AN INTELLIGENT MOBILE APPLICATION FOR GUIDED SELF-EXPRESSION IN NEURODIVERGENT CHILDREN

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ABSTRACT

Children need a safe way to explore their emotions, especially neurodivergent children who are oftentimes isolated from society. Art-based projects have been shown to help children grow emotionally.. We aim to explore a different way in which these children can grow and learn and believe the research that access to this resource will benefit these children. Our goal is to reach as many children as possible without limits and allow them to express themselves through their art. Some of the key technologies that we use are AI chatting, image generation, and drawing tutorials. The AI chat is designed to guide and encourage the students in their creative endeavors. The image generator allows for the children to express their current emotions with a picture that matches what they are feeling. Lastly, the drawing tutorials allow them to follow guided instructions for creating their own works of art. With research supporting art as therapy for neurodivergent children we decided to experiment the real life effects of our app on actual users. Through the anecdotes and feedback of the users we were able to improve parts of the app and see how effective it was at facilitating creativity. With these results it is clear that the effects of art on neurodivergent individuals are positive and help them grow emotionally.

KEYWORDS

Network Protocols, Wireless Network, Mobile Network, Virus, Worms &Trojon

1. INTRODUCTION

The ability to express, identify, and regulate emotions is closely linked with a child's social abilities, academic achievement, and long-term health [7]. This poses a significant challenge for neurodivergent children, especially those with autism spectrum disorder (ASD) and attention-deficit hyperactivity disorder (ADHD). Neurodivergent children often face challenges in emotional regulation, communication, and sensory processing [4]. This can lead to behavioral issues, including irritability and impulsivity, which others may interpret incorrectly, causing potential misunderstanding [5]. Therefore, as emotional literacy becomes increasingly important in child development and education, there is a need for tools to help children explore their emotions in both safe and engaging ways.

Art-based interventions have long been acknowledged as a useful way to help autistic children foster their emotional intelligence [6]. Art therapy and education programs, for instance, have demonstrated effectiveness in building the social skills of young children [9, 10]. Studies have also shown that the use of interactive media is more beneficial for the socio-emotional development in children than traditional education methods, such as text-based books [8].

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However, there remains a gap in accessible, engaging tools that combine both emotional expression with intelligent interaction for younger audiences.

The first methodology by Emma and Patricia uses group art-making sessions in order to reduce the segregation of neurodivergent children in society [1]. Our method tries to achieve a similar goal in allowing neurodivergent children to express themselves freely. Emma and Pratricia need to gather these neurodivergent children in order to achieve their goal where as in ours the children can use the app anytime.

The second methodology by Freya is a one-on-one therapeutic art session with neurodivergent children [2]. This is good in that the children get to physically make art and socialize while doing it however there may be some children who are shy and do not want to draw art in front of another person. Our app allows for the creation of art without the facilitation of another human. Any questions or help that the children may need can be answered using the chatbot in the app.
The third methodology by Safinah and her co-authors explores using a robot to interact with the children in order to encourage their creativity through story telling [3]. This method allows for the children to not worry about being judged for their ideas. The limitation of this is that there is only one robot and so it can only help one child at a time. Our app is distributed through the Google Play store and the Apple App store and so anyone with a phone is able to download the app and experience it.

The proposed app, Coloroo, is a child-friendly mobile platform to support self-expression and emotional literacy through art and artificial intelligence. The app has four major components: (1) an art tutorial system that guides users through step-by-step drawings, helping to build confidence and calmness; (2) an AI-generated image feature using OpenAI's DALL·E model, which creates art based on a child's self-selected mood, color preferences, and thematic choices; (3) a built-in chatbot powered by ChatGPT, offering low-pressure conversations for additional aid and even self-reflection; and (4) a profile that tracks the progress and activity of the user, encouraging continued engagement. All of these components culminate to make an app that addresses different aspects of neurodivergent children.

This approach was chosen because it addresses the emotional and communication barriers that neurodivergent children face, especially those with language challenges. The app offers both structured (art tutorials) and unstructured (chatbot and image generation) methods of expression. Unlike conventional art/drawing or mindfulness apps designed for adults, Coloroo is designed for neurodivergent children and blends generative AI with art learning. It offers a more customized approach and more flexibility in how the user chooses to engage with art.

To test the user experience and functionality of the app, we conducted a survey-based experiment to four preliminary users. With a series of 10 questions rated on a Likert scale of 1-5 (1 being strong disagree and 5 being strongly agree), we addressed core features and goals of the app. With an overall average rating fo 4.18 out of 5, the results confirmed that the users found the app engaging, visually-appealing, and intuitive to use. The strongest aspects were the app's clean interface and aesthetically pleasing visuals. The tutorials were also generally easy to follow and understand. However, lower scores on chatbot interaction and emotional expression suggest that improvements could be made to enhance AI communications and allow more self-expression. In particular, the AI image generation could be improved to better match user expectations. Overall, the experiment confirmed that the app fulfills most of its intended purposes and identified clear areas of revision to encourage greater inclusivity and emotional development.

2. REVIEW OF LITERATURE

Emma Gentle and Patricia O'Brien tackle a similar problem in their research article [1]. They highlight the historical segregation of neurodivergent people in society and how they tend to express themselves creatively through art. Their research serves to illustrate how group art-making can help neurodivergent people form relationships. They conclude that through making art, it can enrich your life and wellbeing, especially for neurodivergent people. Their methodology was to have real people come together and paint. Our method aims to leverage the positives of modern technology by making art wherever you are and whenever according to the needs of neurodivergent children.

Freya Pinney is a neurodivergent therapeutic arts practitioner who encourages her clients to express themselves through art [2]. Her clients are mainly children and through her work she has seen them express themselves more clearly through art than through words or actions. She concludes that "facilitating the creative explorations"[2] of neurodivergent children allow them to move beyond what medicine could ever do for them. Freya uses fingerpainting as her way of allowing children to express themselves. Our method uses whatever the preference of the child is. They can fingerpaint, they can use pencils, they can use acrylics, they can use an ipad for digital art. Our method allows them to use whatever they prefer to use and is available to them.

There was another experiment conducted by Ali et al. on whether having a robot interact with neurodivergent would help them thrive socially [3]. In this experiment they had elementary school children interact with the robot to create picture books. The robot creates a scaffolding that guides the children so they can focus on the creative side of story telling. This scaffolding was tailored toward neurodivergent children. Their conclusion was that by tailoring the robot's interactions to the children it removed the barrier of traditional design practices that affect neurodivergent children. Our app has a similar feature where users can interact with an ai chatbot. This chatbot can help you with creating a picture book but it also has the capabilities of other functions. Users are able to ask the chatbot for advice or help and it will respond with steps to help neurodivergent children.

3. METHODOLOGY: APP DESIGN AND FEATURES

Coloroo was designed as a mobile application that can be accessed via iOS and Android platforms. The target audience is children aged 6–12, since this is a critical developmental stage for emotional regulation and creative growth. The app consists of four major features: (1) structured tutorials, (2) AI-generated imagery, (3) a chatbot mascot, and (4) user profile and progress tracking. The design is intentionally minimalistic to reduce sensory burden, especially for neurodivergent users

A high-level block diagram of the app architecture is shown in Figure 1.

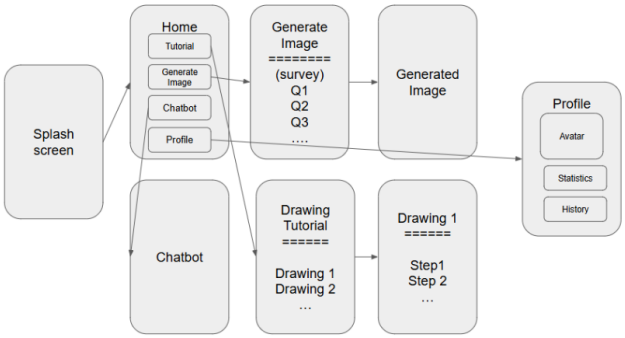

Figure 1. Overview of the app architecture

The tutorials system shows step-by-step drawing guides with static images for each step. These images are stored locally on the device, and they offer visual sequencing to support neurodivergent users' cognitive and sensory processing needs. It uses Flutter's UI framework and interacts with the local file system and progress-tracking module.

Figure 2. Example tutorial steps

```
Text(
  "Step ${stepnumber}",
  style: TextStyle(fontSize: 35),
),  // Text
AnimatedSwitcher(
    duration: Duration(milliseconds: 300),
    child: Image.asset(
      "${widget.folderpath}/${stepnumber}.png",
      key: UniqueKey(),
    )),  // Image.asset, AnimatedSwitcher
Padding(
  padding: const EdgeInsets.all(12.0),
  child: Text(
    instructionList[stepnumber - 1],
    style: TextStyle(fontSize: 28),
    textAlign: TextAlign.center,
  ),  // Text
),  // Padding
```

Figure 3. Code for navigation of tutorials

This code manages navigation through the images of tutorial steps using a variable called stepnumber. Each step consists of an image and a corresponding instructional text. The Image.asset() function loads the image based on the current step, and a Text widget displays the matching instruction pulled from a pre-written txt file.

Two FloatingActionButtons let the user navigate forward or backward. When pressed, the stepnumber variable updates inside setState(), which updates the screen with the new image and text. A progress counter shows the user's current step in the tutorial and the total number of steps. If the user reaches the final step and clicks “Finish,” the app saves their completion status using SharedPreferences, connecting the tutorial page with the profile page.

The image generation function allows users to input preferences based on a list of questions and generate custom illustrations based on their emotions. It uses OpenAI services for Natural Language Processing (ChatGPT) and Image Generation (DALL·E 3). These systems interpret user input and return the resulting image via API communication.

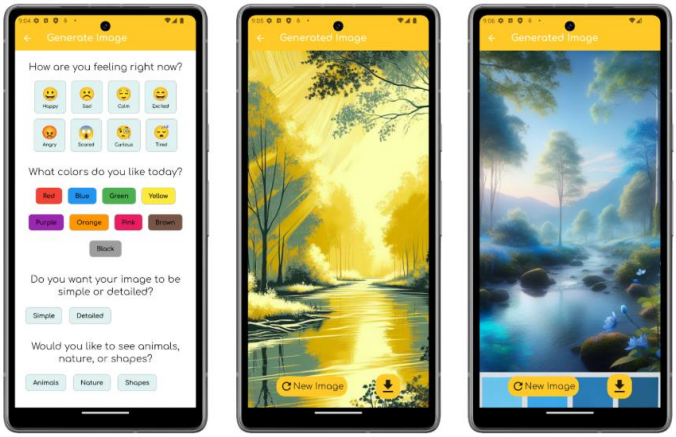

Figure 4. Screenshot of images

```
// Build prompt from survey answers
final prompt = 'A ${_selectedEmotion?.toLowerCase()} ${_selectedTheme?.toLowerCase()} scene, '
    'with ${_selectedEnergy?.toLowerCase()} feeling, '
    'using these colors: ${_selectedColors.join(", ").toLowerCase()}.';
final request = GenerateImage(model: DallE3(), prompt, 1, size: ImageSize.size1024, responseFormat: Format.url);
try {
  final response = await openAI.generateImage(request);
  final imgUrl = response!.data?.last?.url;
  if (imgUrl != null) {
    if (!mounted) return;
    final SharedPreferences prefs = await SharedPreferences.getInstance();
    int? number = prefs.getInt('image_number');
    if (number == null) {
      number = 0;
    }
```

Figure 5. Screenshot of code 2

This code takes what the user wants the image to look like and sends them to OpenAI’s DALLE 3 model to generate an image. The first line creates the prompt using the user's selections from the survey questions. These values are converted to lowercase to ensure the consistency of the prompt and colors are joined into a comma separated string. The GenerateImage object is then started with the DALL·E 3 model, the prompt, and settings for image size and format.

The try block sends this request using openAI.generateImage(request) and waits for a response. It then uses SharedPreferences to update the local counter image_number, which tracks how many images the user has generated, showing them on the profile page.

A kangaroo mascot serves as the interface for conversational AI. The kangaroo was chosen because it symbolizes protection and comfort (a pouch carrying its young), which can reassure children and reduce anxiety. The chatbot is powered by GPT-4.1 and provides low-pressure interactions such as offering creative prompts (“Would you like to draw a forest today?”) or answering simple questions. Unlike traditional educational chatbots, the kangaroo focuses on encouragement rather than correction, creating a supportive environment.

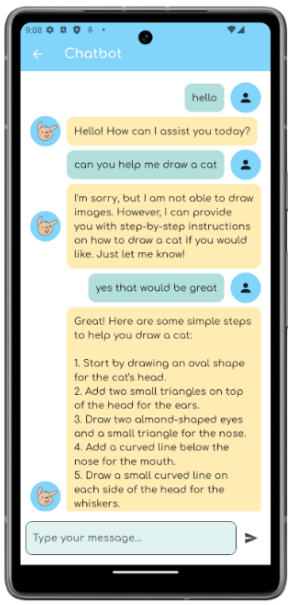

Figure 6. Screenshot of chatbot

```
final request = ChatCompleteText(
  messages: [
    ..._messages.map((m) => {'role': m['role'], 'content': m['content']}),
  ],
  maxToken: 200,
  model: GptTurboChatModel(),
);  // ChatCompleteText
final response = await _openAI.onChatCompletion(request: request);
final reply = response?.choices.last.message?.content ?? 'No response';
await writeMessage(reply, false);
setState(() {
  _messages.add({'role': 'assistant', 'content': reply});
  _isLoading = false;
});
```

Figure 7. Screenshot of code 3

This code shows the request and response between the app’s AI chatbot and the ChatGPT API. The ChatCompleteText object is constructed by embedding the full message history. Each message is formatted in a way that contains a role (either the "user" or the "assistant") and its corresponding message content.

The onChatCompletion() sends the request to OpenAI's API using the GptTurboChatModel() and waits for a response. Once the system receives the response, it extracts the assistant's reply from the API response. If the response is null, the system shows "No response".

The message is then saved using writeMessage(), which makes sure that the conversation history is saved even when the user exits the page. Finally, the chatbot's reply is added to the _messages list, and _isLoading is set to false, which updates the UI. This system is directly connected to the local message history manager and the visual display on the chatbot screen.

4. EXPERIMENT

To test how well the application fits with the target audience, I collected user feedback using a survey. This allows me to better understand how intuitive, engaging, and helpful each feature of the app is. This experiment would help improve design, enhance user satisfaction, and gauge how well the app is being received.

I created a 10-question survey that assesses the functionality and user experience of the most important features of my app. The questions reflect the app's goal to support emotional expression through creativity. The feedback will identify which features are working well and which ones need improvement. Each question is scored on a scale numbered 1-5 (1 = strongly disagree, 5 = strongly agree).

The questions are as follows:

1. The app was easy to navigate and understand.
2. I enjoyed using the AI chatbot to express my feelings.
3. The drawing tutorials were simple to follow and engaging.
4. The AI-generated images matched my expectations.
5. I felt more relaxed or focused after using the app.
6. The visual design and colors of the app made it enjoyable to use.
7. I liked being able to choose how I felt and see it turned into art.
8. I would use this app again in the future.
9. I would recommend this app to a friend or family member.
10. Overall, I felt that this app supported emotional expression in a creative way

Question	User 1	User 2	User 3	User 4
1	5	5	4	5
2	3	3	4	4
3	4	5	5	3
4	3	4	5	4
5	4	4	4	3
6	4	5	5	5
7	5	5	4	5
8	5	4	4	4
9	4	4	5	4
10	4	3	4	3

Figure 8. Table of experiment

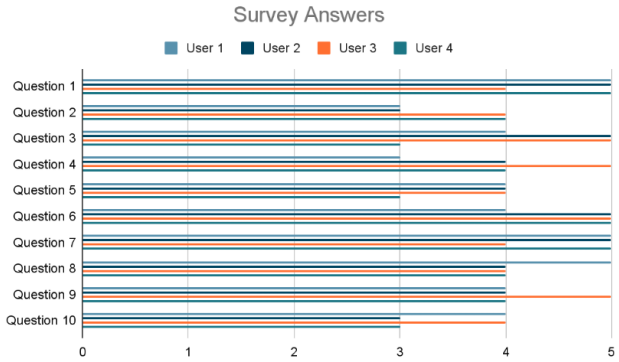

Figure 9. Survey answers

Based on the user responses, the overall average score in answer to the questions is 4.18, indicating a generally positive user experience. The specific results for each section reveal valuable insight into how effective the app is and areas for improvement.

The average score per question is as follows:

Question 1: 4.75
Question 2: 3.5
Question 3: 4.25
Question 4: 4.0
Question 5: 3.75
Question 6: 4.75
Question 7: 4.75
Question 8: 4.25
Question 9: 4.25
Question 10: 3.5

The highest-scoring questions were Question 1 (“The app was easy to navigate and understand”), Question 6 (“The visual design and colors of the app made it enjoyable to use”), and Question 7 (“I liked being able to choose how I felt and see it turned into art”), each with an average score of 4.75. These results suggest that the design of the app is intuitive and visually appealing, as initially hoped. It also shows that the AI image generation function is also appealing to users.
However, the lowest-scoring questions were Question 2 (“I enjoyed using the AI chatbot to express my feelings”) and Question 10 (“Overall, I felt that this app supported emotional expression in a creative way”), each with an average score of 3.5. This suggests that while users appreciated the visual and structural elements of the app, it had limited abilities to truly encourage emotional expression.

Question 4 (“The AI-generated images matched my expectations”) also received a slightly lower score (average 4.0) than other sections. This points to some inaccuracies in the AI output in capturing user expectations.

5. CHALLENGES AND SOLUTIONS

The tutorial system shows step-by-step, image-based drawing instructions to help children follow along on their own. The system is minimalistic and intuitive to help children focus, calm down, and build fine motor skills. One might ask: “Why use static drawing steps instead of animated

tutorials that show the process in motion?" Each step is static and cleanly illustrated to reduce cognitive load and allow the child to move forward at their own pace. Animated tutorials can move too quickly or include unnecessary distractions, which is challenging for some neurodivergent learners.

In the image generation system, a common concern could be regarding the accuracy of the AI-generated image in reflecting what the user wanted. In the app, there is a series of questions where the child can select their mood, desired theme, color palette, and detail level, which can help make the result more personal and aligned with their vision. While exact interpretations may vary, there is a "New Image" button where the child can choose to regenerate a different version. Another concern is that children will rely on AI rather than drawing on their own. However, this tool is not a replacement for drawing, but simply an emotional reflection activity. The user can use the generated image as a reference or their own drawing.

Lastly, some users may not trust the accuracy or legitimacy of the AI chatbot conversation system and question the use of it. As Lulu and Imane point out we want to avoid misinformation especially when it is being taught to or about neurodivergent children [15]. Our chatbot system uses OpenAI's bleeding edge model, GPT-4.1, which allows for accurate and precise information. It is also aware of its own limitations and will not give suggestions outside of its own expertise. We have programmed this model to be aware of the neurodivergent target audience of the app and to take this into account when responding to the user about certain topics. The use of this chatbot also allows for children who are shy or who may need help to ask the chatbot any question without judgement.

6. DISCUSSION

The pilot evaluation shows the potential of combining art and AI to support emotional intelligence and learning in neurodivergent children. Structured tutorials provide easy-to-follow, stepwise tasks that reinforce confidence, while AI-generated images give children an outlet to externalize emotions visually.

At the same time, several challenges remain. An over-reliance on AI for emotional expression can undermine traditional drawing and holistic child development. The simplified mood input may also oversimplify children's feelings. These trade-offs show the need for balance and continued refinement.

On the technical side, the app is very robust in terms of features and efficiency but there are some limitations to what it can accomplish. The first limitation is that the data is stored locally onto the phone rather than on the cloud. This is good for fast retrieval time but if a user switched to a different device then their data would not carry over. If we were to change this to use a cloud database then this would sync the data of a user across multiple devices. Another limitation is the options available for generating an image. Users are only allowed to pick the options available and cannot input their own custom options. For example, the emotions section only allows for eight different emotions. If a user was feeling a different emotion other than the eight available, there is currently no way to input that emotion. To fix this, we can allow for input to be taken from the user for whatever emotion they are feeling. There is always the potential for someone to enter something that is not an emotion and so we would also have to integrate an algorithm to check if what the user entered is actually an emotion.

Future improvements could include adding an in-app drawing. This would allow neurodivergent children to draw directly onto the app and save their drawing on the app. This is especially useful

when following the drawing tutorials that are available on the app and would encourage the creativity of the user.

Ultimately, compared to related work, Coloroo distinguishes itself through its accessibility. Unlike robot-assisted interventions, it requires only a smartphone. Unlike in-person art therapy, it can be used independently, though it can only complement professional support, not replace it.

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