing use or requiring expensive hardware that would mean losing

the portability of an online system. Some options to consider for the web are AR.js, A-Frame and Argon.js. You should study how to adapt existing technologies to an environment designed for people with ASD. For motion detection, if web cameras associated with a body recognition machine learning model are chosen, it must be verified that their result is similar to depth cameras (RGB-D). Of this group, Kinect is the most used and validated in different research projects with children with ASD, however, today it is discontinued; Although there are alternatives, they involve a higher cost and the need to have the necessary equipment. The study should then be of the technical capabilities to capture the precision of movement, such as level of clarity, angle, resolution and distance of camera, as well as prevention for obstruction or erroneous captures, both for one or multiple participants.

Another point to assess is the integration of mathematical models with graphic and creative programming libraries. The input data is usually the position on the two-dimensional x and y axes, which are captured, and the percentage probability of accuracy. As an alternative to PoseNet, Tensorflow today features BlazePose and MoveNet, which increases capture from 17 to 33 body and facial points, or runs at over 50 frames per second for mobile devices and desktop, respectively. A model that has had a leading role in research is OpenPose, which detects different body and facial points, its integration with p5.js or ml5.js. The results of the open questions have provided positive validation to replicate the use of Movarte in contexts of artistic creation, therapy and dance, which is the focus of this work.

The next step is to validate the tool with experts in the thematic lines of ASD, therapists, artists and relatives of diagnosed people, to have a global vision that allows us to propose a specific use case that will be evaluated in later stages. Creative coding offers a simplet language that extends and adapts for people that do not come from technological backgrounds to enhance their work with the nature of code.

It would be interesting to propose an interface that allows p5.js code and graphic resources to be added easily. Other contexts to explore arise from physical exercise, leisure activities and performance, which can follow the same line. Rehabilitation is already widely explored in literature, the focus today is on creative expression and training. It is also necessary to establish evaluative concepts for the complexity of the image, such as the management of colors and shapes, as well as expressive degree.

# 6 CONCLUSIONS

Users with ASD need to refer creative endeavours with an inclusive approach, like art therapy. Dance Movement Therapy (DMT) is an evolving field that needs to be promoted with new technological advances and can be suitable for motor therapy, well being, anxiety relief.

We believe that Creative Coding as important and empowerment tool for autism and has yet a big journey to be validated, though our approach gives hints for future works.

Future work will be made for testing with ASD groups, apply questionnaires and validation of experts for creative assessment, as well as extending the use of the application to educational environments, workshops and leisure use.

Dance Movement Therapy (DMT) provides experiential benefits for people diagnosed with an autism spectrum disorder (ASD), at the level of well-being and expressive development. This research is part of a project that seeks to propose a tool for artistic creation with creative programming tools.

In a first stage, a proof of concept is proposed to validate a prototype with a group of users, quantitatively and qualitatively. The main results denote that it is a novel and attractive idea, suitable for contexts of artistic creation and therapy. However, it is not entirely controllable and has aspects to improve in terms of the diversity of graphic options and usability.

The work will continue with these results towards its next phase, it has the support of collaborating organizations and experts who will provide a lot of information to consider in future stages. A user-centered design will continue and subsequent validation with an environment adapted to end users.

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# REFERENCES

Association, A. P. (2013). *Diagnostic and Statistical Manual of Mental Disorders*. American Psychiatric Association.

Garcia-Medrano, S. (2021). Screen–bridges: dance movement therapy in online contexts. *Body, Movement and Dance in Psychotherapy*, 16(1):64–72.

Jr., R. A., Handman, E., Bayles, G., Jackman, J., Cheng, K., Ritchie, S., Newell, T., and Wright, C. (2018). Choreografish: Co-designing a choreography-based therapeutic virtual reality system with youth who have autism spectrum advantages. pages 381–389. Association for Computing Machinery.

Laugwitz, B., Held, T., and Schrepp, M. (2008). *Construction and Evaluation of a User Experience Questionnaire*, page 63–76. Springer Berlin Heidelberg.

Lord, C., Elsabbagh, M., Baird, G., and Veenstra-Vanderweele, J. (2018). Autism spectrum disorder. *The Lancet*, 392:508–520.

Payne, W. C., Bergner, Y., West, M. E., Charp, C., Shapiro, R. B., Szafir, D. A., Taylor, E. V., and DesPortes, K. (2021). Danceon: Culturally responsive creative computing. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*, CHI '21, New York, NY, USA. Association for Computing Machinery.

Ragone, G., Good, J., and Howland, K. (2020). Osmosis: Interactive sound generation system for children with autism. *Extended Abstracts - Proceedings of the 2020 ACM Interaction Design and Children Conference, IDC 2020*, pages 151–156.

Ringland, K. E., Wolf, C. T., Boyd, L., Brown, J. K., Palermo, A., Lakes, K., and Hayes, G. R. (2019). Dancecraft: A whole-body interactive system for children with autism. pages 572–574. Association for Computing Machinery.

Weitz, N. (2018). The importance of the dance movement therapy in general and child therapy. In *The European Proceedings of Social and Behavioural Sciences*, ERD. Cognitive-Crcs.

Wilson, C., Sitbon, L., Ploderer, B., Opie, J., and Brereton, M. (2020). Self-expression by design: Co-designing the expressiball with minimally-verbal children on the autism spectrum. pages 1–13. Association for Computing Machinery.

Zeidan, J., Fombonne, E., Scorah, J., Ibrahim, A., Durkin, M. S., Saxena, S., Yusuf, A., Shih, A., and Elsabbagh, M. (2022). Global prevalence of autism: A systematic review update. *Autism Research*, 15:778–790.