Identifying Children's Fidget Object Preferences: Toward Exploring the Impacts of Fidgeting and Fidget-Friendly Tangibles

Suzanne B. da Câmara
University of California,
Santa Cruz
Santa Cruz, USA
sdacamar@ucsc.edu

Rakshit Agrawal
University of California,
Santa Cruz
Santa Cruz, USA
ragrawa1@ucsc.edu

Katherine Isbister
University of California,
Santa Cruz
Santa Cruz, USA
katherine.isbister@ucsc.edu

ABSTRACT

Fidgeting involves interacting with objects using repetitive hand movements. Before you can study its effects, you must first study the objects with which people choose to fidget. We present the findings of our five-phase three-month study with 28 children, 24 parents, and 2 teachers examining fidget material qualities and inherent interactions children gravitate towards when fidgeting and what, if any, connections can be made between their emotional state or activity when fidgeting and their fidget interactions/materials preferences. Our study included structured interviews, observations during usage, and design workshops. We present novel insights concerning fidget object preferences, across factors including materials, inter-actions, stealth, durability and sound, which together can act as guidelines in the development of educational, experimental and utility tangibles for children. For example, children tend to prefer a fidget item with inherent squeezing interactions when they are angry and clicking/pressing/tapping interactions when they are bored.

ACM Classification Keywords

H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous.

Author Keywords

Fidgets; Fidgeting; Self-regulation; Tangibles.

INTRODUCTION

Fidgeting and fidget-friendly tangibles have recently witnessed enormous popularity in markets and research. Though people have long been observed to fidget, dedicated products like fidget spinners, fidget cubes and other fidget items, have served to focus public attention on fidgeting and its potential benefits or disadvantages. However, whether or not fidgeting and fidget objects are beneficial or detrimental is still to be conclusively determined [23]. Popular perception of fidgeting is that it is

indicative of inattention or lack of interest [4]. This is such a widely held belief that there are studies that are built on this assumption [9]. However, there is evidence that fidgeting serves various purposes and can be beneficial [25, 1, 20]. Fidgeting, in the form of hand gestures, has been shown to facilitate word retrieval when children are faced with a "tip of the tongue" situation searching for the optimal word answer to a problem [22]. Rather than being an unproductive mental-resource-wasting activity, fidgeting is postulated to regulate focus [5, 8, 19, 24] and has been shown in some cases to increase retention [1].

Research that attempts to study fidgeting often uses pre-existing fidget items that are either readily available, inexpensive, or popular at the time of the study [20, 25, 24]. We argue that alongside studying the effects of fidgeting, one must study the objects people choose to fidget with so that fidget objects suited to their general material and interaction preferences when fidgeting can be used.

We would argue that what is commonly referred to as fidgeting can be divided into two main categories. The first consists of body movements much akin to squirming or reposition-ing yourself in your chair. Movements in this category do not incorporate interacting with objects and consist of body movements of the head, full body, and appendages. This type of fidgeting is often linked to inattention and/or boredom [9]. The second category of fidgeting refers to repetitive activities with the hands manipulating objects, which are done without a direct purpose. To illustrate, think of the contrast between someone fidgeting in their chair during a long lecture with someone fidgeting with a pen by spinning it around with their thumb and forefinger while in a meeting or working on home-work problems.

Our study focused on the material qualities and interactions that children gravitate towards when fidgeting with objects, so that these preferences can inform the design of new fidget items or the choice of existing items to incorporate in future fidgeting studies involving children. Since our goal is to an-alyze children's fidgeting in order to identify the kinesthetic interactions inherent in their fidgeting (i.e. squeezing, twirling, twisting, etc) and the material qualities associated with the items they choose to fidget with, we focused on the second cat-egory of fidgeting as outlined above. For the purposes of this

study, we define fidget items or objects as items people fidget with such as fidget spinners, pens, stress balls, etc. A fidget item can be anything that is not part of a person's body. Hence, fingers, hair, and legs though often used while fidgeting are not considered fidget items.

Fidgeting should not be confused with playing. For instance, playing catch or video games is not fidgeting as both are more mindful or intentional. Included in our definition of fidgeting are doodling, hair twisting, and repetitive movement of various other body parts. We are interested in these actions as well as the more commonly referred to "fidgeting" actions because we are interested in finding out what movements and interactions that children gravitate towards when fidgeting. For instance, hair twisting or twirling is done with a repetitive rotational motion that could be simulated with a fidget object.

In this paper, we present the details of our study and discuss the results across multiple dimensions. Our study was conducted in five phases that apart from interactions with children, also involved discussions with parents and teachers. Based on the data collected from this study, we present our findings on user fidget item preferences in terms of material qualities, inherent interactions, noise, and more such observations. In addition, we present correlations between preferred fidgeting interactions and certain emotions and activities. Through these results, we show the significance of learning fidget object characteristic preferences and how that knowledge can aid in the exploration of fidgeting and its impacts.

MOTIVATION

There is increased interest in fidgeting and its possible benefits or disadvantages. Many studies that attempt to answer these questions use existing fidget objects. We think before one can attempt to answer questions related to fidgeting, fidgeting preferences must be identified. We believe that studies that use fidget items with material qualities and interactions that people naturally gravitate towards when fidgeting, will yield organic interactions and therefore more accurate results as opposed to studies which try to encourage use of fidget objects ill suited to their participants' preferences. Therefore, identifying popular fidget item characteristics will enable informed decisions regarding which fidgets to use or make for a given study. In addition, finding connections between emotions experienced or activities engaged in when fidgeting and preferred fidget item characteristics will enable researchers to make fidget item choices aimed at answering more specific questions. Interaction and material preferences catered to the emotions or actions we want to study can be utilized. For instance, testing the effects of fidgeting on diminishing anger would make/use fidget items that incorporate fidget interactions/material qualities that people gravitate towards when angry.

Sometimes people are conscious of their fidgeting behaviors and sometimes they are not, so merely asking about fidget habits might not be sufficient. Children are a unique group to study in that there often people around them, like parents, teachers, and caregivers, who by choice or profession monitor their behavior. These additional sources of observations

regarding children's fidgeting item preferences provides additional data points which help create a more complete picture of their preferences. While children will self report fidgeting that they are conscious of, it is from their parents and teachers that we are able to get information regarding fidgeting behaviours that they are not conscious of. For instance, one participant was able to show us the items that she fidgeted with in class, when she was bored or when she was studying. When asked for information regarding fidgeting item preferences and behaviors at times when she was working on a hard problem or really concentrating, she did not have an answer for us. However, her mother, who was often nearby when she was doing homework, was able to tell us easily how she fidgets during that time. We noticed the same with teachers since they are paid in part to monitor their student's behaviors. So by conducting a study around children, we were able to get more data points describing their fidgeting habits and preferences and therefore more robust conclusions.

Children are not as adept at verbalizing what they are thinking and/or feeling as adults. This, in addition to the fact that children's fidget object choices might be limited due to financial or parental constraints or even exposure, prompted us to design the study so that three different approaches were used to gather information about the children's fidget item preferences. First they were asked to show or describe the objects with which they currently fidget. Second, we brought a myriad of fidget objects to the study and encouraged them to interact with them so that perhaps they would discover new preferences. Finally, we had them design their ideal fidget with its inherent materials and interactions, so that they wouldn't be limited by the objects they had already experienced.

RELATED WORK

While research relating fidgeting to executive function and childhood developmental theories exists, the physiological, developmental or psychological reasons why people tend to fidget and the cultural differences in fidgeting frequency are outside of the scope of our research [3, 18]. Research exploring technology designed to aid in the development of executive function [26, 11] while interesting, is also outside of the scope of this work.

Popular opinion is so inclined to view fidgeting in a negative light that for research at Florida Atlantic University, a prototype was created that alerts the wearer to fidgeting actions, so that he/she can attempt to curtail them [2]. The goal of our project was the opposite of that thesis. Rather than trying to alert the user to fidgeting actions so that they can be controlled or curtailed, our project attempts to identify preferred fidgeting item characteristics so that fidget items can be chosen such that people are naturally more inclined to interact with them.

There is a limited amount of research in the area of fidget object creation. Karlesky and Isbister [14, 15, 16] created fidget objects that they referred to as Fidget Widgets. These Fidget Widgets were playful in nature and created to "selectively modulate affect and shape cognitive state to support a user's productivity and creativity". Unlike Karlesky and Isbister's Fidget Widget research, which was focused on adults, our

research is focused solely on the preferences and behaviors of children.

Recent work conducted at Lund University [20], inspired by research that indicated that squeezing a small ball or walking lead to increased creativity [21, 10] postulated that fidgeting might have a similar effect on creativity and looked for a link between fidgeting and increased creativity. After using ready-made store bought fidget items for initial studies, Nyqvist made several prototypes but was unable to definitively prove that one was better than another at fostering creativity. Rather than concentrate on which interactions or materials people might gravitate towards when doing creative work, the study focused on why people fidget and identified four reasons: to focus (engage cognitively), explore (release cognitively), active (engage physically), and relax (release cognitively). Nyqvist's research did not link any of those reasons to preferred interactions or material qualities in fidget items.

In addition to the above-mentioned work, numerous fidget objects, backed by research [13], have been marketed as attention and focus enhancers (i.e, fidget spinners, fidget cubes, etc) for people with attention deficit hyperactivity disorder (ADHD). However, they lack the prior research to inform their design and ensure that they are providing interactions and experiences that children find appealing. Instead, research around these items has focused on whether or not fidgeting with them is beneficial, without ever first researching the needs and preferences of the populations they were intended for.

The primary distinction between the previously mentioned studies and our current research is that we do not seek to build a fidget object or to investigate a current fidget object but rather to inform the design of future fidgeting objects for educational, experimental, and other practical purposes.

METHODS

In collaboration with Committee for Children, we chose a convenience sample of 28 children (10 boys and 18 girls) between the ages of 6 and 11 (see Figure 1 for children's age distribution); 24 of their parents; and 2 of their teachers from two different after-school facilities to explore the following questions: Do all children fidget? When (e.g., at school, studying, when angry, sad, etc) and how (e.g., twisting, petting, bouncing, tapping, pinching, etc) do they fidget? What object properties do they gravitate towards? How does fidgeting serve the child (e.g., maintaining focus, regulating emotion, dispelling energy, etc.) What connection, if any, exists between why children fidget and preferred fidget materials and/or interactions?

The children were recruited from the two after-school programs by posting flyers in those facilities advertising the program, and directing interested children/adults to the front office, where a more detailed informational sheet was provided. If interested in having their children participate in the study, the parents then needed to turn in a signed permission form. By signing the form and having their child participate, the parent agreed to take part in two phases of the study as well, Meet & Greet and Group Session. Due to the nature of the study, we decided to allow siblings and others take part in the
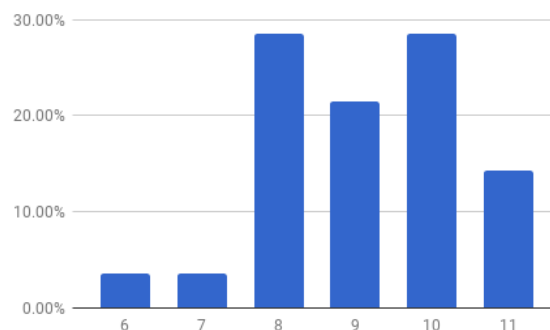

Figure 1: Age distribution of participating children (median age: 9)

process even if they were not strictly in the target age range (8-10).

While we never asked any questions directly relating to socio-economic status, parents educational background, or family makeup, through information obtained from conversations with the parents, teachers and the children themselves it became clear that we had a very diverse cross-section of children taking part in the study. For instance, at least two of the children were living in a homeless shelter with their mother at the time of the study, another was living with her mother in a trailer without running water, and several of the children were from what were clearly affluent homes. Six of the children had at least one parent who was pursuing his/her Bachelors degree at the time of the study. Several children came from one-parent homes and at least one child came from a two-parent same sex home. In addition, at least two of the students in the study have been diagnosed with ADHD.

We conducted a multi-phase study utilizing established user-centered design practices. Guided by children-specific usability testing [12, 7], we conducted a series of interviews, observation and design workshops [17] with the children to gather the necessary information to answer our research questions. Due to the often subconscious nature of fidgeting, we also chose to include the parent(s) and teachers of the children participating in this study in order to capture more complete data regarding the children's fidgeting habits and preferences.

There were five phases to the study: Exploration, Meet & Greet, Group sessions, Brainstorming, and Teacher Interview. Each phase is outlined in more detail below. The children took part in the Exploration and Brainstorming while their parents took part in Meet & Greet and Group sessions. Exploration, Meet & Greet, Group sessions, and Brainstorming were done with small groups of 5-to-8 participants. Teacher Interview was done one-on-one.

Exploration

In the Exploration phase, we obtained information from children about their fidgeting preferences and behaviors. This phase was done in two parts. During the first part, we asked each of the children whether or not they fidget and if they do, to tell us the associated times and frequency, possible reasons,

and inherent materials and interactions of the fidget items that they used. If the child had the item with him/her, we took a picture of the fidget item and recorded a video of the child interacting with it. If the child didn't have the item(s) with him/her, we asked him/her to describe the item(s) in detail. During the second part, we used several bins containing an assortment of fidget items (see Figure 3). There were 29 different types of fidget items, each of which could have variations in color and shape, with a total combination of over 90 unique fidget items from which the children could choose. We instructed each child to pick a favorite fidgeting item(s) from the bin. The children had complete freedom of choice and were encouraged to touch and manipulate all of the fidgets during this exploration. At the end of the session, we asked each child to tell us what their favorite fidget item(s) were, and why and when they thought they would use them.

Meet & Greet

The main purpose of Meet & Greet was to gather some preliminary information and get parental buy-in for the field study. In order to do this, we arranged to have food and drinks at the end of the day when the parents were scheduled to pick their children up from the after-school program. While they and their children were eating, we asked the parents 4 short answer questions about their child's fidgeting habits. While speaking with the parents, we educated them on the difference between fidgeting and playing and reminded them about the group meeting scheduled for the following week.

Group Session

In the Group Session phase we obtained more detailed information from the parents about what fidgeting behavior and preferences they observed in their children. We met with the parents of the children in the study in small groups of 5 to 8 people and asked them more detailed questions about their children's fidgeting habits. The session was not a focus group in the traditional sense that a question is thrown out and the group discusses it, rather each parent was asked the same set of questions in turn with subsequent and past answers sometimes being changed upon reflection about the answers given by other parents present.

Brainstorming

During the Brainstorming phase, children designed their ideal fidget item complete with material and interaction preferences.
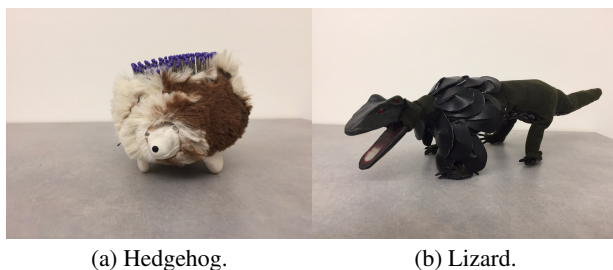

(a) Hedgehog.   (b) Lizard.

Figure 2: Smart fidget prototypes shown to the children for reference.

Figure 3: Examples of some of the fidget items supplied during EXPLORATION.

This phase consisted of three activities. First, we showed the children two smart fidget prototypes (built during the work by Cottrell *et al.* [6]) and allowed them to handle and interact with them (see Figure 2). We explained the various interactions that were incorporated into each prototype (i.e., twisting, squeezing, petting, clicking, bending, etc) and then allowed each child to handle and interact with them. After that, we allowed the children to examine a variety of the materials the researchers considered when they developed the prototypes, so that they could have an idea some of the different materials that are possible. Finally, we asked the children to draw pictures of what their ideal fidget object would be and to label it, by asking them the following questions: If you could design the perfect fidget what would it look like? What would it be made of? What would the inside be made of? What things could you do with it? Like could you bounce it or roll it or twist it? Can you draw it for us and label the drawing with all of the materials it's made of along with all of the things that it does? When would you use it? What do you like about this perfect fidget item that you just drew? (see Figure 4). We encouraged them to use their imagination and incorporate any materials and/or interactions that they had been exposed to, prior to or during the study, which they would want to have in their fidget item. We then interviewed each of the children and asked them to explain their dream fidget item.

Teacher Interview

In the Teacher Interview phase, we obtained teacher observations regarding the children's fidgeting behaviors and preferences. The teachers were asked the same questions that the parents were asked in the Meet & Greet phase and the Group Session phase. The only difference was that the teachers were asked all of the questions one-on-one in a single session.

Data Handling

The video taped sessions (Exploration, Group Sessions, and Brainstorming) were transcribed. Information from the transcripts was then transferred to a spreadsheet. The spreadsheet has columns for the child associated with the fidget item, the age and gender of the child, the fidget item, whether or not
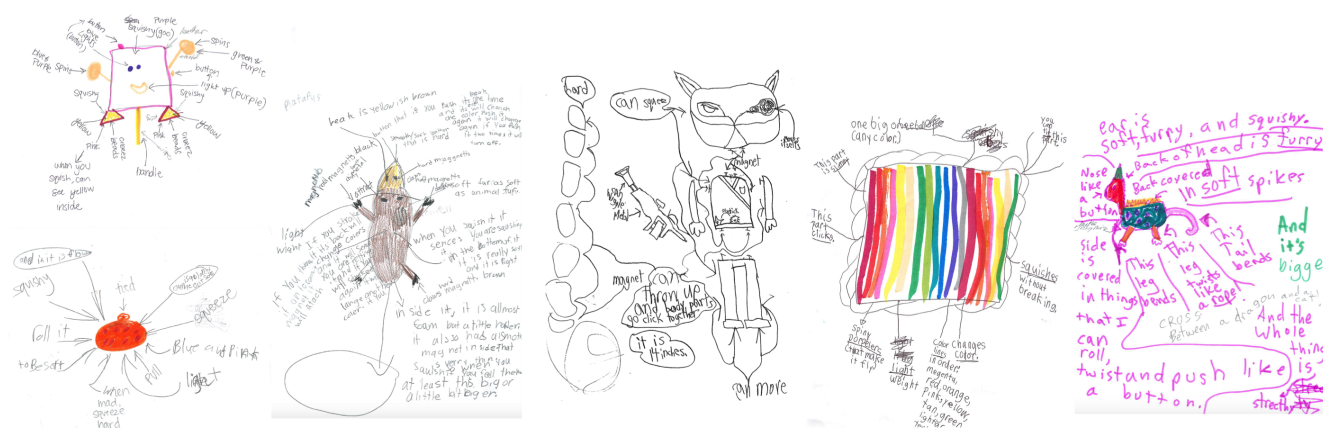
Figure 4: Drawings of the participants' ideal fidget items from BRAINSTORMING.

the fidget item is an accessible or multi-use item, whether or not it is a complex item (has multiple interactions built in), description of the fidget item with material properties, interactions inherent in the fidget item, what the child likes about that fidget item, and when or why the child uses that fidget item. In order to obtain the preferred interactions, materials and items, we input all of the fidget items (as well as the component materials and interactions inherent in each of those items) mentioned for a particular child by either the child himself/herself, the child's parent(s), or teacher. Because we realize that a child's current fidget items might be influenced or limited by financial or parental constraints, we included information on all of the fidget items that the child identified as his/her favorites during Exploration. In addition, to make sure that the child's preferences weren't unduly limited by the fidget items that we brought to Exploration, we analyzed the ideal fidget item that each child drew during Brainstorming, recording all of its component materials and interactions. The text for each fidget item was color coded to denote the source of the information about that item with the following scheme: black - fidget items that they showed or described to us during Exploration, light blue - fidget items that we provided that they spent time interacting with during Exploration, dark blue - favorite fidget items that we provided during Exploration, green - items parents mentioned, red - items teachers mentioned, and orange - ideal fidget drawing components. We then looked to see how many children in the study gravitated towards each material, object and interaction. Analysis of the reported reasons why the children fidgeted was done in a similar way. When looking for what if any connections exist between why they fidget and what materials or interactions they chose to fidget with, we were careful to look at when they said that they used or would use a particular fidget item. We initially thought that analysis of what items the children chose to interact with during Exploration in conjunction with their favorite fidget item from Exploration might yield interesting results in terms of the child being open to various types of interactions and materials or primarily being interested in certain interactions, materials or form factors, but due to time constraints and lack of initial conclusive results we chose to

ignore those items in our final analysis. Thus, the light blue items in the spreadsheet were not counted towards our final results. This makes sense as they were not items for which the child declared a preference.

OBSERVATIONS

During the Meet & Greet phase, we noticed that many of the parents were not clear about what we meant by fidgeting. Several of them confused fidgeting with playing and when asked to tell us about the fidgeting items that their children used, they said things like video games. We would not consider playing video games fidgeting, because it is a purposeful activity that engages a child's full attention. As a result of this, we educated the parents about what we considered fidgeting. Later, during the Group Session phase, several of the parents mentioned that after having spoken with us a week earlier in Meet & Greet, they had noticed fidgeting behaviors and patterns in their children that they had not noticed previously.

Through interacting with the teachers over the course of the study, we realized that the teachers were aware of the differences between fidgeting and playing and further, that they had a wealth of information about the children's fidgeting habits and item preferences. This seemed especially true of fidgeting behaviors done when the children were forced to sit in one place and focus on something that was difficult for them, as is the case when they study or do school work, rather being free to move about. Consequently, we decided to expand our study to include Teacher Interview to record their responses to the same questions that the parents were asked in the Meet & Greet phase and the Group Session phase.

RESULTS

Fidgeting

All of the children in our study were found to fidget. Even if one source (a parent or the child himself/herself) responded that a particular child did not fidget, we always heard from another that said child does indeed fidget along with a description of when, why and the properties inherent in the fidget items that said child uses. Further, we observed that even when a

Category	Count	Key words
Perform Cognitive Tasks	25 (89%)	thinking, working, homework, learning, school work, when they don't know the answer, reading, studying, listening, focusing, during class
Alleviate Boredom	24 (86%)	bored, boredom, bored at home, bored in class
Regulate Emotions	22 (79%)	angry, mad, sad, frustrated, anxious, nervous, calming, soothing, unhappy, upset, discomfort, chill out, scared, happy, worried
In Class	20 (71%)	school or class are specifically stated
Dispel Excess Energy	14 (50%)	excess energy, dispel energy, can't sit still

Table 1: The reasons why children fidget.

Material	Count
Rubber	24 (86%)
Squeeze Ball	24 (86%)
Plastic	22 (79%)
Orbeez	17 (61%)
Pencil/Eraser	15 (54%)

Table 2: Materials that the participants liked.

child initially responded that he/she did not fidget, that child's teacher or teacher and parent(s) responded to the contrary.

Why They Fidget

As can be seen in Table 1, there are various reasons why children fidget. We grouped the reported reasons that they were found to fidget into five categories that are not necessarily mutually exclusive. The table shows examples of the words that the study participants used to describe when/why the children fidget that were grouped into each category. For instance, thinking, learning, reading, and focusing were some of the words that we grouped into a category called Perform Cognitive Tasks. Four of the categories (Perform Cognitive Tasks, Alleviate Boredom, Regulate Emotion, Dispel Excess Energy) are location independent. By this we mean that inclusion of a stated reason in any of these four categories is based solely on the activity or desired result and not on where it occurs, while the fifth category (In Class) is defined as any fidgeting for any reason that takes place in a school or classroom type setting. We made a separate category for this location specific fidgeting because fidgeting in this setting is often discouraged by the child's parent and/or teacher. Despite this, 71% of the children still fidget in this setting. We created a separate category for fidgeting when bored rather than include boredom prompted fidgeting in the Emotion Regulation category because it was so prevalent in the data that we felt that it warranted its own category.

Material and Object Preferences

In our study, the results show that the children gravitated towards a variety of objects and materials when fidgeting. Table 2 lists the top 5 overall material/object preferences. The table is a mix of both materials and specific objects because when a specific kind of object was prevalent in the data, we felt that it warranted its own category. Otherwise, since the variety of fidget items was so diverse, we grouped items by their component materials.

Accessible or Multipurpose Item Preferences

While the children in our study fidget with a wide assortment of fidget items, many of the fidget items, especially those employed in schools or other places with classroom like settings, are accessible or multipurpose items. For this study, we define accessible as either parts of the body (e.g., hands, fingers, hair, legs), clothing, or items that are readily at hand. We define multipurpose items as those items that have a primary purpose other than as a fidget object. Items in this category include pens, pencils, erasers, white out bottles and hair ties. Twenty-six of the 28 children (93%) fidgeted with accessible or multipurpose items.

Soft Material Preference

From among the children's material and item preferences, we found that 20 of the 28 children in the study (71%) liked fidget items that contained a material that could be considered soft. Not to be confused with smooth or pliable, items considered soft included clothes, fur, blankets, and cotton. Several of the kids who didn't even mention cloth or fur materials did mention that they liked soft exteriors (like soft rubber).

Preferred Interactions

Preferred fidget interactions can be found in Table 3. It is important to note that we differentiated between squeeze and squish. We defined squeezing as an interaction that does not alter the original form of an object. Once squeezing ceases, the object merely returns to its original shape. Squishing, on the other hand, changes the shape of the object. You can squish clay but squeeze a stress ball. The motion involved in the two interactions is the same as both involve pressing your fingers together or closing your hand into some approximation of a fist. The difference lies in how the interaction feels to the person doing it. The push back can be of varying strengths depending on how hard it is to continue to squeeze the object in question.

When collecting data in the study, we distinguished between clicking, pressing, and tapping. For the purposes of this study, we define tapping as a motion that is done on a surface that does not change as a result of the motion. So think of tapping your fingers on a table. You move your finger/fingers in a downward motion and there is no force exerted on your finger to stop its movement downward or aid its movement back up. Clicking is similar to tapping in that you move your finger/fingers in a downward motion but unlike tapping, you must exert a force in order to move your finger in that downward motion. The object that you click is then depressed and stays that way even after you stop exerting force in a downward motion. Like tapping, there is no force exerted on your finger

Interactions	Count
Squeeze	25 (89%)
Stretch	22 (79%)
Squish	20 (71%)
Click/Press/Tap	20 (71%)
Pull	19 (68%)
Roll	15 (54%)
Twist	15 (54%)

Table 3: Interactions that the participants liked.

to aid its movement back up. Pressing is similar to both tapping and clicking in that it is done by exerting a force by your finger/fingers in a downward motion. Like clicking, pressing contains a force exerted on your finger to stop its downward movement. However, unlike clicking, when you stop pressing, there is a force exerted by the object being pressed that aids your finger's movement back up. So if you pressed a button down and then stopped pressing but didn't move your finger from the button, the button would return to its original upright position the minute that you stop pressing in essence lifting your finger in the process. Due to the similar movements involved in all three, we decided to look at clicking, pressing and tapping together as one category. When considered in this way, we found that 23 of the 28 children (82%) liked objects that incorporated this interaction. Their attraction to this type of motion was further supported by the fact that 14 of the 23 children (61%) who showed a preference for this interaction built it into their ideal fidget design.

Relationships between materials/interactions and reasons to fidget

Regarding relationships between materials/interactions and reasons to fidget, we observed two things. First, every time a reason is mentioned for wanting to use an object that contains a clicky (pressing, clicking, tapping) interaction, the reasons given are primarily either that the child was bored or that the child was doing cognitive tasks such as focusing, doing homework, or thinking. Second, while squeezing is always a popular interaction regardless of the reason, when children are angry or stressed, they are more likely to want to interact with items that have squeeze or squish interactions built in than any other interaction. The same is not true in reverse. Just because children are squeezing or squishing a fidget object, does not mean that they are angry or stressed.

In addition to material and interaction preferences and social emotional ties to fidgeting, several other insights came out of the study related to durability, stealth and sound.

Rough Fidgeting

Sixty-four percent of the children in the study, 18 of the 28 participants, were observed pushing the physical boundaries of the fidget items. Many were seen to either grip the object with two hands, robustly squeezing it in an attempt to get it to burst, over-stretching to see how far they could pull one side from another, or putting all of their weight on an object while squishing it into the table.

Stealth

Children feel the need for stealth when fidgeting. Eight of the children (29%) mentioned in passing at some point during the study that they were worried that their fidget items would get taken away. This worry was exacerbated if the items were too big or looked "too much like a toy". The child's concern for stealth is further supported by the fact that many of the items that they fidgeted with at school were small or multipurpose items. When examining the fidget items that we supplied as part of the Exploration phase, some of the comments we overheard the children saying were: "probably not at school because I'd feel like they'll just take it away from me" and "Oh so it's too big to use either at school or at home". Of the participants in the study, 26 of the 28 children (93%), reported using accessible (e.g., body parts, hair, clothing) or multipurpose items (e.g., pencils, erasers, hair ties, white out bottles) that couldn't be taken away.

Sound

Children like sound. Eleven of the 28 children (39%) mentioned liking an object because of the sound that it made. An example of this is that one child liked clicking the buttons on the light switch side of the fidget cube stating 'I really like this clicking noise'. However, as was the case with fidget items looking too much like toys, children were careful not to choose items that were too loud. Among them, several liked the slight squishing sound that a gel filled squeeze ball made when it was squeezed. One of these children stated that 'if you put it up to your ear it sounds like it's really- it sounds like it's really squishy.'

Fidget Item Form

The children in our study were found to fidget with both creature-like and abstract fidget items, with creature-like items being among the fidget items of 19 of the 28 children (68%). Creature-like items refer to any item that has a face and could be anthropomorphized. 10 of the 25 children (40%) who completed ideal fidget designs in the Brainstorming phase created creature-like designs.

Parent Responses

We were able to obtain fidgeting behavior and preference information concerning 27 of the children in the study from the 24 parents who participated. This was due to some siblings being in the study. Of these 24 parents, 18 participated in both the Meet & Greet and the Group Session providing information concerning 21 of the children. Of the 18 parents who took part in both the Meet & Greet and the Group Session phases (though asked similar fidgeting related questions in the two phases), 12 parents (66%) gave much more detailed information regarding their child's fidgeting behaviors and fidget item preferences in the Group Session phase as opposed to the Meet & Greet. Of those 18, three specifically mentioned they were able to give more informed answers as a direct result of participating in the Meet & Greet phase.

Teacher Responses

Our analysis of the collected data supported our decision to expand out study from four phases to five with the inclusion of

the Teacher Interview phase. The teachers gave more detailed responses in 14 out of the 20 cases where the information was obtained from both the parent(s) and teacher. In addition, teachers were often more cognizant of when and why the children fidgeted as opposed to just that they did. Further, while parents' fidgeting answers were often vague, especially when asked if they noticed any patterns to when or why the children fidgeted, teachers could often find social and emotional tie-ins as to why they were fidgeting. For instance, the teachers were more likely to link the fidgeting to a particular activity or state of mind and were better able to explain how fidgeting with that item served the child. An example of this is that while one parent was unable to cite any reasons connected to their child's fidgeting, her teacher stated that the child fidgeted to "calm and center her, and it makes her happy". Another example of this is that even though both a parent and a teacher referenced a child fidgeting with a ball, the parent stated that the child fidgeted with it when bored while the teacher said that he used it when "he's angry or needs to take a time out...I don't know if it's a control thing", it's self soothing and a mode for him to focus.

DISCUSSION

Conclusive findings and links

The Meet & Greet phase of the study was designed for two purposes: to obtain preliminary data about the children's fidgeting item preferences and habits and to get parental buy-in of the study to encourage their participation in the Group Session phase. However, during the Meet & Greet phase, we noticed that many of the parents were unaware of their children's fidgeting habits and preferences and in fact, in some cases, even of the difference between fidgeting and playing in general. This is suggestive of two additional benefits of the Meet & Greet phase of the study. First, by reminding the parents of the Group Session phase the next week and telling them that we would be asking more detailed questions about their children's fidgeting habits and item preferences at that time, we were able to focus their attention on this activity for the next week. Second, the phase provided an opportunity for us to educate the parents on the difference between fidgeting and playing and thereby ensure that their attention was focused towards the correct activity. Therefore, the main functions of the Meet & Greet phase were to educate the parents, obtain study buy-in, and focus attention on fidgeting activity.

Several of the parents mentioned during the Group Session that after having spoken with us a week earlier during the Meet & Greet, they had noticed fidgeting behaviors and patterns in their children that they had not noticed previously. The children's fidgeting habits did not change as a result of the Meet & Greet, but rather the parent's knowledge and awareness of fidgeting was raised due to their participation in the Meet & Greet.

As initially designed, our study was a four-phase study devoid of the Teacher Interview phase. However, through interacting with the teachers over the course of the study, it became clear that they were often more attuned than parents to the children's fidgeting behaviors and preferences. This seemed especially true of fidgeting behaviors done when the children were forced

to sit in one place and focus on something that was difficult for them, as is the case when they study or do school work, rather being free to move about. Consequently, we decided to expand our study to include teachers' responses to the same questions that the parents were asked in the Meet & Greet phase and the Group Session phase.

Since the teachers were not only involved in the planning of the sessions but also had to be present in the room during each session that involved the children, they were already aware of the differences between play and fidgeting and their attention was already focused on those behaviors. Further, since teacher buy-in was essential in order to conduct the study in their classrooms it was obtained prior to the study. As stated previously, the primary functions of the Meet & Greet were to obtain buy-in to encourage participation in the Group Session, to educate on the differences between play and fidgeting, and to focus their attention on the children's fidgeting. Therefore, since the main functions of the Meet & Greet were already obtained with regards to the teachers, we decided to combine the two parent phases (Meet & Greet and Group Sessions) into one phase for the teachers. Consequently, the teachers were asked in one session all of the same questions that the parents were asked in the two. Analysis of the information obtained from the teachers substantiated our decision to include the teachers and combine the two phases into one for the teachers. Further, as suspected, their answers alluded to the teachers often being more aware of fidgeting that takes place when a child is bored or forced to sit in one place or work on school related cognitive tasks such as homework, learning something new, focusing, and reading.

Analysis of the data leads us to believe that the contrasting participant (parent, teacher and the child him/herself) observations regarding whether or not a child fidgets or in what situations a child tends to fidget stem not from the child him/herself rarely or sporadically fidgeting but rather from the responder not noticing it or not being around in situations where that particular fidgeting behavior is done. That a child would respond in the negative when asked whether or not they fidget and their parent(s) and teacher would respond that they did, merely underscores the thought that fidgeting is often a subconscious act rather than a conscious one. Given that several of the parents in the study held more than one job or juggled school and work, it is not unlikely that a parent would fail to notice all of their child's fidgeting given the many demands on their time and focus. In addition, many of the children finished their homework at the after school program so their parents seldom if ever witnessed them focusing on schoolwork or any fidgeting that might accompany that activity. It is important to note that the teachers interviewed never responded that a child did not fidget. We think this is because the teachers spend the majority of their time with the children in a classroom-like setting where they are watching the children while supervising their behavior and work.

We were initially concerned that showing the prototypes to the children prior to having them design their own ideal fidget item would unduly influence their designs. In order to offset this, we told them that the prototypes were a combination

of all of the interactions and materials that the people who made them thought should be included in an ideal fidget item and that they (the children) should think of all of the fidget items that they already used and that we had shown them during the course of the study, in addition to the materials that we shared with them in the beginning of the session, and imagine a perfect fidget item that incorporated the materials and interactions that they liked the best. As a result of this, the drawings that the children made do not seem to have been influenced by the prototypes. The ideal fidget item drawings ranged from very complex items with multiple interactions built in to simple items with only one interaction. With the exception of maybe one dragon/cat fidget item, which is only similar to the lizard prototype in that dragons are somewhat similar to lizards, none of them looked at all similar to the hedgehog or the lizard prototypes.

The results showed that the majority of the children exhibited a tendency to test the physical limitations of a fidget item by interacting with it in a rough manner. Due to the prevalence of rough fidgeting behavior observed by the children, durability is a main concern when making or choosing fidget items for children. Perhaps the children's propensity toward what we deem as rough interactions can be attributed to their natural curiosity with regards to how things are made and what they can do. One exchange with a child during the Exploration phase that was indicative of this was as follows:

CHILD: like this one I like because, this one (blue to green squish ball with the net) it makes you want to cut it but then at the same time it doesn't want you. Like you wanna cut it but you don't want to cut it

RESEARCHER: cut it meaning get rid of the bag?

CHILD: no

RESEARCHER: cut it meaning you wanna get what's inside out?

CHILD: yeah, like (motions cutting the part sticking out of netting with finger)

Unlike adults, children must satisfy their fidgeting urges while operating within parental or teacher parameters of what is acceptable. From our observations of and interviews with the children in the study, we discovered that what they choose to fidget with is impacted by the environment in which they are fidgeting and whether or not they have to satisfy their fidgeting needs within the confines of what their parent(s) and/or teacher(s) find appropriate. Due to this adult imposed constraint, children often forgo their preferred fidget items and instead try to make-do with something that they think they can get away with. As a result of this many children choose to fidget with accessible or multipurpose fidget items that are much less likely to be taken away by parents, teachers, and/or caregivers. This is further evidenced by the fact that children try to accommodate their desire for fidgets that make noise by choosing fidget items that make subtle sounds that are less likely to be heard by anyone else. An example of this is the barely discernible squishing sound that a gel filled squeeze ball makes when squeezed.

In line with our results concerning children's need for stealth, they are very conscious of the size and conspicuous nature of things and of what they think they can get away with in different locations. One child chose a favorite fidget item in the Exploration phase and when asked where she would interact with it she said that she would interact with it at the after-school facility. When asked if she would also interact with it at home or at school, she replied 'no because it's too big.' She went on talk about another of her preferred fidget items and said that she liked it 'cuz it was more compact.'

Kids were found to value tactile sensation as the majority of children stated a preference for fidget items made of soft materials.

In a way, squeezing is similar to pressing in that both actions require force to move or change the shape of the object and both also experience a push back sensation as the object tries to return to its original shape or position. Similarly, squishing is much like clicking in that though force is required to click or squish the object, the object stays in the position that those actions put it in and there is no push back. So given the similarities between these preferred interactions, it is interesting that squeezing and pressing are not the preferred interactions for one emotion or activity and squishing and clicking are not the preferred interactions for another. All four interactions use movement of the fingers and yet the sensations they create are different. Perhaps it is because squishing and squeezing results in a clenched fist which goes better with dispelling energy when you are angry and pressing and clicking do not.

Use-Case scenarios
Future studies with children on the benefits or disadvantages of fidgeting should include fidget items that appeal to the largest subset of children. Our findings of the most popular fidget interactions and material properties can be used to inform the selection of fidget items to use in these studies. By incorporating fidget items with characteristics that appeal to a broader range of children, children are more likely to fidget with them organically rather than having to be prompted. Therefore, selecting fidget items with squeeze, squish, press, click, tap and stretch interactions and soft rubbery materials might yield more accurate results than incorporating fidget items that children do not naturally want to interact with.

Since children gravitate toward fidget items that make sound but fear of having them taken away prevents the children from either choosing them or else from using them in school and/or home settings, fidget items with either subtle sounds or sounds that can be turned off should be created or used during fidget studies. These fidget items would still satisfy their desire for noise while also making the items less distracting to those around so they will be less likely to be taken away. This will enable the children to use them in a multitude of settings that should yield better results in long term studies where the children take the fidget items home.

Further study is suggested to determine if our initial findings that a unidirectional link between anger and a preference for fidget items with a squeeze interaction exists for all or the majority of children. In addition, because our findings show

that children have a propensity to gravitate toward fidget items with a squeeze interaction when angry, future studies regarding whether or not fidgeting can serve to aid in self regulation by diminishing anger might yield more accurate results by incorporating fidget items that have an inherent squeeze interaction than by using fidget items without this interaction.

Our findings also showed a link between the fidget actions of pressing, clicking, and tapping and performing cognitive tasks such as studying, doing homework, focusing, and learning. We suggest that future studies be conducted exploring this relationship to determine whether or not it holds true with other populations of children or even other populations in general. Additionally, studies interested in whether or not fidgeting aids cognitive functions such as focus, retention, or understanding could benefit from the inclusion of fidget items with inherent pressing, clicking, and/or tapping interactions. Further, since we also found a link between boredom and fidget items with those inherent interactions, studies regarding whether fidgeting could modulate boredom could potentially increase their accuracy by incorporating such items.

CONCLUSION

We conducted a five-phase field study which focused on the fidgeting habits and fidget item preferences of children between the ages of 6 and 11, for the purposes of discovering when and why they fidget, in addition to what types of fidget items they naturally gravitate towards in terms of their material properties (exterior and interior materials) and interactions.

Our findings revealed that the children in our study fidget for a variety of reasons: engaging in cognitive tasks, regulating emotion, and dispelling excess energy. Of the emotions that tend to trigger a need to fidget, boredom was the most prevalent. Top material preferences for fidget items were rubber and plastic while top fidget objects were squeeze balls, Orbeez, and pencils/erasers. Squeeze, stretch, squish and the combined category of click/press/tap were the four most liked interactions inherent in fidget items. Further, we found that stealth, durability and sound are all things that need to be considered when building fidget items.

Children are forced to satisfy their fidgeting needs within the narrow confines of what they think the adults will let them get away with using. Therefore, if a fidget item is intended to be used all the time, in order for it to be used and evaluated successfully, either the issue needs to be addressed with both the parents and the teachers of a child by educating them on the possible positive outcomes of fidgeting and fidget items or else the fidget items developed need to blend into the child's usual environment either by being or looking like multipurpose items.

We believe the results of our study are of value to anyone interested in creating tangible interfaces for children, who would like to be sensitive to the affordances of the materials and potential manipulations of those tangibles. Our own research group is currently using the results of this study to engage in the development of smart fidget objects to aid children in self-regulation and emotional management.

REFERENCES
1. Jackie Andrade. 2010. What does doodling do? *Applied Cognitive Psychology* 24, 1 (2010), 100–106.

2. Scott A. Barnard. 2009. *The "Stop-It" Anti-fidgeting Device*. Master's thesis. Florida Atlantic University, The address of the publisher. An optional note.

3. Clancy Blair and Rachel Peters Razza. 2007. Relating effortful control, executive function, and false belief understanding to emerging math and literacy ability in kindergarten. *Child development* 78, 2 (2007), 647–663.

4. Jonathan SA Carriere, Paul Seli, and Daniel Smilek. 2013. Wandering in both mind and body: Individual differences in mind wandering and inattention predict fidgeting. *Canadian Journal of Experimental Psychology/Revue canadienne de psychologie expérimentale* 67, 1 (2013), 19.

5. John Cloud. 2009. Better Learning Through Fidgeting. (2009).

6. Peter Cottrell, April Grow, and Katherine Isbister. 2018. Soft-bodied Fidget Toys: A Materials Exploration. In *Proceedings of the Twelfth International Conference on Tangible, Embedded, and Embodied Interaction (TEI '18)*. ACM, New York, NY, USA, 42–48.

7. Allison Druin (Ed.). 1998. *The Design of Children's Technology*.

8. Stephen Garger. 1990. Is there a link between learning style and neurophysiology. *Educational Leadership* 48, 2 (1990), 63–65.

9. Nenad Gligorić, Ana Uzelac, and Srdjan Krco. 2012. Smart classroom: real-time feedback on lecture quality. In *Pervasive Computing and Communications Workshops (PERCOM Workshops), 2012 IEEE International Conference on*. IEEE, 391–394.

10. Abraham Goldstein, Ketty Revivo, Michal Kreitler, and Nili Metuki. 2010. Unilateral muscle contractions enhance creative thinking. *Psychonomic bulletin & review* 17, 6 (2010), 895–899.

11. Stuart Gray, Judy Robertson, and Gnanathusharan Rajendran. 2015. BrainQuest: an active smart phone game to enhance executive function. In *Proceedings of the 14th International Conference on Interaction Design and Children*. ACM, 59–68.

12. Libby Hanna, Kirsten Risden, and Kirsten Alexander. 1997. Guidelines for usability testing with children. *Interactions* 4 (1997), 9–14.

13. T A Hartanto, C E Krafft, A M Iosif, and J B Schweitzer. 2016. A trial-by-trial analysis reveals more intense physical activity is associated with better cognitive control performance in attention-deficit/hyperactivity disorder. *Child neuropsychology : a journal on normal and abnormal development in childhood and adolescence* 22 5 (2016), 618–26.

14. Michael Karlesky and Katherine Isbister. 2013. Fidget widgets: secondary playful interactions in support of primary serious tasks. In *CHI'13 Extended Abstracts on Human Factors in Computing Systems*. ACM, 1149–1154.

15. Michael Karlesky and Katherine Isbister. 2014. Fidget widgets: designing for the physical margins of digital workspaces. In *Proceedings of the 8th International Conference on Tangible, Embedded and Embodied Interaction*. ACM, 301–304.

16. Michael Karlesky and Katherine Isbister. 2016. Understanding Fidget Widgets: Exploring the Design Space of Embodied Self-Regulation. In *Proceedings of the 9th Nordic Conference on Human-Computer Interaction (NordiCHI '16)*. ACM, New York, NY, USA, Article 38, 10 pages.

17. Majeed Kazemitabaar, Jason McPeak, Alexander Jiao, Liang He, Thomas Outing, and Jon E Froehlich. 2017. MakerWear: A Tangible Approach to Interactive Wearable Creation for Children. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*. ACM, 133–145.

18. Charlie Lewis, Masuo Koyasu, Seungmi Oh, Ayako Ogawa, Benjamin Short, and Zhao Huang. 2009. Culture, executive function, and social understanding. *New Directions for Child and Adolescent Development* 2009, 123 (2009), 69–85.

19. Malia F Mason, Michael I Norton, John D Van Horn, Daniel M Wegner, Scott T Grafton, and C Neil Macrae. 2007. Wandering minds: the default network and stimulus-independent thought. *Science* 315, 5810 (2007), 393–395.

20. Rebecka Nyqvist. 2016. *Fidgeting for Creativity*. Master's thesis. Lund University, Lund Sweden.

21. Marily Oppezzo and Daniel L Schwartz. 2014. Give your ideas some legs: The positive effect of walking on creative thinking. *Journal of experimental psychology: learning, memory, and cognition* 40, 4 (2014), 1142.

22. Karen J Pine, Hannah Bird, and Elizabeth Kirk. 2007. The effects of prohibiting gestures on children's lexical retrieval ability. *Developmental Science* 10, 6 (2007), 747–754.

23. Rachel A Schecter, Jay Shah, Kate Fruitman, and Ruth Lynn Milanaik. 2017. Fidget spinners: purported benefits, adverse effects and accepted alternatives. *Current opinion in pediatrics* 29, 5 (2017), 616–618.

24. Donald Slater and Jean French. 2010. Fidget toys in the classroom: refocusing attention. (2010).

25. Sheryl Stalvey and Heather Brasell. 2006. Using Stress Balls to Focus the Attention of Sixth-Grade Learners. *Journal of At-Risk Issues* 12, 2 (2006), 7–16.

26. Orad Weisberg, Ayelet GalOz, Ruth Berkowitz, Noa Weiss, Oran Peretz, Shlomi Azoulai, Daphne KoplemanRubin, and Oren Zuckerman. 2014. TangiPlan: designing an assistive technology to enhance executive functioning among children with adhd. In *Proceedings of the 2014 conference on Interaction design and children*. ACM, 293–296.