ABSTRACT

Touch is a unique channel in affect conveyance. A significant aspect of this uniqueness is that the relation of touch to affect is immediate, without the need for symbolic encoding and decoding. However, most pioneering research work in developing remote touch technologies, result in the use of touch as a symbolic channel either by design or user decision. We present a review of relevant psychological and sociological literature of touch and propose a model of immediacy of the touch channel for conveyance of affect. We posit that the strategic provision of contextualizing channels will liberate touch to assume its role in affect conveyance. Armed with this analysis, we propose two design guidelines: first, the touch channel needs to be coupled with other communication channels to clarify its meaning; second, encourage the use touch as an immediate channel by not assigning any symbolic meaning to touch interactions. We proceed to describe our haptic interface design based on these guidelines. Our in-lab experiment shows that remote touch reinforces the meaning of a symbolic channel reducing sadness significantly and showing a trend to reduce general negative mood and to reinforce joviality.

Author Keywords
Haptic Interface, Remote Touch, Affective Interaction.

ACM Classification Keywords
H5.2. User Interfaces: Haptic I/O, Theory and methods
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Human Factors, Design

INTRODUCTION

Since Samuel Morse’s invention of instantaneous text communication by the telegram in 1837, and Alexander Graham Bell’s patenting of the telephone in 1875, telecommunications has grown into a multi-billion market. Today, instantaneous-everywhere communication in the form cellular phones, SMS, and paging is the fastest growing segment in tele-communications [3]. Instant messaging, video and audio teleconferencing, and social networking are becoming dominant uses of the internet. E-mail is ubiquitous. In current communications milieu, three channels or modalities dominate: audio/voice, text, and video. Touch, as a unique and expressive modality to convey love, comfort and affect revealed by lots of previous psychological and sociological research, is largely ignored in current communication technologies. This paper explores the prospect that remote touch interaction can support immediate human-to-human affective interaction.

We present scientific background for the psychology of touch, arguing that touch is a unique and immediate channel of affective interaction, and that context is required. We review literature on mediated touch technology, and show that most existing systems are used for symbolic communication rather than for immediate affective exchange. We posit that this is because of the lack of context. We present our haptic interface that is situated with a speech channel, and present results showing affective communication using our system.

TOUCH

Harry F. Harlow pioneered the study of the nature of love and affection from a psychological point of view. In his famous experiments, infant rhesus monkeys were taken from their mothers and ‘raised’ by either a terry-cloth or wire surrogate, all else being held constant [16]. The monkey infants with different ‘mothers’ developed to be radically different. The wire-mother-fed monkeys appeared to be pathological violent and aggressive, while the terry-cloth-fed monkeys (though not completely normal) did not express such characteristics. This classical experiment suggests that touch plays a central role in development. Harlow himself related his findings to humans emphasizing the visceral need for physical contact in his famous 1958 paper, “The Psychology of Love”.

In a phenomenological study reported by Register et al. [25], a group of human subjects reported on their “intimate
experiences” to ascertain the common understanding of intimacy. One of their major findings is that non-verbal communication is critical in the experience of intimacy, and that it is difficult to explain or to communicate this experience in words. They write: “It seems that there is an element of intimacy that is more accurately expressed via other sensory modalities, such as sight and touch, and in the absence of language.” to ascertain the common understanding of intimacy.

Collier discussed the emotional expression of touch from the perspective of the physiological response of the recipient in relation to contextual variables such as gender, relationship, culture, age etc. [9]. While there are measurable responses that relate to the emotional states of the recipient, and the emotional intent of the originator of the touch, Collier concludes that “Touch should not be broken down into separate features which are then used independently, or divorced from the total context in which it occurs.” Indeed, physiological responses are multiply determined (e.g. sweat can result from need for “cooling the skin and increasing its resistance to tears and abrasions, as well as increasing sensitivity during sexual arousal” [9] p 41, 43). He further states that touch responses depend heavily on contextual variables even for identical physical contact between same individuals. In other words, touch is a rich and unique form of human interaction that may not be easily expressed in its logical constituent parts.

PROPOSITIONS

A major proposition of this paper is that human touch carries unique affective information. We introduce the idea of ‘immediacy’ to the concept of touch (as illustrated in Figure 1). In Figure 1a, affective touch is immediate in that it does not go through any transformation into a symbolic expression. The originator does not think of a message to be expressed in the touch. She is not ‘trying to say’ anything, and the recipient does not interpret a message – the reception of affect is immediate. This is a common sense idea. When a child hugs his parent, he does so because he wants to, and needs to. When lovers embrace and kiss, they just embrace and kiss – they are not attempting to make any statement. The alternative is shown in Figure 1b where touch is construed as a message that has to be expressed in symbolic terms and encoded as a specific kind of touch by the originator, and has to be decoded into symbolic expression and interpreted by the recipient. This distinction is not trivial. If touch is immediate in this formulation, then it holds a unique place that is not easily subsumed by some other modality. If it is mediated through symbol, it could be otherwise mediated. It is this immediacy that, we argue, makes the exploration of digitally conveyed touch important (Note that there may be a confusion between the concept of touch being mediated by symbol and the idea of digitally mediated touch. The former relates to the process within the humans on both sides of the touch, and the mediation is through the instrumentality of symbol [32-33]. Digital mediation is a technology affordance by which touch is conveyed remotely. We will make this distinction clear by using the term digital mediation for the latter throughout this paper).

We believe that the science of human touch and affect as represented by literature reviewed earlier supports our model of touch as an immediate medium for affect. We also note that this model does not cover certain socially codified physical interaction such as a handshake that is obviously symbolic in nature ([18] p. 43).

Our discussion on touch-related work in psychology and communication suggests that touch interaction has the ca-
pacity for immediate conveyance of affect, and that this immediacy is maintained when contextualizing information channels are present. In the absence of such channels, remote touch interaction tends to reduce to a low-bit-rate, low-information-content channel for symbolic information communication. Our goal is to empower the touch channel for its unique function by the provision of context.

DIGITALLY MEDIATED REMOTE TOUCH
We discuss digital mediation of touch, introducing the physiological phenomena to be mediated, and reviewing some prior attempts for such mediation. We note that even the possibility of digital mediation may be called into question. It is indeed possible that touch is such an intimate interaction that psychological/social meaning is only possible with physical co-location because physical presence is part of the meaning itself. Hence, ‘existence proofs’ that affect is conveyed by digitally mediated remote touch is critical. This existence proof is part of the goal of our research.

What is touch?
Touch as a physiological phenomenon can be classified in two ways. The first relates to the sensory perception of touch – whether it is cutaneous or kinesthetic [19]. Cutaneous perception is obtained from the sensors in skin, responding to texture, temperature etc. Kinesthetic perception is sensed through the receptors in muscles and joints, enabling the awareness of limb position, and the ability to perceive force. Any digital mediation will have to realize actualization that produces one or both of these sensations.

The second classification relates to active or passive sensing [20]. Active touch is sensed by the person who initiates the touch, whereas passive touch is sensed by the person being touched. Cullen, in his work on the neurobiology of touch, states that the reason of distinguishing these two modes is that human processes them differently in order to precisely guide motor control and achieve perceptual stability [10]. Hence, both modalities are related in the sense that proprioceptive sensing of active touch is necessary to interpret the passive sensation of the body-material interface. Hence, systems that mediate touch needs to address both active and passive sensation as an integrated phenomenon.

Digital Mediation
Haans and Ijsselsteijn [14] conducted a recent overview of digital touch mediation technologies. They seek to relate digitally mediated touch approaches with social-psychological meaning. The difference between their analysis and ours is that they take as a starting point the idea that meaning is mediated through symbol, and they do not address the ability of the various systems they reviewed with respect to the propositions we advanced as critical to touch conveyance. Nonetheless, their review highlights three shortcomings of the state-of-knowledge in digitally mediated touch: 1. That the field lags “in developing a deeper theoretical understanding of the presumed effects of mediated social touch on the social interaction process”; 2. That “very few studies are available that report on the empirical system validations beyond the level of anecdotal descriptions of user experiences”; and, 3. “Most authors do not state exactly how the addition of touch channel will enrich current communication media.” We believe the lack of understanding of the immediate nature of touch and its uniqueness with respect to immediate affect conveyance contributes to all three shortcomings.

Early in 1986, two Canadian artists White and Back proposed the idea of building a remote arm wrestling device using motorized force-transmitting systems [35], called telephonic arm wrestling. Their machine was successfully demonstrated in several shows, and initialized the agency on the technique of remote haptic systems. Strong and Gaver proposed three remote interfaces that support intimacy [30], among which, shaker is a haptic interface where a simple remote force feedback mechanism is designed to enable light-hearted play among friends. After shaker, numerous remote haptic devices emerged, which provide various design features to support information exchange and emotion expression in different manners. In the following, we discuss a set of such devices. In 1997, Dodge presented their “The Bed” system in which a pair of beds are linked with a pair of pillows (a head pillow with input sensors, and a body pillow that vibrates and produces heat), and a curtain for back projection. The purpose of the system is to support intimacy between two people by transmitting presence and activity information. However, no user test appears to have been conducted with the system. Brave and Dahley described an inTouch [5] system that used a pair of linked devices with rollers that mirrored each other’s movements. Users placed their hands on the rollers, and as they moved the rollers, the paired device would mirror the roll in displacement and force. Users reported that the device supported ‘playful’ interaction, but some remarked at their inability to send coded messages over the devices. In 2001, VibroBod was proposed [12], where vibrations and temperature were applied as “visceral modes to aid intuitive social perception in networked interaction.” The idea is to couple a pair of devices on the laps of users that are able to sense a user’s grip on one device and produce vibrations and heat on its paired device. While the paper suggest that pairs of subjects would use this device while communicating by phone, IM, or chat, it is unclear from the paper that the device was used in this multi-modal manner, or how the modes interacted if they were used jointly. The paper did report a study with 15 subjects that after practice, the “users found VibroBod to facilitate meaningful experiences”. In another device called LumiTouch [8], two pictures frames with the photo of a pair of users on each other’s desks are used as interfaces. When the sender squeezes the picture frame on her desk, her partner’s picture frame would glow. In a test with a random user pairs, the subjects developed
interpersonal symbolic signals (the authors called this an ‘interpersonal language’) that were sent over the devices. Users created different combinations of light intensities, colors, and pulses and agreed with each other upon private meanings to their interaction. One user used a pulsing green and blue series to communicate “Good luck! A flashing red meant “Good bye, I am busy now.” Hansson and Skog present a concept for communication between strangers called “LoveBomb” [15]. The idea is to deliberately forbid contextual channels in favor of the transmission of ‘shock-waves’ that convey different affective signals by means of vibration patterns. Each device has two buttons representing positive emotions (a heart) and negative emotions (a tear), and upon activation, a random nearby device in a public space will vibrate (a rhythmic, or an arrhythmic pattern to represent the two affects). The device was not built, and the paper was based on a focus group study that suggested that the demographic group most likely to appreciate this would be teenagers. Oakley and Modhrain described the Contact IM design that employs a haptic phantom to allow IM users to engage in playful haptic interaction by playing a game as they communicate over IM [23]. Apart from a study showing that the interaction methodologies (IM and haptic game) did not interfere with each other, no study was advanced to show the affective interaction was achieved. Motamedi described a system designed for couples in long distance relationships [21]. The idea is to model the interaction as a kind of interactive ‘fabric screen’. Each person’s screen shows an out-of-focus video of his/her counterpart. When the screen is touched, the concomitant portion of the video comes into focus. The goal is to support playful visuo-tactile exploration of each other’s video to support intimacy. While no formal evaluations were done for the installation that was developed, general comments by colleagues who have tried the system were positive. Unfortunately, all the preceding are two-page notes and there does not seem to be any follow-up work on any of the systems supports affective interaction beyond the original system descriptions. The one common thread through the papers that had anecdotal studies, however, is the desire or propensities to communicate symbolic information through the systems.

Mueller et al [22] and DiSalvo et al [11] describe a ‘hug’ devices that support remote hugging. An inflatable koala bear serves as the input device. When it is squeezed, a paired inflatable vest inflates to simulate a hug. After 4 seconds, the hug ends, and a ‘kissing sound’ is sent back to the koala to express ‘appreciation’. The target use was to support intimacy between people in close relationships. A user test was not reported (the system was presented to a design workshop). The consensus was that the pumps for the vest inflation was too noisy and slow, and that the participants did not think that the system was useful in daily life. DiSalvo et al [11] developed a prototype hug device, called The Hug. The paper focuses on design, seeking to justify each design aspect from the shape of The Hug to it’s behavior. The device is essentially an ‘internet telephone’ where a ‘call’ is placed when its ‘left paw’ is squeezed, and the user says “hello”, and hangs up when the ‘right paw’ is squeezed and the user says “good bye”. Colored lights, vibration patterns, thermal fibers that radiate warmth, and sounds are used to present ‘effect’ that is detected when a paired Hug is squeezed, or stroked. While the design rationale was well explicated in the paper, no user study was reported.

Chang et al presented the ComTouch system designed to enable symbolic communicative function through a tactile interface [7] that was attached to cellphone and utilizes encoded haptic patterns in communication. They report preliminary studies in which benefits were found with the tactile channel for 1. Redundancy between voice and haptics for emphasis, 2. Mimicry of haptic patterns to indicate attention and camaraderie, and 3. Turn taking signals. Apart from mimicry, the haptic patterns were symbolic in nature.

In 2006, Bonanni presented TapTap [4] which simulates touch through vibration, pressure, short pokes and heat via a scarf-like device. The goal is to record and replay patterns of touch through a series of vibrator pads located in four pockets in the scarf. This device aims at providing emotional support ‘nurturing human contact’, but no user study was presented to support the claims. Tug n’ Talk [1] is a belt-buckle-like device that supports the notice from others to be sent in the form of a tug (when a chain hanging from one buckle is tugged, a chain connecting the buckle to the shirt of the paired device is pulled). No user study was reported for the device that featured force-feedback between the linked devices. The suggested uses were for passing messages of attention between people.

Rovers and van Essen designed two related devices HIM [27] and FootIO [28]. Both devices are used within instant messaging to convey hapticons (similar as emoticons), where encoded tactile patterns represent the emotion that people in chatting deliberately send out. We note that emoticons are not immediate expressions of emotion, but are part of a symbol system to communicate para-linguistic information through a channel of symbols [17, 26], and have to be interpreted for correlation with real emotions.

The Kiss communicator [6] supports users to send signals to show intimacy by squeezing and blowing the interface. A similar device, Connexus [24], allows users to exchange sign of intimacy through vibration and lighting. The device called Tele-Handshake [2] uses a force feedback device and shared visual interface to create the sensation of shaking hands between people over distance. HandJive [13] is a remote haptic entertainment interface that allows users to compete or collaborate, where the force feedback technique provides the sensation of moving a physical object.

Several observations from these work reviewed above include: 1. Some of the systems were designed with symbolic communication as integral components in the meaning of
touch; 2. Even when symbolic communication was not specifically prescribed, users tend to use the systems to transmit deliberately encoded messages, turning a rich human touch system into a low-bit-rate signaling tool; and 3. Few user studies were reported on the affective use of the systems, making it hard to derive design principles for enabling immediate affective interaction through remote touch.

**DESIGN OF A REMOTE TOUCH INTERFACE FOR IMEDIATE CONVEYANCE OF AFFECT**

We believe this dominance of symbol is because of lack of contextualization. Touch, by nature, has the capacity of carrying immediate affective information. However without contextualization, it will be reduced to a low-bit symbolic channel and lost its immediacy in conveyance of affect. A key aspect of designing a remote touch interface for immediate conveyance of affect is to provide context channel.

Context for touch may be divided into three categories with different time-scales of influence. At the longest timescale, culture, personal styles, and the culturally defined appropriateness of behavior in specific places (e.g., touch in bedrooms with closed doors have different meaning than similar touches in an open hallway). Secondly, the characteristic of personal relationships contextualize touch between people, but these relationships grow and transform constantly. Third, even within constant culture and relationship, the meaning of touch changes moment by moment, typically contextualized by the content of a verbal channel.

**Design Guidelines**

We address design to support the third class of contextualization. We advance two design guidelines: 1. The touch channel should be coupled with a verbal communication channel; and, 2. No pre-defined symbolic meaning is assigned to digitally mediated touch interaction – the users are free to construct their own meaning. By not assigning any explicit meaning of touch interaction, we expect to be able to study how people use touch as an immediate channel to convey emotions.

**Target Touch Interaction**

The design space of mediated touch is huge and the design dimensions include touch locations, patterns, duration, force, heat and so on. As a first step, we choose holding/squeezing an upper arm as our mediated target. There are two main reasons: first, upper arm is a more public body area, i.e. NVBP [18]. People in different relationships from spouse to friends will feel comfortable to convey emotions by touching upper arm; second, the meaning invoked by touching upper arm is relative rich. With different force and duration, touching upper arm could convey appreciation, support, affection, compliance, attention-getting, announcing a response, greeting, departure, and numerous hybrid meanings [18]. Hence, an upper-arm design will allow us more degree of freedom to study how people in different types of relationships to convey different meanings by holding other’s armband in a digital mediated manner.

**Physical Input Squeeze Device**

Recall that touch can be active or passive. For interactive touch the originator typically requires both proprioceptive and receptive (passive) information. We decide to use a rigid smooth object that fits the typical palm as our input device as it naturally supports passive touch response, and that this force is proportional to the squeeze applied to the receiver’s upper-arm.

**HAPTIC DEVICE IMPLEMENTATION**

We designed and developed a prototype of the digitally mediated touch device using Shape Memory Alloys (SMA) [29] and force sensor [31] shown in Figure 2. The device is composed of an armband embedded with 6 SMA wires, a squeeze device and a programmable microcontroller board. The input device triggers specific touch effects with patterns and the degree of user’s squeezing force, and the armband generates the concomitant touch and haptic effects via SMA wire’s contraction. The microcontroller board provides powers to SMA wires and sensors, acquires sensor data, and controls the SMA.

The armband is embedded with SMA wires. Each of the wires is tied onto both sides of the armband (see Figure 2 a and b). The SMA material is made of nickel and titanium, and it can undergo change in shape and hardness when heated or cooled. Its resistive heating property enables SMA to be heated directly with the electric current resulting in the kinetic motion of contraction in the armband. This
produces the squeezing force the armband wearer’s arm. As the SMA cools, it returns to its original length.

We use a commercially available ornamental ‘wooden egg’ for the squeeze input device. The egg is cut in half longitudinally and a thin-film Flexiforce force sensor is inserted between the halves to measure the users gripping force.

We employ a Basic Micro Inc controller board equipped with serial I/O and 16 input/output pins to drive both the input and output tactile devices. The output pins drive a set of ULN2803A Darlington transistors to produce sufficient current to drive the SMA wires. We employ a standard RS-232 to Bluetooth adapter to interface between the microcontroller and the PDA.

EXPERIMENT
To test whether remote touch accompanied with vocal context can convey emotions, we designed a between-subject story-telling experiment. In this experiment subjects are invited to listen to an emotive story recording which is told by a professional actress. The emotional state of subjects are measured before and after the experiment session as well as the degree to which they understand the story. The experiment includes two conditions. In condition 1, subjects listen to a story while remote touch will be applied on their upper arm at several points of the story. In condition 2, subjects listen to the same story recording without remote touch channel. We are interested in whether remote touch channel can make any difference to subjects’ experience of emotional state as well as understanding of information.

We use pre- and post-Positive Affective Negative Affective Schedules (pre- and post-PANAS) to measure the changes in subjects’ current feelings and emotions. This form is adopted from Positive Affective Negative Affective Schedules –Expanded form (PANAS-X) [34]. The scale consists of 60 words, and participants are asked to mark each word, using a scale, according to how they are feeling right now. The scale is 1 (not at all) to 7 (extremely). The internal consistence reliabilities (Cronbach’s coefficient alpha) are high, generally ranging from .85 to .90 for positive affect, and .85 to .90 for negative affect. Additionally, the correlation between positive affect and negative affect is generally low, ranging from -.05 to -.35, giving quasi-independence between positive affect and negative affect.

**Decision of Story and Touch Points**
A suitable story used in this experiment should be: 1) emotive so it has the power to affect people’s emotion state; 2) not widely known. If some subjects have heard about the story before it might reduce the reliability of our experimental results; 3) be attractive to a wide range of people with different backgrounds. We decide to avoid stories dealing with sensitive topics such as religions and politics. We chose and edited a story named Story of Stevie (http://brosia.com/StoryOfStevie.html). This story is emotion-laden and has a happy ending.

As we said, meaning of touch is largely shaped by context. How we embed touch signals with story content is important to the success of this experiment. Touch ‘episodes’ must be situated within the listener’s experience of the story to be contextual. Touch at different time will make a big difference on subjects’ experience of the remote touch.

The experimenters proposed 29 possible touch points in the story and invited 6 people to evaluate these touch points by rating the question “Is this an emotional high point in this story?” in 1-5 scale. Fourteen touch signals are chosen which has scores equal to or higher than 15.

**Participants**
We recruited study participant using SONA experiment management system maintained by Psychology Department at Virginia Tech and the graduate student mail-list. Subjects recruited from SONA system will be assigned one extra class credit as participation compensation while other subjects have no compensation. 16 subjects participated in our experiment, including 6 females and 10 males. The average age is 23.6. They are undergraduate and graduate students and university staff members. 14 are native English speakers, the other two have lived in an English-speaking country 20 and 8 years respectively. Experimenters assume that they have no language problems in study participation.

**Procedure**
Subjects are randomly assigned into one of two experiment conditions. Before they listen to the story, they are asked to fill a background information form, a pre-PANAS form. For subjects in with-touch condition, a trial session of experiencing remote touch device on their upper arm will be followed. The experimenter made sure subjects can feel touch sensation clearly and are used to it. Then subjects in both conditions will listen to a story recording that is articulated by a professional actress. As we mentioned before, subjects in with-touch condition were “remotely touched” by the actress from time to time according to the development of story while subjects in without-touch condition

<table>
<thead>
<tr>
<th>Negative Affect</th>
<th>Positive Affect</th>
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<tbody>
<tr>
<td>afraid, scared, nervous, jittery, irritable, hostile, guilty, ashamed, upset, and distressed</td>
<td>active, alert, attentive, determined, enthusiastic, excited, inspired, interested, proud and strong</td>
</tr>
<tr>
<td>Sad, blue, downhearted, alone, lonely</td>
<td></td>
</tr>
<tr>
<td>Happy, joyful, delighted, cheerful, excited, enthusiastic, lively, energetic</td>
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| Table 1. PANAS Subscales |
didn’t receive any touch. After the story-telling session, subjects are asked to fill a post-PANAS form and a 10-question quiz about the content of the story. A brief interview followed about how subjects in with-touch condition felt about the remote touch device.

Results and Discussion

Mood Change and Story Understanding

Mood change was measured by the PANAS that includes four subscales: negative affect, positive affect, sadness and joviality. Table 1 shows the composition of different subscales. Two-sample T-Tests were run to determine the statistical significance of mood change across conditions.

On average, subjects in both conditions experienced negative mood reduction (condition 1 showed a reduction of 1.25 and condition 2 showed no change) and a gain in joviality (condition 1 showed a gain of 2.0 and condition 2 showed no change). Although the trends show negative mood reduction and increased joviality in the with-touch condition, our experiments did not show statistically significant results different across conditions. (Loss of Negative: T(12)= -0.86, p<0.20; Gain of Joviality: T(13)= 0.43, p<0.34). See Figure 3a and d. Our study showed no change in positive mood in either the with-touch or without-touch conditions (neither average reached 0.5, see Figure 3b).

Subjects in the with-touch condition experienced a loss in sadness (mean loss =0.75) while subjects in the other condition experienced a gain in sadness (mean gain=1). T-Test shows there is significant difference in change in sadness emotion across conditions. (Loss in Sadness: T(13)= -1.4, p<0.09). See Figure 3c.

Our study showed no difference in story understanding across conditions.

User Feedback

We performed a semi-structured interview at the end of the experiment for the eight with-touch subjects to gain further insights into their experience.

Three subjects reported that their acceptance/rejection of remote touch depended on emotional content. One said he felt more comfortable being touched in the sad part of the story rather than happy part since touch helps him to calm down and not feel alone when he is ‘sad or fearful’. Another subject felt that the ‘happy moment touches’ were unnaturally trying to compel him to be happy.

Two subjects also mentioned they prefer using remote touch with people they have pre-established or close relationship with. One subject said: “If it is more personal, happening at certain time between two more emotional connected (people), I will be better to visualize it.” Another mentioned he would prefer to use the device with his girlfriend or maybe his child rather than with strangers or even friends. It suggests people in a close relationship (romantic relationship and parent-child relationship) have more need of affective interaction technologies, like remote touch.

Discussion

Our results show that remote touch reduces sadness significantly. This is important since the highest density of touch occurs near the end of the story where the originally sad story transforms into a happy ending. Our results suggest that the touch amplified the effect of the story over the non-touch condition. While our results did not reach significance in the joviality measure, it did show a trend in the positive direction with touch. Likewise, the negative affect measure showed reduction in the with-touch condition as opposed to no change in the without-touch condition. This shows the effect of the device on such measures as sadness, downheartedness, and loneliness. The PANAS positive affect measures have more to do with excitement, alertness, attentiveness etc. – all of which relate to ‘positive energy’.
rather than the emotions in our story. Our interview results reinforce our interpretation that there was an emotional effect in the with-touch condition.

CONCLUSION
We argued that touch may be liberated from having to bear the symbolic communication load, and become a unique channel for conveyance of immediate affective interaction. We showed how this contributes to our understanding in designing tactile devices for effective communication of information and affect in tandem. Armed with this rationale, we have presented principled design for a digitally mediated social touch interaction system. Our in-lab storytelling experiment showed that remote touch can reduce sadness emotion significantly and has a trend to reduce general negative mood and to reinforce joiviality.

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