

Tactile Feedback in Mobile: Consumer Attitudes About High-Definition Haptic Effects in Touch Screen Phones

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1. Executive Summary

This study, the first to evaluate consumer attitudes about HD-haptic effects in applications designed for smartphones, found clear and measurable preferences for the technology. The findings confirm the value proposition for HD haptics-enabled phones and offer guidance manufacturers and developers can use when applying HD haptics to differentiate their products in the market.

The study employed quantitative and qualitative techniques to evaluate consumer attitudes about HD haptics in smartphones. The controls included devices that used industry standard haptic techniques and devices that did not have any haptic features.

The key findings include the following:

- **The vast majority of respondents (~ 90%) said they prefer mobile phones that offer HD haptics** compared to standard or no-haptics alternatives. Very few respondents said they don't care one way or the other about the feature. Among those who preferred the alternatives, a greater number preferred standard haptics than preferred non-haptics handsets.
- **Consumers have clear and measurable preferences for HD-enabled applications.** The study gave participants the opportunity to measure their preferences for haptic implementations in two representative games: Frozen Bubbles and Pinball. Overall, they preferred the HD haptic versions of each game compared to the controls. Further, the sophistication of the HD haptic implementation had a significant impact on their responses: their preference for HD options increased substantially, and across all performance parameters evaluated, when the implementation was customized to deliver specific rather than generalized tactile effects.
- **Haptics improves the user's application experience and HD haptic effects produce an even better experience.** The participants were given a chance to evaluate a HD haptic-enabled typing application that produces the sensation that the buttons move when touched. The participants said they prefer the option offering HD haptic effects.
- **Next-generation applications are perceived by consumers to have high value.** The study participants were introduced to a new concept for HD haptics, called "expressive alerts," which give the user the capability to use haptics to personalize the various types of messaging alerts and other notifications they receive on their phones. The suggested features had extremely high appeal and almost all participants said they were likely to use the feature if it becomes available on their phone.
- **The ability to customize and personalize a phone with HD haptics is very important to consumers** and therefore critical to the success of the technology in mobile phones. After testing the typing application, almost all participants expressed a desire to be able to increase or decrease the intensity of the touch sensation. The ability to customize alerts with different HD haptic sensations, especially to differentiate between personal and business messages, was important to the vast majority of participants.

This paper explains the context in which the study was conducted, the methodology used in the research and its most important findings, and presents recommendations that can be used to guide application development with HD haptic technologies.

2. Study Overview

Haptic technologies—which enable consumers to perceive sensations such as texture, vibration or other tactile qualities when using electronic devices—have become popularized in many leading product categories, such as the control pads for console games and automobile control panels.

Haptic technologies are installed in about 200 million mobile phones, but despite the sophistication of the handsets and the opportunities haptics offer for creating innovative and differentiating touch-feedback features, the capabilities have not been fully utilized.

For example, haptics are integrated into the core OS and application layers in many leading Android handsets, but the technology is used primarily to provide basic touch feedback for messaging or other basic user-interface functions, not to enhance features or applications. Haptics are not offered with the iPhone, even though the iPhone’s design specifications are considered by many to represent the current state-of-the-art for handset innovation.

Numerous studies have examined narrow aspects of the value standard haptic technologies bring to mobile devices, but no studies have yet evaluated the value that high-definition (HD) haptics adds to the devices or the potential value that next-generation applications, created with HD haptics, can provide. This paper presents findings from a controlled study conducted to establish the value consumers give to the integration of HD haptic features in mobile phones.

This paper defines industry standard haptics as haptics that are built with OEM- or vendor-supplied application programming interfaces (APIs); for handsets that use the Android operating system, standard haptics are provided by the Google API. This paper defines high-definition (HD) haptics as a haptic technology that 1) uses a broad frequency response from an actuator to create very rich and high-fidelity haptic effects and also 2) integrates system-level and application-level software with the haptic technology; the two approaches, when used together, create a HD haptic user experience. This paper defines next-generation haptic applications as those that combine multiple sensory inputs to create an instinctive and compelling user interface and user experience; these user-interfaces communicate via multimodality or via visual, auditory and tactile feedback and use multimodality to create context aware applications.

The research was designed to ask the following key questions:

- Do users like haptics in their mobile devices?
- How do they respond to different levels of haptics, such as the industry’s standard haptic features now available in phones, or high-definition (HD) haptic features that provide more refined effects?
- Is a HD-enabled device more attractive to a user than a device that is not HD-enabled?
- If given a choice between an HD-enabled device and a non-HD-enabled device for their next phone, which would users prefer?
- Are the haptic technologies now used in the industry sophisticated enough to interest the market or do HD haptics provide a better user experience?
- How will consumers respond to next-generation haptic applications?

3. Methodology

This was an extensive study that employed both quantitative and qualitative techniques to assess consumer attitudes about HD haptic effects in mobile phones. A large sample of consumers participated in the central location test, which was conducted in person at a research facility in San Francisco, Calif. during October 2010. Travis Research designed and conducted the study.

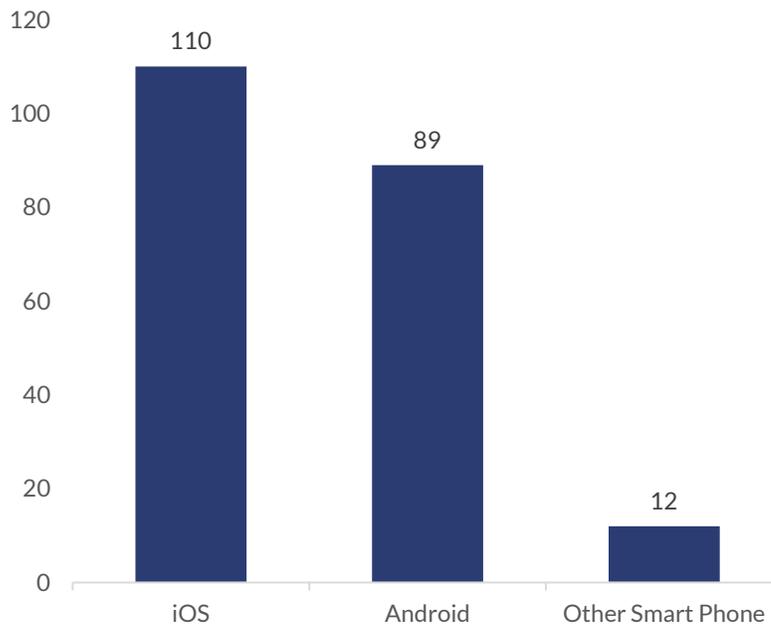
3.1 The Sample Selection Process

The study participants included 211 consumers who were identified through a random calling process and then selected according to strict screening and qualification criteria to ensure that all participants were familiar with touch screen phones.

In particular, the selection process was designed to ensure that the sample evenly represented consumers who had prior experience with haptic-enabled phones and those who did not. It was also designed to determine if iPhone customers, who have no experience with haptics, would show any preference for or against haptics. Researchers also used the selection process to ensure that half of participants represented iPhone customers and the other half represented non-iPhone customers who own touch screen phones that employ industry standard haptic features. The sample selection procedures achieved this configuration.

The panel selected included 110 current iPhone users and 101 people who are current users of non-iPhone touch screen phones. Almost all (90%) of the non-iPhone participants use Android devices.

Figure 1 – Distribution of Personal Touch Screen Phones Owned by Participants



The selection process was also used to ensure the participants represent specific demographic characteristics. The target demographics included the following:

- The 19-49 age group, with half in the 19-29 segment
- Even distribution according to gender, with no more than 60% of one gender representing the iPhone and non-iPhone groups
- Plays a game on their phone at least once per month, with the majority playing games three or more times per month

- Sends an email or text message from their phone at least once per day, with the majority sending three or more per day

The panel selected met all of the demographic targets required for the study. The screening process also eliminated those who had participated in a focus group or in-person research effort within the past six months and those who are employed in an industry or business that would have competitive interest in the technology studied or the research project.

For additional demographic breakdown of study participants, see Section 9: Additional Data.

3.2 The Participants' Smart Phone Experiences

The participants selected for the study are experienced smart phone users. On average, they play games on their devices on 15 or more days per month; download 9 to 10 applications per month; and send about 40 messages per day.

Because iPhones have been on the market longer than other types of touch screen phones, and because non-iPhone devices from various manufacturers continue to enter the market, the iPhone users participating in the study had more experience with their devices than the other participants.

In general, iPhone users owned their devices for twice as long as the non-iPhone participants: an average of 14.5 months and 7 months, respectively. More than two-thirds (67%) of the participants who own iPhones indicated they had their devices for six months or more. Nearly two thirds (60%) of the non-iPhone users had their devices for less than six months.

3.3 Test Set-Up and Procedures

In general, the tests were designed to assess the participants' reactions to HD haptic features installed on smart phones and their preferences for HD haptic enhancements in specific applications compared to alternatives currently in the market, which include handsets that do not offer haptics and handsets that offer standard haptics. The tests were conducted in small group sessions, managed and led by a proctor, with 6 to 8 participants involved in each session. Each session began with a 10-15 minute pretest survey to gather demographics information; the handset testing sessions lasted about 30 minutes.

The tests were set up to compare the participants' reactions to HD features installed on demonstration handsets against two controls: 1) handsets employing standard haptic technology and 2) devices that do not offer haptic features (no-haptics).

The phones tested in the study all used the Android OS. Two sets of phones were used:

A touch screen handset with HD haptics and an identical handset that does not offer haptic features (the non-haptics phone). These devices were used in the study by participants who are current iPhone users. The devices made it possible to compare attitudes about the HD haptics experience against a non-haptics experience for those who have not been exposed to haptic features previously.

A touch screen phone with HD haptics installed and an identical model with standard (default) haptics software installed. These devices were used in the study by participants who are non-iPhone users. The devices made it possible to compare attitudes about the HD haptic experience against a standard (default) haptics experience that these users are accustomed to.

The participants evaluated two games and one application. The games included Frozen Bubbles, which was tested by one-half of the study participants, and Pinball, which was tested by the other half of the study participants. The application evaluated was a typing exercise. This was evaluated by all the participants.

The participants were asked to play the game or use the application on their test and control handsets and immediately fill out a self-administered questionnaire seeking quantitative and qualitative attitudes and preferences about the features. They were also told about a new concept for HD haptics, called "expressive

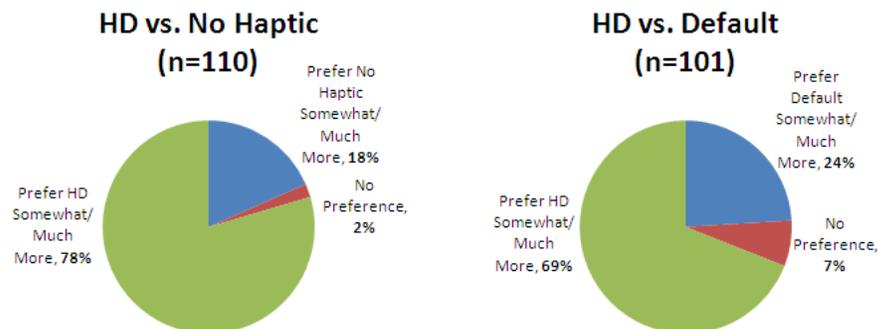
alerts,” and given examples of its potential use in various applications, including incoming message alerts, social network alerts, location-based alerts and calendar alerts. They were asked to address quantitative and qualitative questions about their attitudes and preferences for these various capabilities.

4. People Prefer Haptics

It’s definitive. Nearly everyone has an opinion about haptics and those opinions are favorable: people want HD haptics on their phones and they feel strongly about this.

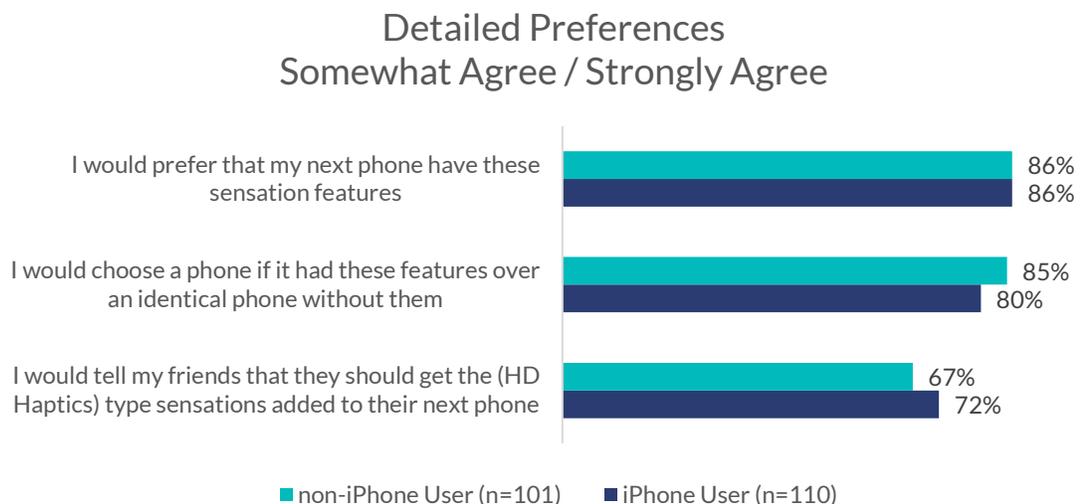
Whether they are iPhone users who are not ordinarily accustomed to haptics or non-iPhone users who do have standard haptics on their personal devices already, the vast majority say they prefer HD haptic-enabled phones compared to phones that use standard features or no-haptics. Very few participants said they had no preference. Among those who preferred the alternatives, a greater number preferred standard (default) haptics than non-haptic handsets. And iPhone users revealed that they have a higher preference for HD haptics than non-iPhone users have.

Figure 2 – Overall Preferences for HD Haptics



Further, if given the choice, nearly all users from both groups (86%) would prefer their next phone to have HD haptics. More than 80% would select a phone with these features over an alternative that does not have haptics. Notably, the findings suggest that haptic features have the potential to sell themselves in the market. More than two-thirds of the participants said they would tell their friends to get the HD typing sensations added to their next phones.

Figure 3 – Detailed Preferences for Phones with HD Haptics



5. The Value Proposition: HD Haptics Makes Applications Engaging

The study revealed that consumers prefer popular games that are enhanced with HD haptics, especially when the games incorporate customized HD effects.

Two game applications were tested in the study: Frozen Bubbles and Pinball. Frozen Bubbles is a game that is commercially available from app stores. A version of the game that relies on HD haptics was tested against the same game installed on the control devices with standard settings. Standard haptics does not support haptic capabilities for gaming applications, and as a result, users testing Frozen Bubbles on standard settings did not experience any haptic effects. In the game tested, HD haptics is provided when a player shoots a bubble, when bubbles collide or when the bubble patterns are matched. Overall, users preferred the HD haptics-enabled version. They also found it to be more engaging with HD haptics versus no haptics.

Figure 4 – Frozen Bubble and Pinball Games



“Best feature is to identify specific contact by having particular vibrations. Bubbles game was more realistic by having vibrations.”

(iPhone User)

Unlike Frozen Bubbles which was not designed with haptic effects, the pinball application used in this study was custom-designed with specialized HD-haptic effects enabling the user to sense the texture of the game’s surface as the virtual pinball rolls over it. For example, the user could feel the difference between a smooth surface or surface simulating a metal grate. The customized game was tested against a non-haptics version of the same game installed on the control devices.

The majority of users testing pinball said the HD enhancements made the overall gaming experience better than the alternatives. The iPhone users, in particular, said it made the game more engaging compared to the no-haptics alternative. Among all users, there is greater willingness to purchase the game at an acceptable price

when Pinball is played on the HD phone versus the no-haptics options. The iPhone customers are the most interested of all participants in purchasing the HD-enhanced game.

“It makes it more interactive, especially when you can feel different sensations in the games. I liked feeling the pinball going over the metal grating.”

(Non-iPhone User)

Figure 5 – Preferences for HD Haptics vs. No Haptics in Pinball and Frozen Bubble Games

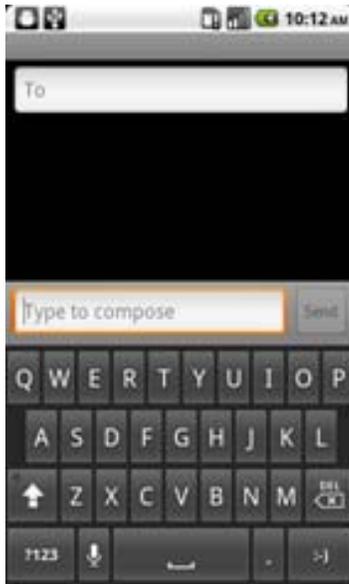
	Pinball			Frozen Bubbles		
	Prefer HD Somewhat/ Much More	No Preference	Prefer No Haptics Somewhat/ Much More	Prefer HD Somewhat/ Much More	No Preference	Prefer No Haptics Somewhat/ Much More
Overall Gaming Experience	76%	5%	19%	55%	19%	26%
Gaming is More Engaging	75%	14%	11%	66%	17%	17%
Will Make Me Play Better	63%	26%	11%	40%	40%	20%
Purchase the Game at an Acceptable Price	70%	9%	21%	43%	38%	19%

In summary, users strongly preferred the HD haptics option versus non-haptics in both gaming applications. Interestingly, the pinball application, which was specially designed with optimized haptic effects, generated a higher level of enthusiasm overall, and significantly so, compared to the HD haptic effects used in the Frozen Bubbles game. The users’ preferences for the optimized HD haptics implemented in the pinball game resonated in all gaming attributes evaluated: the overall gaming experience, how engaging it is compared to the alternatives, if it helps the user play better, and if the user is likely to purchase it at an acceptable price.

6. HD Haptics Makes Virtual Keyboards More Realistic

HD haptic effects can be employed to make practical interactions on a phone more tactile. Consumers evaluating a standard Android keyboard say they prefer options that employ HD haptic effects compared to the non-haptics and standard haptics alternatives: With HD haptics, a virtual keypad feels more like a real keypad during the typing process.

Figure 6 – Standard Android Keypad



This test used the standard Android keypad included with the handset messaging application. The keyboard was enhanced with HD haptic features to give the user the sensation that they could feel the buttons when typing. Study participants typed a scripted message into the messaging application’s virtual keypad to evaluate the HD haptics effect and compared it to the typing application installed on the control devices they were given.

There were many qualitative responses to suggest that users had some difficulty adapting to the keyboard layout, which was unfamiliar to them. Despite this confounding factor, the participants overall preferred the HD-enabled typing experience over the standard (default) and no-haptics alternatives.

“It gives me a sense of typing on a real keyboard. As it is now with my current iPhone, I only hear clicking sounds when typing. With the sensation feature I am less likely to make errors as I would feel more comfortable typing with the sensation features.”

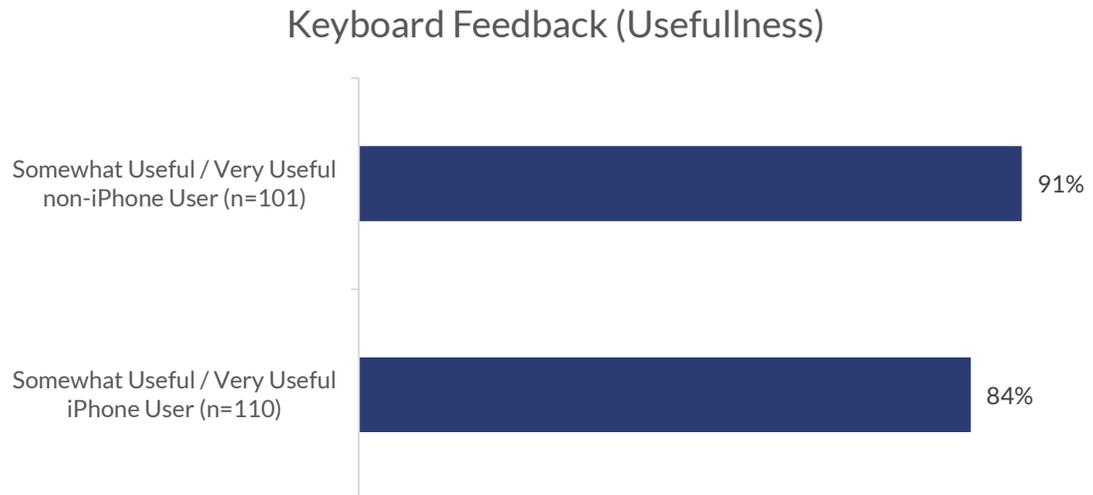
(iPhone user)

Figure 7 – Overall Typing Experience

	HD vs. No Haptics			HD vs. Default		
	Prefer HD Somewhat/ Much More	No Preference	Prefer No Haptics Somewhat/ Much More	Prefer HD Somewhat/ Much More	No Preference	Prefer No Haptics Somewhat/ Much More
Overall Typing Experience	61%	6%	33%	54%	7%	39%

Participants were also interested in the opportunity to customize their keyboard tools with HD haptics. When asked how useful they would consider the ability to customize their keypad features with HD haptics to create different types of touch sensations, such as soft, hard, electric, etc., the vast majority said this would be a useful feature. The feature was considered useful by 91% of non-iPhone users and by 84% of the iPhone users.

Figure 8 – Usefulness of HD Haptics Enabled Keyboard Customization



7. Consumers Place High Value on Innovative Next-Gen Apps

HD haptic technologies can be used to create compelling next-generation features for standard phone functions. Consumers participating in the study expressed substantial levels of interest and even excitement about the potential opportunity to personalize phone functionality with HD haptics.

The study evaluated interest and preferences for a next-generation HD haptic concept, called “expressive alerts.” The expressive alerts allow consumers to personalize the notifications they receive on their phone with vibrations or other tactile effects that make it possible to “feel” the notification as it comes to their phones. They can also apply different effects depending on the type of message received or the source of the message.

Expressive alert concepts evaluated in the study included the following: incoming message alerts for personalizing calls, email or text messages; social network alerts, for characterizing alerts for Facebook wall posts, messages, or tweets; location-based alerts, for notifications announcing Wi-Fi availability, a coupon from a nearby restaurant or a friend nearby; and calendar alerts, for differentiating appointments according to priority or type, such as personal or business.

The key finding: Participants indicated that they are extremely willing to adopt innovative HD haptic-enabled applications. More than 90% of all respondents said they are likely to use the feature if it becomes available on their phone.

Figure 9 – Overall Value of Expressive Alerts

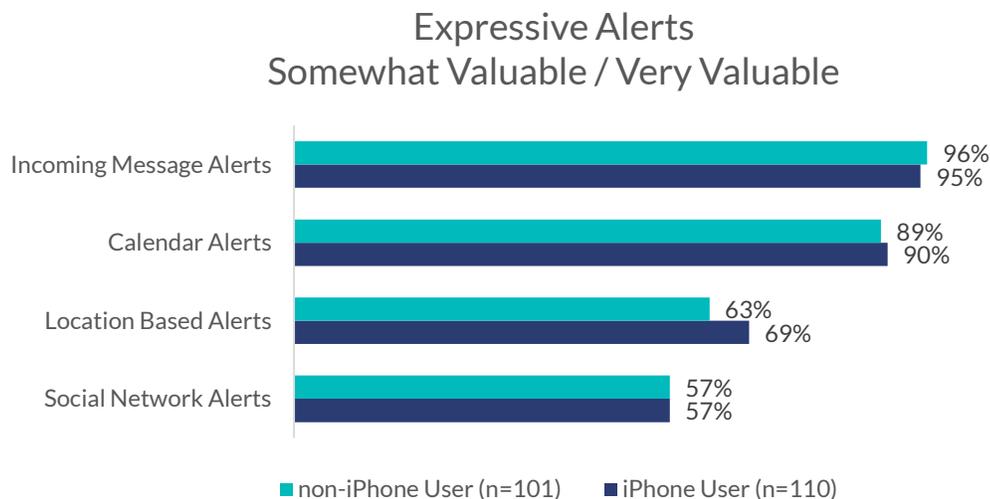


“I like that there are multiple alerts you can choose and use them for important text messages, phone calls, appointments. This is very helpful when you cannot have the volume up on your phone.”

(iPhone user)

The study yielded additional metrics to characterize user interest in the specific expressive alert categories evaluated. For example, it found that expressive incoming message alerts have extremely high appeal: About 95% of iPhone and non-iPhone users consider these to be valuable. Expressive calendar alerts are also highly popular: About 90% of iPhone and non-iPhone users consider these to be valuable. Further, expressive location-based and social-networking alerts are well-received: A strong majority of users (69% of the iPhone customers and 63% of the non-iPhone customers) found these to be valuable.

Figure 10 – Value of Expressive Alert Categories



Importantly, the study participants appreciated that the expressive alert feature is an attribute their current phone doesn't have and they would greatly prefer a phone with HD haptic-enabled expressive alerts over their current phone. In fact, about three-quarters of the respondents expressed this preference. They expressed an equivalent preference for phones that offer expressive incoming message alerts and the ability to differentiate between business and personal calls.

Figure 11 – Preferences for Specific Expressive Alert Features

	iPhone Users (n=110)			Non-iPhone Users (n=101)		
	Prefer HD Somewhat/ Much More	No Preference	Prefer Personal Phone Somewhat/ Much More	Prefer HD Somewhat/ Much More	No Preference	Prefer Personal Phone Somewhat/ Much More
Alerts Overall	75%	10%	15%	78%	8%	14%
Incoming Alerts	76%	8%	16%	77%	8%	14%
Business vs. Personal Calls	75%	18%	7%	76%	14%	10%
Appointment Reminders	57%	25%	18%	66%	19%	15%
Friend is Nearby	55%	42%	3%	52%	40%	8%
Location Based Service Alerts	50%	41%	9%	46%	47%	7%
Wi-Fi Availability	49%	38%	12%	42%	44%	14%
Facebook Update Alerts	39%	49%	11%	41%	43%	16%

Interestingly, while participants were highly interested in expressive alert features in use cases they can relate to easily—such as incoming message alerts and the ability to differentiate between business and personal calls—they did not indicate a preference for expressive alert features for less familiar use cases. They were indifferent to expressive alerts pertaining to nearby friends, location-based services, Wi-Fi availability, and Facebook updates. Yet, despite the generally neutral reactions to these features, very few responded negatively. This is an area of interest for further research because it suggests that consumers are open-minded about innovative uses of HD haptics for expressive alerts. This open-mindedness should encourage developers to innovate with these features and presents another opportunity for future research.

Finally, the expressive alerts evaluation also suggests that these features can be used to create differentiating applications for market sub-segments because the respondents' attitudes about the various types of alerts varied according to age, income and gender. For example, location-based expressive alerts found greater appeal among older participants (those 30-40) compared to younger participants (age 19-29); location alerts appealed more to upper-income participants (\$60,000+) compared to lower income (under \$60,000); incoming-message alerts appealed more to males than females; and expressive alerts for business vs. personal calls appealed more to upper income respondents than those in the lower income category.

"I like the alert sensations. My current phone has the same alert sound and vibration for all contacts. (HD) would be helpful to know the importance of a call or alert without taking the phone out of the pocket."

(iPhone user)

8. Consumers Place High Value on Innovative Next-Gen Apps

Manufacturers and developers who are considering adding haptics capabilities to their mobile phone products should consider the following recommendations, which are informed by this study:

- Handset manufacturers that want to differentiate their devices should use HD haptic technologies to provide a better user experience.
- Handset manufacturers should provide users with the ability to customize the haptic settings on their device to provide both sensation control as well as UI personalization.
- Applications ultimately drive the user preference for haptics, and the best haptics implementations are those that tightly integrate haptic technology with system-level and application-level software to create a high-definition user experience.
- Application-driven devices that include gaming or other features that benefit from sensory feedback should include HD haptic technologies to create an instinctive and compelling multi-modal haptics experience that incorporates visual, audio and tactile feedback.
- The extremely positive response to expressive alerts documented in this study suggests that consumers are eager to embrace innovative new HD haptic applications. HD haptic-enabled next-generation features can provide killer apps and even new communication methods such as expressive alerts.
- The design of haptic effects must take into account the demographic characteristics of the target market for the intended applications and provide users with the capability to customize haptics settings for their applications.

9. Consumers Place High Value on Innovative Next-Gen Apps

Figure 12 – Application Usage Breakdown of Study Participants

	iPhone Users (n=110)	Non-iPhone Users (n=101)
Mean Total Messages (sent per day)	38.1	44.5
Mean Days Play Game (per month)	19	15
Mean Total Apps (downloaded per month)	9.2	9.7

Figure 13 – Demographic Breakdown of Study Participants – Sex

	iPhone Users (n=110)	Non-iPhone Users (n=101)
Male	53%	50%
Female	47%	50%

Figure 14 – Demographic Breakdown of Study Participants – Age

	iPhone Users (n=110)	Non-iPhone Users (n=101)
19 to 29	49%	53%
30 to 39	31%	28%
40 to 49	20%	19%
Mean Age	32.1	31.6

Figure 15 – Demographic Breakdown of Study Participants – Education

	iPhone Users (n=110)	Non-iPhone Users (n=101)
High School or Less	4%	9%
Vocational/Trade School	3%	1%
Some College or More	93%	90%
Some College	30%	37%
College Graduate	44%	27%
Attended Grad School	4%	8%
Graduate Degree	15%	18%

Figure 16 – Demographic Breakdown of Study Participants – Income

	iPhone Users (n=110)	Non-iPhone Users (n=101)
Lower	39%	52%
Under 20,000	6%	9%
\$20,000 but less than \$30,000	5%	10%
\$30,000 but less than \$40,000	5%	12%
\$40,000 but less than \$50,000	7%	8%
\$50,000 but less than \$60,000	15%	14%
Upper	61%	46%
\$60,000 but less than \$75,000	9%	13%
\$75,000 but less than \$100,000	18%	14%
\$100,000 but less than \$150,000	13%	7%
\$150,000 or more	21%	12%

About Immersion Corporation

Founded in 1993, Immersion (NASDAQ: IMMR) is the leading innovator in haptic technology; the company's touch feedback solutions deliver a more compelling sense of the digital world. Using Immersion's high-fidelity haptic systems, partners can transform user experiences with unique and customizable touch feedback effects; excite the senses in games, videos and music; restore "mechanical" feel by providing intuitive and unmistakable confirmation; improve safety by overcoming distractions while driving or performing a medical procedure; and expand usability when audio and visual feedback are ineffective. Immersion's TouchSense technology provides haptics in mobile phone, automotive, gaming, medical and consumer electronics products from world-class companies. With over 1,000 issued or pending patents in the U.S. and other countries, Immersion helps bring the digital universe to life. More information on Immersion's TouchSense[®] technology at <http://www.immersion.com>

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