Emotional Interfaces for Interactive Aardvarks: Designing affect into social interfaces for children

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ABSTRACT
Character-based social interfaces present a unique opportunity to integrate emotion into technology interactions. The present paper reports on the use of three emotional interactions (humor, praise, and affection) in the audio interfaces for two character-based interactive learning toys. The reasons for selecting the emotions used, the design rationale for their application, and findings from usability testing are reviewed. It is suggested that as a form of pretend play-acting akin to puppetry, social interfaces can engage the emotions of users in a variety of beneficial ways.

KEYWORDS: Learning, audio interface, children, social interface, emotion

INTRODUCTION

Social interfaces and affect

The past few years have witnessed a growing interest in interfaces that engage users not just cognitively, but emotionally as well. Most of these efforts are driven by a practical desire for better interfaces. Social interfaces, for example, are thought to make technology use more enjoyable and natural by mimicking familiar social conventions [20,21]. Building interfaces that engage user emotions has a far stronger rationale when the users are children, however. Most interactive products for children have an explicitly educational aim. And there is a clear consensus in the psychological and educational fields that a variety of positive emotions play critical roles in fostering learning and mental growth in children [2,8,23]. Emotions in educational interfaces for children therefore can do more than just improve the interface's quality. They can play an important role in achieving the learning goals of the product itself.

Previous research on emotion in children's interfaces has tended to emphasize task-related considerations, such as motivation for persistence [22], rather than social engagement with the interface itself. This focus is perfectly appropriate when the human-computer relationship is viewed as that of a user to a tool. Under the "technology as tool" model, task motivation, the satisfaction of a job well done, and the intrinsic pleasure of feeling in control of the interaction are the only emotions that matter [31]. Just as designers of screwdrivers or drills do not consider issues of warmth or playfulness when making a tool effective and easy to use, interface designers have not concerned themselves with such issues when building interactive tools such as spreadsheets or phone menus.

Emotional engagement at the interface has assumed more importance in recent years, as interactive technologies have become part of aspects of human activity other than work and have been taken up by users other than adults. A "social" model of interaction, in which interfaces are deliberately designed to mimic familiar human social interactions, has appeared as a complementary alternative to the tool model. The social model sees the human-computer relationship as not just a user-tool engagement, but also as a partnership or collaboration between the user and the computer [13,21]. The merits of the social approach have been the subject of some debate [9,12,20]. Whatever one's opinion, though, there is empirical support for one key element of the social approach: computers do seem to elicit behavioral and affective responses in users that mimic their social responses to other people.

Social mimicry as an interface model

A growing body of literature has documented that adult users respond to a variety of computer interface elements, such as voices or faces, as if they were being produced by human agents [26,29,36]. In addition, there are studies demonstrating that adult users respond to specific emotions in the interface as if they were being produced by human agents [11,25]. Such systematic research data on children's reactions to social elements in interfaces is lacking.

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However, two previous studies of speech output for children have reported that the emotional tone of the speech had a strong influence on children's reception of the spoken message [16,33]. And more concretely, Microsoft's ActiMates Barney interactive character appears to successfully use a social interface to elicit playful pleasure from children. Such evidence suggests that children most likely respond to social interfaces in a manner similar to adults [34].

Because of their ability to invoke emotional responses in users, social interfaces, particular those embodying specific characters and personalities, provide a unique opportunity to integrate affect into interactive learning. But in what manner? Computers As Social Actors (CASA) is a model of HCI that suggests that principles of human social interaction can also be applied to human-computer interaction [11,27]. The CASA approach theoretically encompasses all elements of HCI design, from pop-up menus to error messages. However, it has particular relevance for character-based interfaces, where the user engages the interface in an explicitly social manner. The present paper describes the successful application of the CASA concept to the design of emotional interactions in the audio interface of a character-based interactive learning toy.

Meet Arthur and D.W.

It is obviously an advantage if the characters in the interface are already familiar and appealing to intended users. Arthur and D.W. are fictional siblings, the creations of children's author Marc Brown. They have been familiar to American children for more than 15 years. They are the central characters in more than 30 children's books, a popular television series, and several educational CD-ROM titles, all aimed at the four- to eight-year-old population. Arthur and D.W. are anthropomorphized aardvarks who live in a suburban neighborhood with other animal families. Their animal-like appearance notwithstanding, Arthur and D.W's behavior is completely human, as are their personalities. They are highly individual, with their own specific traits and preferences, while sharing the same interests and concerns as their audience. Arthur and D.W. also have appealing social styles. In all their fictional adventures, they are loyal and devoted friends, playful and fun-loving. They show strong personal integrity, as well as empathy toward others. It is not surprising that children find Arthur and D.W. to be very sympathetic characters. Relying on this affection to elicit social and emotional responses from children was the starting point for the interfaces for two new ActiMates characters: ActiMates Arthur and ActiMates D.W.

ACTIMATES CHARACTERS AS SOCIAL INTERFACES

ActiMates characters are animated, interactive plush dolls. ActiMates Arthur and D.W. (hereafter A/Arthur and A/D.W.) are both approximately 13 inches in height. Motors provide simple arm and head movement, and a small loudspeaker provides audible speech, allowing the character to gesture and speak. Children interact with A/Arthur and A/D.W. by actuating seven sensors located inspecific parts of the character's body: One in a watch on the character's right arm, and one in each hand, foot, and ear. (See Figure 1.) A ROM chip hidden in each character's body allows the characters to respond to children's inputs. The characters move using programmed motion, and speak using a pre-recorded, digitized speech vocabulary of more than 4,000 phrases.

Figure 1. ActiMates D.W. and ActiMates Arthur. Children respond to the character's speech and gestures by squeezing sensors located in the hands, feet, ears, and watch (visible on right arm).

A/Arthur and A/D.W.'s sensor interfaces are organized by the sensor's location on the character's body. Separate functions are associated with the ears, watch, and feet sensors.

Ears are to hear what A/Arthur and A/D.W. are thinking

Squeezing the ears allows children to "eavesdrop" on A/Arthur or A/D.W.'s thoughts. Each ear squeeze plays one of dozens of unique phrases that ask questions, offer opinions, share jokes, and give compliments. The content of these phrases is scripted to reflect the individual thoughts and feelings of the fictional characters Arthur or D.W. Phrases with emotional content fell into several categories:

Jokes. A/Arthur and A/D.W. share silly ideas or comical events with the child. Arthur, for example, says "You know what's gross?" and then proceeds to name something silly, such as "sweaty gym socks," that elicits humorous reactions of disgust from the child.

Secrets. A/Arthur and A/D.W. say, "Come closer, I want to tell you a secret!" and then confide an embarrassing fact or a private opinion to the child.

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Playful Teasing. A/Arthur and A/D.W. make mock requests or gently tease the child with information they know, such as the child's birthday.

Compliments. A/Arthur and A/D.W. both express affection for the child, through such comments as "I'm lucky to have a friend like you!"

The watch is for telling time

When the watch is squeezed, the character says the current time, date, and day of the week. If the date is a holiday, the character announces that fact along with the date. The character can be programmed to know a specific birthday, and will treat that date as a holiday.

Feet are for games

When a foot is squeezed, the characters play games. Both A/Arthur and A/D.W. play the same games. The games include:

Rhyme Time. The character says two words and the child must squeeze a hand sensor if they rhyme (e.g. parrot, carrot) or a foot sensor if they do not (parrot, dolphin).

How Long Is That? The character challenges the child to estimate a specific length of time (5, 10, 15, or 20 seconds) and squeeze a hand sensor when the duration is passed.

The Stopwatch Game. In this game, children perform actions, such as standing on one foot, while the character times the duration. Children squeeze a hand sensor to stop the clock and hear the character report how long the activity lasted.

The Memory Game. In this game, children memorize, then execute, progressively longer lists of sensor squeezes ("Hand, foot, ear, foot…"). Each time the list is correctly input using the character sensors, a new element is added to the list on the next round.

Silly Sentences. The character combines randomly selected adjectives, nouns, and verbs to create nonsense sentences such as "The jiggling wombat does the cha-cha with the stinky antelope!"

Countdown. In this game, the character says, "Let's count down backward and then say {phrase}," where the phrases are randomly selected lines such as "Surprise!" or "Blast off!"

Unlike the ears, feet, and watch, the hand sensors do not have a dedicated function. Instead, they are integrated with the ear and foot functions and serve different purposes in each context. They are part of game interfaces when games are active. In the ear phrase menu, they serve to repeat the last phrase spoken, so children can repeat a given phrase on demand.

Personality and the audio interface

The foundation of the A/Arthur and A/D.W. social interface is the personality of the individual characters. Personality plays a crucial role in human social interaction. The consistency of an individual's preferences, attitudes, and actions over time creates a consistent set of expectations in others that makes the behavior of familiar individuals predictable. Even very young children have been shown to make predictions based on knowledge of personality and personal attributes [10,14,29]. Consistency of personality creates consistency in the social interface, by making the character's interactions predictable.

As plush dolls, A/Arthur and A/D.W. have fixed facial features, and thus must rely exclusively on speech and gesture as an interface. Fortunately, speech is a rich medium for conveying affect. Speech patterns convey critical information about personality and emotion. When applied to the audio interface, they can provide authenticity and a feeling of realism [37]. While it is possible to simulate different emotional elements using synthesized speech [17], a special requirement for interfaces based on familiar characters from television is that their voices must be recognizable in order to be accepted as authentic. To meet this constraint, speech for the interfaces was created from recordings made by voice actors, rather than synthesized.

The familiarity of the voice is only the most basic element requirement of character speech, however. The degrees to which the character's speech is both natural sounding and true to the character in content and style also establish character authenticity and realism. Specific features in the ActiMates audio interface addressed each of these aspects of speech.

Spontaneous variation and conversational speech

Two strategies were used to make the characters' spoken comments seen natural, rather than "canned" or programmed. The goal of both strategies was to avoid the highly repetitive and unnaturally rigid language so common to interactive systems. The existing literature on audio interface design tends to emphasize issues of consistency and brevity of comments as key interface features that promote efficiency of navigation [28]. The cost of the efficiency gained by such standardization, however, is robotic and unnatural-sounding speech. Human speakers are very inconsistent, spontaneously varying their utterances even when saying the very same thing over again at different times. In a character-based interface, including such natural variations makes the interface speech seem more the speech of another person than of a machine.

The first way variability was added to the interface was by varying the syntactic constructions of specific interface instructions. Instead of consistently using a fixed "action-input" sequence to give interface instructions (e.g. "To play

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a game, squeeze my toe!"), A/Arthur and A/D.W. randomly alternate action-input and input-action versions of the same information, using a "Squeeze my toe to play a game!" construction as well. The second way variability was added to the character's speech was by randomly varying the order of phrases in the ear menu and the order in which games are presented when the foot is squeezed. This randomization creates a sense of unpredictability that contributes to the impression that the characters are making spontaneous, rather than programmed, responses to the child.

Characteristic speech and authenticity

Spontaneous variation makes character speech more natural sounding. A second issue in a personality-based interface is the familiarity and authenticity of the character, established through idiosyncratic language and comments. Two personality-specific speech elements were used in the design to establish the character's identity. The first is the inclusion of random interjections when games are initiated. Starting a game, A/Arthur and A/D.W. say, for example, "Let's play a memory game!" or "I know! Let's play a memory game! Or "Hey! Let's play a memory game!" The use of "Hey!" and "I know!" as interjections is not only consistent with the speech patterns of the Arthur and D.W. fictional characters, but with the colloquial speech in the four- to eight-year-old target user age group as well. The other personality-specific language in the interface is the use of "signature" phrases from each fictional character, such as Arthur's exasperated "Oh, brother!" and comments from D.W. that reflect her self-confidence, such as "You know what? I know everything!" Such phrases reinforce the character's identity for the child, and add to the overall authenticity of the character as a familiar social actor.

A voice that matches the character's voice on television and CD-ROMs, naturalistic variation in speech, and the use of characteristic speech patterns serve a specific purpose in the interface. They encourage children to respond emotionally to A/Arthur and A/D.W. in the same manner as they do to the Arthur and D.W. they see on television or on CD-ROM. This emotional engagement is a prerequisite for engaging the specific emotions targeted by the design during play with the ActiMates characters.

THREE VALUABLE EMOTIONS

Three specific emotional interactions were selected for inclusion in the A/Arthur and A/D.W. interfaces. Each emotion met three criteria. First, the emotion was consistent with the personalities of the individual characters; second, there was clear empirical support for the benefits of the emotions to children's learning and development; and third, the emotion could be integrated into the interface in an appropriate manner. The emotional interactions that met these criteria are: praise and encouragement, laughter and humor, and warmth and affection. A summary of the specific places they are used in the interface is shown in Table 1.

Praise and encouragement

In the Arthur television program and books, encouragement and praise account for a large amount of the content of the interactions among Arthur, D.W., their friends, and family. Praise plays a valuable role in learning. Task-sensitive praise is a form of social reinforcement that has repeatedly been shown to affect both task performance and motivation [5,8]. It is also implicated in task persistence when children are mastering new material [24]. Five of A/Arthur and A/D.W.'s games use praise from the character to encourage play: Rhyme Time, The Stopwatch Game, The Memory Game, How Long Is That, and Countdown. In each of these games, correct responses are cheered and praised by the characters. In The Memory Game, where the list to be memorized gets longer with each successful round, praise is even more performance-specific: with each round, as longer lists are correctly recalled, praise becomes more energetic and enthusiastic in tone to match the challenge in each round.

Table 1. Content associated with specific emotions

Praise and encouragement	Laughter and humor	Warmth and affection
Rhyme Time	Silly Sentences	Secrets
Stopwatch Game	Action prompts	Playful Teasing
Memory Game	Playful Teasing	Compliments
How Long Is That	Action prompts	
Count-Down	Jokes	

Testing demonstrated that praise motivated children's performance during games. They smiled or nodded in response to character praise, and several even responded verbally (e.g. A/Arthur: "You're good at this!" Child: "I know!"). User testing of the games during product development also identified an additional role for praise beyond reinforcement for success: praise was found to lessen the aversive feelings that accompany failure. Failure was an issue for two games: The Memory game (TMG) and How long is that? (HLIT). Unlike Rhyme Time and Countdown, which are simple, single-trial games that are easy to play, TMG and HLIT are more challenging. Both require sustained effort and repeated trials for success, meaning that failures are frequent.

In the initial designs for both games, when children failed a round by making an error, a new round of the game started

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immediately after the error was confirmed by the character, with the character simply saying, "Let's try again!" Children's reactions to this transition from failure to a new round were striking: They often looked down or looked away from the character, and interacted less frequently with the character for several minutes afterward. Adding praise for the effort ("That was hard!" or "That was a tough one!") prior to starting the new round seemed to soften the blow, by acknowledging the difficulty of the task. In subsequent testing with the new phrase added, the decline in positive affect and interaction that had accompanied failures without the comment did not recur.

The second place that praise and encouragement was used in the interface was during periods of user inactivity. After a fixed amount of time has passed during which the child has not actuated a sensor, A/Arthur and A/D.W. either make a suggestion ("Squeeze my toe to play a game!") or randomly give a spontaneous statement of admiration or praise ("You know what? You RULE!" "You're so cool!" "Don't stop now! You're doing great!" etc.) These phrases serve two purposes. First, they make the characters seem less task-driven, by diluting interface directives about the sensors with personal statements directed to the child. (See [34] for the use of this same strategy, for the same effect, in a different social interface). The second is to motivate the child to continue interacting with the character. Results from user testing suggested these phrases achieved the desired effect: children's responses to spontaneous praise after a period of inactivity were to smile and touch the character, an action often followed spontaneously by sensor inputs and renewed play.

Laughter and humor

Laughter, silliness, and comedy play a role in all of Arthur and D.W.'s adventures in the Arthur books and television show. Humor has clear value for the developing child. Generating humorous behavior, sharing humorous experiences, and responding to humorous situations with amusement are behaviors that all correlate with a variety of positive social and cognitive measures [23]. Humor is effective in learning situations as well [7,40]. And perhaps most critically, humor and laughter are powerful social behaviors. Laughter and smiling are far more likely in social situations than in solitary situations, suggesting their fundamentally social nature [1]. Humor also has benefits for social interaction. It reduces social distance, and humorous peers are rated as better liked [32,38]. Social humor and laughter are so pervasive that facilitating them is not difficult. One of the most robust findings in social psychology is the "contagious" nature of laughter and smiling. When another person is present, children respond more readily and freely to humorous material – especially if the other person is laughing or reacting with pleasure to the same humorous stimuli [6].

Laughter is used in two content areas in the ActiMates interface: in the Silly Sentence (SS) game and as part of phrases that are said when the ear is squeezed. In SS, the character says a nonsense sentence, then laughs in reaction to the content, occasionally commenting "That's funny!" or "That's silly!" In testing, children tended to smile when the character laughed, and visually attended to the character. Several actually responded verbally when the character said "That's funny!" by agreeing ("It sure is, Arthur!") or disagreeing ("No, it's not.")

Laughter was also used after practical jokes that A/Arthur and A/D.W. played on the user, and after they made humorous comments. For example, A/D.W. (whose hair is made of yarn) has an ear phrase "Does my hair look stringy to you? (giggle)". Most girls tested in A/D.W.'s formative research reacted with smiles and giggles. They remarked on the comment to others, laughing or grinning, as well. In many cases, they spontaneously began grooming the character's hair after hearing this phrase. Both characters also joke about their own interface, saying for example, "I'd squeeze your foot if I could reach it! (giggle)." A majority of children smiled or laughed in response to hearing this line, and several four-year olds (the youngest age tested) jokingly held their feet up to the character.

Humor without explicit laughter is used in the interface in many more of the characters' ear phrases. A/D.W., for example, says "I'm not afraid of anything! Except maybe…" and then randomly adds a ludicrous exception, such as "…bugs that are bigger than my head!" These comments were designed to convey that even someone with D.W.'s courageous nature can still have fears. Similarly, A/Arthur asks "Are my glasses on straight? I don't want to look goofy!" This phrase gently communicates Arthur's concern with looking foolish to others, an anxiety the fictional character shares with his target users.

Warmth and Affection

Empirical studies have long linked warm and affectionate interactions with positive outcomes and adjustment in children on a variety of measures. The affection and warmth of peers and authority figures has been shown to influence mental growth in children, increase motivation, enhance feelings of self-esteem and positive-self regard, and more [2,3,19,30]. Affection among friends and family is a significant emotional theme in Arthur and D.W.'s television and book adventures, as well. In both the television program and the books, characters explicitly comment on how much they value their friendships ("Arthur, you're the best friend a guy could have!"), and on how much they enjoy each other's company ("How can I have my first sleepover without you? You're my best friend!").

A/Arthur and A/D.W. utilize warmth and affection in the interface in a variety of ear phrases. Each character has

several distinct ear phrases that express affection and admiration for the child user. For example, A/D.W. confides "I'm lucky to have a friend like you!" A/Arthur says "I wish you were in class with me!" The two characters also have ear phrases to build affection through two indirect strategies: sharing Secrets and Playful Teasing. Both characters confide in the child user, saying "Come closer, I want to tell you a secret!" and then divulge a personal preference or opinion. Playful Teasing builds intimacy by using personal knowledge of the child in a playful manner. Once they are programmed to know the child's birthday, the characters randomly announce their knowledge, saying in a playful tone, "I know YOUR birthday! Your birthday is {month/date}!"

Testing of these different ear phrases with children revealed that the phrases were received positively by children of both sexes. The typical reaction to affectionate language was for children to smile, comment, and interact with the character. Girls often had another striking reaction: they would pull the character physically closer to them. When secrets were presented, children actually leaned closer to the characters to hear the confidential information. The divulging of secrets had a particularly striking effect for girls using A/D.W.: several girls turned to the researcher and giggled as they confided the secret they had just learned.

PUPPETS, PRETEND, AND HCI

The strategy behind the use of character-based social interfaces is to build on the social responses of users in order to support technology interaction. A/Arthur and A/D.W. use this strategy to achieve an additional goal: fostering beneficial emotions in young users during their playful learning efforts. Character-appropriate emotional interactions that are beneficial to development were included in the interface where they supported the content most effectively. User testing indicated that these interactions achieved their intended goal of eliciting the appropriate emotional responses in children. The result is an interface that promotes mental growth through the systematic use of social responses to positive affect, and one that children find highly engaging and appealing, as well.

Social interfaces for children have broader goals than helping a user complete a task efficiently. Their mimicry of human interaction makes such interfaces more like a form of puppetry than strictly a form of tool. Puppetry invites children to pretend that inanimate objects are sentient, and to respond to their speech and actions as if they are being produced by social agents. Such pretend or "as if" engagement is a sophisticated form of dual representation in which children interact with an object, such as a doll, by endowing it with imaginary properties (making it talk, for example), while simultaneously understanding that the doll is just a toy. Pretend play fosters intellectual growth in children precisely because it engages them in two levels of thinking simultaneously: in the physical world of the toy and in the imaginary world where the toys are used as props for acting out imagined events [4,15,18]. Putting these intellectually rich processes to work in technology interfaces makes the interface itself a prop for pretend engagement, a design philosophy very different from the traditional, tool-based notion that interfaces should be "transparent" or invisible to the user [31].

If social interfaces are a form of pretend, it is worth noting that the CASA model itself is in fact based on a premise strikingly similar to pretend play. "The CASA paradigm maintains that individuals can be induced to behave *as if* computers warranted human considerations, even though users *know* that the machines do not actually warrant this treatment…[11, p.552, italics in original]." The A/Arthur and A/D.W. social interfaces induce pleasant emotions in users in a manner consistent with human interaction, even though children know that Actimates characters are toys and not peers. The effectiveness of such interfaces suggests that the interpersonal CASA approach appears to have much to offer as a conceptual model for character-based interface designs. Children treat character-based social interfaces as if they are pretend playmates: friendly guides, assistants, or partners who have a specific, user-assigned social role to play in any given interaction. A straightforward way to have character interfaces "behave" as users expect them to in such situations is to make them mimic social interactions as closely as possible in their responses and actions to user inputs.

Pretend playmate social interfaces enrich technology interaction by adding playful elements such as humor, warmth, spontaneity, and personality to the interface. Such interfaces are certainly not suitable for all technology applications. There are sound theoretical reasons, for example, why play-based interactions are inappropriate for productivity tools [35]. But in situations where learning and mental growth are goals of the interaction, and where children are the intended users, pretend playmate interfaces have a valuable role. That they can facilitate children's emotional as well as cognitive development says as much about the power of the playful imagination as it does about social interfaces. That they can engage user emotions as dramatically as they do suggests that we have only begun to understand all the different ways that technology, applied in a developmentally appropriate manner, can be used to support mental growth.

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