Towards Safe Self-Stimulatory Behaviors in Autistic Children: HarmAlert4AutisticChildren (HA4AC)

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Abstract: Self-Stimulatory behaviors, or stimming is quite common in Autism and can begin as early as infancy. Autistic infants may show early signs of stimming through repetitive movements such as hand flapping, rocking, or head banging. These stereotypical behaviors help self-regulation and are generally not harmful unless they pose a safety risk (e.g., head banging) or significantly interfere with daily activities. In such cases, the parent or caregiver must immediately intervene to ensure the safety of the child. To foster a safe environment for autistic children, we introduce a novel problem of identifying potentially harmful self-stimulatory behaviors to alert the parent / caregiver. To pave the way for research, we consolidated a video-based dataset "HarmAlert4AutisticChildren" which categorizes autism-related stimming behaviors into two categories: helpful and harmful. We utilize existing publicly available video datasets that focus on a different problem of self-stimulatory behavior classification in autism. The curation process is based on a systematic review of the literature of clinical research studies that analyze the impacts of various self-stimulatory behaviors in autistic children. In addition to introducing a new research problem and a new dataset, we also provide baseline results using the Contrastive Language-Image Pretraining (CLIP) model. The dataset and code are available on GitHub: https://github.com/AleenahK/HarmAlert4AutisticChildren-HA4AC.

1 INTRODUCTION

According to the National Institute of Mental Health, Autism Spectrum Disorder (ASD) is a lifelong neurological and developmental disorder that can cause significant social and behavioral challenges. Diagnostic criteria for ASD involve the evaluation of social-communication skills, including poor eye contact, difficulty maintaining conversations, and lack of developmentally appropriate peer relationships, in addition to the presence of restricted or repetitive behaviors such as stereotyped motor movements, hypo- or hyper-sensitivities, and unusual interests (American Psychiatric Association et al., 2013). It is known as a spectrum disorder because there is a wide variation in the type and severity of symptoms people experience.

Restricted and repetitive behaviors (RRBs) are a core characteristic of ASD and are also referred to as 'stereotyped behaviors', 'stereotypy', 'self-stimulatory behaviors' or 'stimming' in clinical literature. We will use these terms interchangeably throughout the remainder of the article. These behaviors include a range of actions including but not limited to hand flapping, head banging, finger tapping, spinning, scratching, clapping, rocking back and forth, and lining up and flapping objects. It also includes producing auditory stimuli, such as whistling, humming, or idiosyncratic speech.

Early research studies declared these stereotypical behaviors redundant and discussed how these can negatively impact autistic people by causing myriad difficulties such as hindrance in learning capabilities (Koegel and Covert, 1972), and social interactions (Koegel et al., 1974). It is important to note that these initial studies were based on very small groups of autistic children.

Recently, there has been an increase in research that attempts to shift the focus towards exploring the experiences of autistic adults. Based on thematic analysis of qualitative data obtained through questionnaires, interviews, and focus groups of autistic adults, the researchers aim to understand their experiences and perceptions of self-stimulatory behaviors. As a result, it is revealed that self-stimulatory behaviors

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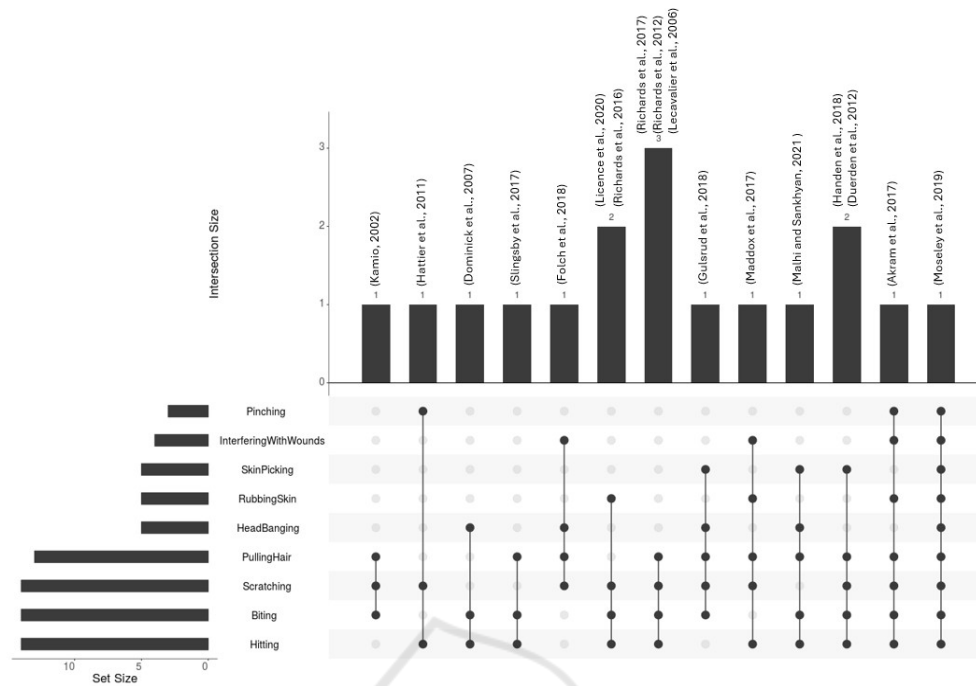[a] https://orcid.org/0009-0001-2807-1551

Figure 1: Summarizing Clinical Studies on ASD-related Self-Injurious Self-Stimulatory Behaviors.

help regulate intense emotions, dissipate anxiety, and manage sensory sensitivities, while suppressing these leads to further stress (Kapp et al., 2019), (Charlton et al., 2021).

According to the National Autistic Society, self-stimulatory behaviors are often very helpful and enjoyable; however, some of these can be self-injurious, for example, head-banging, scratching, biting, skin picking, hair pulling, etc.

According to a 2017 study (Guan and Li, 2017) published in the American Journal of Public Health, individuals with a diagnosis of autism are at a substantially heightened risk of death due to injury. During the 16-year study period, about 27.9 % of the deaths in autistic individuals were attributed to injury mortality. In addition, deaths due to unintentional injury in autistic individuals were nearly 3 times as likely as in the general population especially for children under 15 years.

Hence, we conclude that self-stimulatory behaviors can be either helpful or harmful. It is crucial for the parent / caregiver to analyze the situation and act accordingly. It is very important to provide a supportive environment to allow autistic people to freely engage in stimming without having to suppress it. On the contrary, if the behavior is causing any kind of harm like self-injurious behaviors, the parent/caregiver should address it with appropriate interventions.

We realize that ASD not only has significant neg-ative impacts on a child's development, but it also affects their family's social, emotional, and economic well-being. Providing care and support for autistic people requires a significant investment of time and effort. Parents and caregivers frequently report experiencing stress and anxiety related to caring for an autistic child. (Estes et al., 2013), (Lecavalier et al., 2006).

In an effort to help autistic people and their families, we propose a new computer vision task with the objective of developing models that can distinguish between helpful and harmful self-stimulatory behaviors to send alerts for intervention. The very initial step towards building such an automated system is to provide a standard, publicly available, video-based dataset representing both helpful and potentially harmful behaviors. This research paper focuses on utilizing existing ASD-related video datasets, originally formulated for other tasks, to curate a new dataset.

2 DATASET CURATION

A high-quality video dataset aligned with helpful and harmful self-stimulatory behaviors is crucial for building robust automated systems that are capable of identifying self-injurious behaviors and alerting the parent or caregiver to intervene and ensure the safety of autistic children.
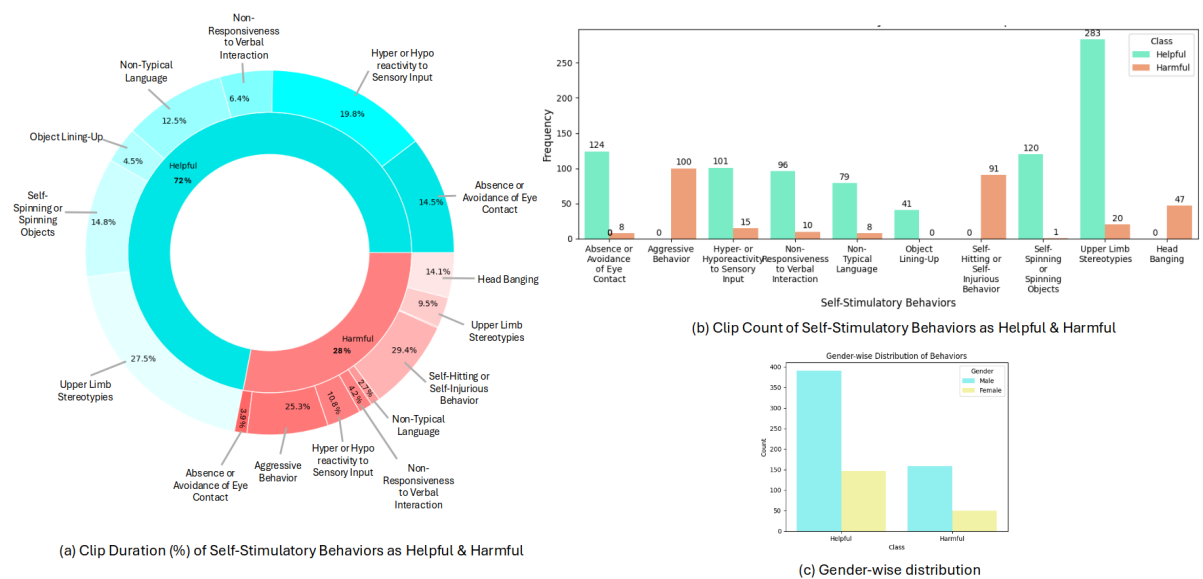
Figure 2: Harm Alert 4 Autistic Children - HA4AC Dataset.

Unfortunately, to the best of our knowledge, such a dataset does not exist, and due to ethical concerns, like identity protection, creating it from scratch is also challenging. However, the computer vision research community has been working towards building datasets that represent self-stimulatory behaviors with the aim of developing diagnostic systems to identify early signs of autism. Early diagnosis and intervention can significantly improve verbal and non-verbal communication, learning capabilities, social reciprocity, and overall well-being of autistic children. These datasets have been collected from publicly available videos of autistic people filmed by their parents or caregivers and shared on social media platforms such as YouTube.

These ASD-related datasets have representations of different self-stimulatory behaviors, such as, head banging and hand flapping, however they don't classify the nature of the behavior as positive or negative. We aim to leverage these publicly available datasets to curate a new dataset by categorizing the available action classes as either HELPFUL or HARMFUL.

To avoid any kind of personal bias, instead of relying on our instincts, we perform a systematic literature review of behavioral studies conducted by clinical researchers to analyze both positive and negative impacts of various self-stimulatory behaviors.

Based on this analysis, we then bifurcate the self-stimulatory behaviors present in the existing ASD-related datasets and propose the new "HarmAlert4AutisticChildren" dataset to identify potentially problematic stimming behaviors in autistic children.

In the following section, we present a systematic review of clinical research studies focused on autism-related self-stimulatory behaviors to analyze their positive and negative impact on autistic people to classify them as helpful or harmful.

2.1 Clinical Studies

To understand the impacts of different self-stimulatory behaviors, such as, their functions (e.g. self-regulation, sensory stimulation) or their consequences (e.g. self-harm), we conduct a systematic study of existing clinical literature. We aim to distinguish between helpful or harmless self-stimulatory behaviors, especially those that can potentially cause harm by identifying the overlap between self-stimulatory and self-injurious behaviors in autistic people.

2.1.1 Search Keywords

We identify four sets of keywords to search for relevant behavioral studies related to autism, namely: Context, Neutral, Positive, and Negative. Each of these sets represents field-specific jargon and is listed as follows.

- **Context:** self-stimulation, self-stimulatory behaviors, stereotypical behaviors, stereotypy, stimming, autism, ASD, fidgeting
- **Neutral:** statistics, impacts, affects, analysis, insights, prevalence, frequency
- **Positive:** helpful, benefits, positive, self-soothing, emotional regulation, healthy, de-stress

- **Negative:** risk factors, issues, difficulties, negative, harm, injury, self-injurious, self-harm, dangerous, aggressive

2.1.2 Search Queries

We formulate search queries using the appropriate combinations of search keywords mentioned in Section 2.1.1. To retrieve relevant articles, we use both generic and action-specific queries. Action-specific queries include additional keywords that represent self-stimulatory behaviors such as "head banging" and "hand flapping". We provide one example of each of these categories in neutral, positive, and negative contexts, respectively.

- **Generic Queries**
  - Impacts of self-stimulatory behaviors in Autism
  - Autistic self-stimulation and emotional regulation
  - Self-injurious stereotypical behaviors
- **Action-Specific Queries**
  - Hyper-sensitivities in autistic individuals
  - Helpful vocal stims
  - Head-banging injuries in autism

2.1.3 Search Results & Analysis

In this section, we discuss the results of our search and provide analysis that helped us categorize self-stimulatory behaviors as helpful and harmful. We first share insights about the helpful stimming behaviors followed by those that are potentially harmful according to evidences from clinical studies.

Studies that highlight the benefits of self-stimulatory behaviors and advocate for them are based on first-person accounts of autistic adults. Autistic children often struggle to communicate and express their feelings due to the prevalence of non-verbality and minimum verbality. Due to this reason, they are also not able to explain the significance of self-stimulatory behaviors in their life. With the help of early intervention therapies, autistic children manage to gain language abilities later in their life.

Research studies based on first-person accounts of autistic adults advocate in favor of self-stimulatory behaviors and describe stimming using words with deeply positive connotations such as 'calming', 'comforting', 'soothing', 'joyful' and 'enjoyable'. Stimming helps autistic people overcome feelings of nervousness, anxiety, and anger, or express happiness and excitement (Kapp et al., 2019). It also helps autistic people organize their thoughts, improve focus, and get rid of excessive energy (Joyce et al., 2017).

We present a summarized list of different motor, vocal, and visual stereotypes that often help autistic people based on personal experiences shared through questionnaires, focus groups, and questionnaires conducted in these behavioral studies.

- **Motor Stereotypes:** hand flapping, body rocking, pacing back and forth, finger tapping, spinning, twirling pen or jewelry, doodling, jumping or bouncing
- **Vocal Stereotypes:** humming, whistling, echolalia, use of atypical language
- **Visual Inspection:** aligning objects, spinning objects

We also share some personal accounts of autistic individuals in their own words which convey their sentiments in a persuasive way.

- *"People should be allowed to do what they like"* - (Kapp et al., 2019)
- *"Stim your heart out"* & *"Syndrome rebel"* - (Stevenson, 2020)
- *"It feels like holding back something you need to say"* - (Charlton et al., 2021)
- *"If I don't Do It, I'm Out of Rhythm and I Can't Focus As Well"* - (McCormack et al., 2023)
- *"I Wish They'd Just Let Us Be"* - (Sagar et al., 2023)
- *"It Helps Make the Fuzzy Go Away"* - (Friedman et al., 2024)

Next, we discuss clinical studies that report the prevalence of negative or harmful stereotypical behaviors related to autism. Self-harm or self-injurious behavior (SIB) is a major concern for autistic children and adolescents. These behaviors are defined as non-accidental, non-suicidal, self-inflicted actions that result in physical injury (Yates, 2004). Examples of such behaviors include self-biting, self-hitting, hair pulling, skin picking, scratching, etc. (Furniss and Biswas, 2012), (Guan and Li, 2017), (Maddox et al., 2017). We summarize the results of our search for harmful self-stimulatory behaviors in Figure 1. With the help of an Upset Plot (Lex et al., 2014), we visualize the intersection of different stereotypical actions studied in these research studies. The latter half of the figure represents the occurrences of these behaviors in clinical literature (left) and the different combinations studied together (right), while the former half provides references of these studies. Self-hitting, self-biting, self-scratching, and pulling hair are the most reported stimming behaviors with respect to Autism Spectrum Disorder.
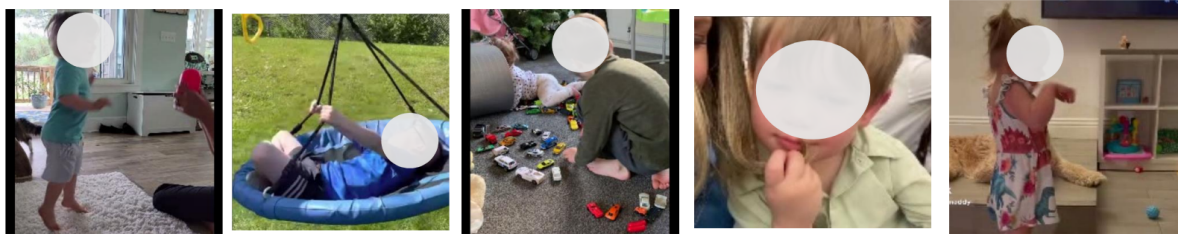
(a) Self-Stimulatory Behaviors categorized as "Helpful"
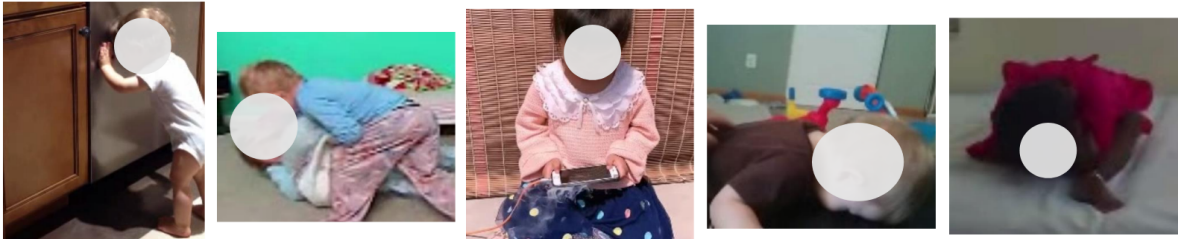
(b) Self-Stimulatory Behaviors categorized as "Harmful"

Figure 3: Examples of Helpful & Harmful Self-Stimulatory Behaviors.

Table 1: Comparison of Existing ASD-related Datasets used in the "HarmAlert4Autistic" Dataset.

	SSBD	ESBD	SSBD+	ASBD	AV-ASD
Original Size	75	141	61	165	928
Categories	3	4	3	4	10
Self-Stimulatory Behaviors	ArmFlapping HeadBanging Spinning	ArmFlapping HandAction HeadBanging Spinning	ArmFlapping HeadBanging Spinning	ArmFlapping HandAction HeadBanging Spinning	AbsenceOrAvoidanceOfEyeContact AggressiveBehavior Background HyperOrHyporeactivityToSensoryInput Non-ResponsivenessToVerbalInteraction Non-TypicalLanguage ObjectLining-Up Self-HittingOrSelf-InjuriousBehavior Self-SpinningOrSpinningObjects UpperLimbStereotypies
Annotated	Yes	No	Yes	Yes	Yes
Source	YouTube	YouTube	YouTube Vimeo DailyMotion	YouTube	YouTube Facebook
Release Year	2013	2021	2023	2023	2024

2.2 Self-Stimulatory Datasets

In this section, we study existing ASD-related video datasets that have been the focus of the computer vision research community in the past decade. We discuss these datasets in chronological order of their existence. A summarized comparison of these datasets is presented in Table 1.

2.2.1 Self-Stimulatory Behavior Dataset (SSBD)

The first attempt to create a video dataset for modeling self-stimulatory behaviors related to Autism Spectrum Disorder was made by (Rajagopalan et al., 2013) in 2013. The Self-Stimulatory Behavior Dataset (SSBD) consisted of 75 distinct videos distributed into three categories: Arm Flapping, Head Banging, and Spinning. These videos were recorded in natural settings by parents or caregivers of autistic chil-

dren and were collected from the popular social media website YouTube.

2.2.2 Expanded Stereotype Behavior Dataset (ESBD)

In 2021, (Negin et al., 2021) proposed a larger dataset called the Expanded Stereotype Behavior Dataset (ESBD). The new dataset consisted of a total of 141 videos, approximately twice the size of the SSBD dataset. They also added a new class label referred as "Hand Action" together with the existing classes, Arm Flapping, Head Banging, and Spinning. The problem with the ESBD dataset is that it was not properly annotated with start time and end time of the stimming behaviors. We provide proper annotations for all videos in the ESBD dataset to include them in our new dataset.

2.2.3 Updated Self-Stimulatory Behavior Dataset (SSBD+)

(Wei et al., 2023) made an effort to expand the existing SSBD dataset by including 12 new videos and removing 11 noisy videos. Like the SSBD dataset, the new videos were also added from YouTube. The final dataset consisted of 61 unique and noise-free videos spanning the same three categories: Arm Flapping, Head Banging, and Spinning.

2.2.4 Autism Stimming Behavior Dataset (ASBD)

Recently, (Ribeiro et al., 2023) combined all the aforementioned datasets: SSBD, ESBD and Updated SSBD to create a new consolidated dataset called the Autism Stimming Behavior Dataset (ASBD). The final dataset consisted of 165 distinct videos that spanned four classes. They also provide annotations for start time and duration of the stimming actions.

2.2.5 Audio-Visual Autism Spectrum Dataset (AV-ASD)

(Deng et al., 2024) recently introduced a more extensive audio-visual dataset to stimulate further research for the diagnosis of autism-related behaviors. Unlike preceding datasets, AV-ASD includes both social interaction challenges, and restricted and repetitive behaviors (RRBs). The AV-ASD dataset is also richer in terms of both quality and quantity, having a much greater number of both categories and samples. This dataset comprises 928 clips extracted from 569 unique videos distributed in 10 categories. These video clips include diverse behaviors and environment settings and are collected from popular social media platforms YouTube and Facebook. The dataset provides multiple labels for each video clip considering the fact that an autistic individual can exhibit multiple autistic behaviors at the same time. The dataset also provides precise time-stamp annotations for the start and end of each autistic behavior.

3 HarmAlert4AutisticChildren

The HarmAlert4AutisticChildren (HA4AC) dataset is our effort to consolidate a new dataset using videos from the five existing datasets discussed in the previous section. It is the first dataset designed to enable research towards the development of automated systems that should be capable to distinguish between helpful/harmless and harmful self-stimulatory behaviors. The proposed dataset consists of a total of

731 video clips extracted from 368 distinct videos downloaded from various social media apps, such as YouTube, Facebook, Vimeo and DailyMotion. These videos are captured in realistic, unbounded scenes and include diverse behaviors which fall in one of the two categories: Helpful (527 clips; 10761 s) or Harmful (204 clips; 3437 s). The shortest clip has a duration of 2 seconds, while the longest clip is 14 minutes and 48 seconds long. All video clips have carefully assigned time stamp annotations representing *start time* and *end time* of the self-stimulatory behavior exhibited in the clip.

Based on the analysis presented in Section 2.1.3 and Figure 1 of this article, we are able to identify the following self-stimulatory behaviors from existing datasets as 'Harmful': *Head Banging*, *Aggressive Behaviors*, and *Self-Hitting Or Self-Injurious Behaviors*. The rest of the self-stimulatory behaviors are considered as 'Helpful' as they seem to be harmless considering the literature. However, these stimming behaviors do not always occur in isolation and often overlap with each other. Figures 2 (a) and 2 (b) represent the percentage of time duration and frequency of occurrence of these stereotypical behaviors that show their contribution to both Helpful and Harmful classes, respectively. Figure 2 (c) represents the gender-wise distribution of the data indicating the dominance of male autistic children in the dataset. This disparity aligns with research studies that claim autism spectrum disorder is more commonly diagnosed in males than females. The male-to-female ratio in autism diagnoses is often cited as around 4:1. According to another research study (Schuck et al., 2019), females camouflage the symptoms of ASD more than males potentially contributing to the difference in prevalence.

Figure 3 presents a set of five samples for each of the two class categories.

4 EXPERIMENTS

For benchmarking purposes, we evaluate the performance of CLIP-based models in zero-shot settings for our newly curated HA4AL dataset. Below are the experimental details of the baseline models.

4.1 Contrastive Language-Image Pretraining (CLIP)

The Contrastive Language-Image Pretraining (CLIP) model (Radford et al., 2021) is a multi-modal vision and language model which maps image and text pairs to a shared embedding space. CLIP is widely

known for its ability to generalize and perform zero-shot learning effectively. Despite originally being designed for images, CLIP can be easily adapted to work with videos. We use the following two strategies to evaluate the CLIP model on our downstream task.

4.1.1 Vanilla CLIP

The most straightforward approach to adapting the CLIP model (Radford et al., 2021) for video classification is to apply temporal pooling to the embeddings of individual frames, thus generating a unified representation. In our experiments, we used the ViT-B/16, ViT-B/32, and ViT-L/14 models in zero-shot settings.

4.1.2 Video Fine-Tuned CLIP

The ViFi-CLIP model (Rasheed et al., 2023) employs video-based fine-tuning of the image-based CLIP model to bridge the domain gap between images and videos. The input video frames are first processed using the CLIP image encoder to obtain feature embeddings. These embeddings are then integrated through feature pooling, followed by similarity matching with the corresponding text embeddings. The ViFi-CLIP ViT-B/32 model used in our experiments is fine-tuned on the Kinetics-400 dataset (Kay et al., 2017). Kinetics-400 is a human action dataset with 400 classes and at least 400 video clips per class covering a wide range of both human-action and human-human interactions. The fine-tuning process is performed for 10 epochs, and the resulting model is evaluated on the downstream HA4AL dataset under zero-shot settings.

4.2 Evaluation Metric

To evaluate the performance of the CLIP-based models in our downstream task using the HA4AL dataset, we use accuracy as the evaluation metric.

Table 2: Experimental Results.

Model		Accuracy
Vanilla CLIP	ViT-B/16	37.2 %
	ViT-B/32	41.9 %
	ViT-L/14	**56.1 %**
ViFi-CLIP	ViT-B/32	50.7 %

4.3 Results & Analysis

The zero-shot evaluations of both vanilla CLIP and ViFi-CLIP on our downstream task show impressive generalization capability of the CLIP model in Table

2. In case of Vanilla CLIP, the ViT-L/14 model performs better than the other variants ViT-B/16 and ViT-B/32 with a 56.1 % accuracy. The reason being that the ViT-L14 model has a larger configuration with more transformer layers and, therefore, more learnable parameters. The ViT-L/14 has a 14x14 patch size which enables it to capture finer details and increases it's capacity to learn complex relationships in the data. To compare Vanilla CLIP with ViFi-CLIP, we use the same ViT-B/32 configuration. As expected, ViFi-CLIP outperforms Vanilla CLIP with an 8.8 % improvement due to the fine-tuning advantage. It is unsurprising that the model with the largest configuration, ViT-L/14 outperforms the rest.

5 CONCLUSION

In this research paper, we introduce a new computer vision-based recognition task to identify potentially harmful and harmless stereotypical behaviors in autistic population. We took the first step towards solving this problem by proposing a new dataset, the HarmAlert4AutisticChildren (HA4AC) dataset. We perform a systematic review of the existing clinical literature to understand the topography, functions, and consequences of self-stimulatory behaviors to categorize them as helpful and harmful. By evaluating existing datasets for self-stimulatory behavior recognition, we filter positive and negative examples of exhibiting self-harm and aggression. We also present baseline results using CLIP-based video classification models to benchmark future research efforts.

6 FUTURE DIRECTIONS

The proposed HA4AC dataset suffers from a class imbalance problem, with helpful stimming behaviors constituting 74 % and harmful behaviors comprising only 26 %, at a ratio of 3.55:1. Furthermore, the HA4AC dataset exhibits gender imbalance, with the male population comprising 74 % of the data points and autistic female children underrepresented. In our future work, we plan to work on this class imbalance problem and employ state-of-work large-language models to improve the accuracy on the video classification task.

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