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Privacy versus Functionality

Striking the balance

NUANCE

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Introduction

Today's technical basis for creating satisfying and safer driving experiences has reached a new peak: Advanced natural language understanding (NLU), artificial intelligence (AI) technologies, and the connected car's access to a multitude of data – their combined potential theoretically opens the door for features that are specially tailored to each driver and provide a high degree of personalization.

In practice, there are quite a few obstacles on the road to features that rely on collecting, sharing, and processing vast amounts of data. Obviously, privacy laws, regulations, and security considerations have to be taken into account. Moreover, and certainly not easier to deal with, the uneasiness of users with giving up privacy, sharing their data in exchange for new functionality has to be addressed.

Take, for example, Nuance's Smart Fuel, a Dragon Drive Domain with integrated AI technology: The driver needs to refuel. In answer to this request, the assistant will not just offer a list of gas stations. It optimizes the potentially large choice and comes up with a preselected list that takes into account the current fuel level and the required fuel type. The list also reflects the driver's preference for a specific brand, and even the preference for taking shorter detours versus finding the lowest price. For this feature to be effective, however, the system must be allowed over time to collect and access data in the car and to learn from the driver's decisions.

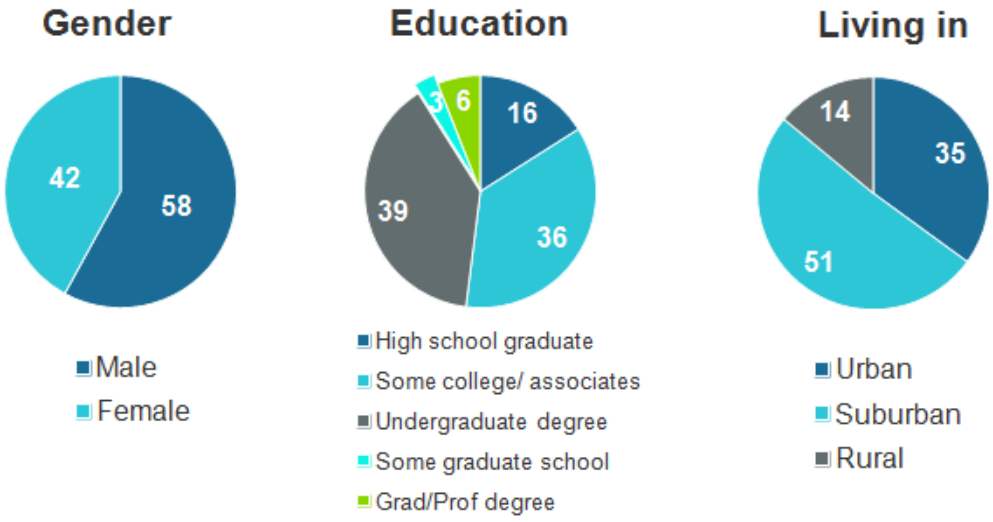
With regard to enhanced and safer driving experience the question is, how comfortable and willing are users to give up privacy in exchange for data- and AI-dependent features. To come closer to an answer, Nuance has conducted an online survey that presents features empowered by new technologies and specifically asks the users which benefits they would be willing to exchange personal data.

This whitepaper introduces the basic setup of the survey as well as details on how the participants reacted to the various questions on privacy and functionality. Finally, the results will be summed up with a tentative look at the future of data-dependent features.

Survey setup

Set of participants

The online survey was completed by 100 US participants. The participants' gender, educational background and living conditions is fairly representative of the US population with only minor, negligible deviations.



Study setup: Participants

It should be pointed out that, with view to the US population and to potential customers, male participants are slightly over-represented. However, the survey results have shown little gender differences, so the skew can safely be ignored.

Questionnaire and survey methodology

Structure of the questionnaire

The questionnaire was structured in 3 sections that covered the following aspects:

– **Demographic section:**
  This section asked about the participant's gender, profession, and age and also gathered details on the person's living environment and mobility. These details allowed to evaluate the answers on privacy and functionality in terms of demographic categories, as e.g. gender differences.
– **Section on privacy:**
  Participants had to answer questions on what personal information they would generally be willing to share with their car system. None of these questions explained why or for what feature the data would be needed.
– **Section on functionality:**
  Participants were presented with intelligent features for the connected car system. After each presentation they rated the feature and indicated their willingness to share the personal data required for this feature.

The participants were divided into two groups of 50 participants each. Both groups started with the demographic section. One group – the "privacy first" group – was presented with the section on privacy first and had to answer the questions in the functionality section afterwards. The other group – the "functionality first" group – dealt with the functionality questions first and then went on to the privacy section.

With this breakdown, we wanted to find out whether the attitude towards sharing data changes when users know and have thought about specific features versus the other way around: Are users more protective of their data after they have intensively thought about privacy? Find a detailed presentation of the results in the following sections.

Question types

For the sections on privacy and functionality, there were two types of questions:

– **Yes-no questions:** In the presentation of the results, the reported percentage refers to those who answered **Yes**.
– **Questions using a 1-5 rating scale**, with 1 indicating strong disagreement and 5 indicating strong agreement. A result with a score of 3 indicates that most participants were neutral.

Results: Protecting privacy

This section of the survey investigated participants' willingness to share their personal data and to let the system learn about and adapt to their preferences. Below are the individual questions and their results. The results distinguish between the two survey groups defined above, the group that was first confronted with questions on privacy and the group that learned about new data-dependent features first. Both groups show a strong tendency to protect their personal data. However, some answers of the "functionality first" group reflect that these participants can connect the shared data to a specific feature and are therefore more willing to give up some privacy.

What would you share with your car?

Participants were informed that the shared data was strictly confined to the car: It would not leave the car and would not be accessible in the cloud. In this section, each of these is data that the user would have to enter directly into the system, possibly while creating a user profile, or during a setup process.

Information	Privacy section first	Functionality section first
First name	76%	86%
Last Name*	**34%**	**62%**
Social Security Number	0%	4%
Birthday	48%	48%
Home city	84%	90%
Home state	84%	86%
Home street address	58%	68%
Work city	76%	76%
Work state	72%	74%
Work street address	62%	64%
Credit card brand*	**10%**	**56%**
Credit card number	2%	10%
Preferred method to pay for parking/fuel*	**36%**	**72%**
None of these	10%	4%

Survey results: Sharing with car – Personal data
* Bold font and asterisk marks significant differences between the two groups

We see that users trend towards being more likely to share more data when they are in the functionality first group, though only last name, credit card brand, and preferred method to pay for parking and fuel are statistically significant. In

the second section on functionality, credit card brand and preferred payment method have specific use cases that users evaluated, so we suspect that given the proper use cases, users would likely share more information. Note that most of this data (with the exception of social security number, credit card number, and birthday) are relatively low-risk to share.

What would you sync from your phone?

Participants here were asked what information they would allow the phone to sync with their vehicle. Some of these are already requested by many cars today, such as contact names and phone numbers.

Information	Privacy section first	Functionality section first
Contact names	70%	84%
Contact phone numbers*	72%	88%
Contact relationships (spouse, brother etc.)	40%	50%
Contact profile pictures from Facebook	32%	48%
Calendar	50%	56%
Messages, full message history	20%	32%
Messages, incoming while driving	48%	60%
Calls, full call history	30%	42%
Social Media*	**26%**	**46%**
None of these	14%	10%

Survey results: Sharing with car – Synchronizing from phone
* Bold font and asterisk marks significant differences between the two groups

We see a similar trend to what we saw before: participants trend more toward a willingness to share information from their phone in the functionality first group, though only links to social media accounts are significantly different. All-in-all, most notably, this is the first category where we ask for information that relates to people other than the driver.

What do you allow the system to learn about your preferences?

Finally, we asked participants if they would allow the system to learn things about them over time as they use the system.

Information	Privacy section first	Functionality section first
Type of fuel purchased	76%	80%
Gas stations distance from route	84%	88%
Average fuel level when filling up	86%	84%
Time and place you call contacts *	**14%**	**40%**
Geospatial location history	38%	56%
Navigation destination history	40%	78%
Music player history	70%	66%

Survey results: Sharing with car -- Preferences
* Bold font and asterisk marks significant differences between the two groups

The fuel-related and music-related items were widely viewed as acceptable to learn by most participants. However, the timing and navigation/geospatial items were less likely to be shared by those in the privacy first group. The same trend emerges once again for these, where those who were exposed to the functionality first were more likely to share this information. While the time and place contacts were called is the only statistically significant difference, the geospatial and navigation destination history both are *very* close statistically, indicating that this type of tracking is acceptable if users see it being used for a valuable use case.

Results: Rating functionality

In this part of the survey, participants learned about possible new features, had to rate their value and were asked about their willingness to share data in exchange for this feature.

Let it be said from the start: For most of the presented features, the tendencies of the two groups were the same, so the results are collapsed and displayed as a single group. Significant differences between “Privacy first” and “Functionality first” participants only occurred for one feature, the **Intelligent navigation suggestions.** This is driven by the functionality group having a lower likeability and value rating for this, though we do not have sufficient data to understand why, and it’s unclear to us why this may be the case.

This section begins with this exception and then moves on to the other use cases and their ratings.

Intelligent navigation suggestions

Situation:
The driver initiates a 300 mile drive with enough fuel for 200 miles.

System knowledge requirements:
– Length of journey
– Range with current fuel level
– Gas prices from a content provider.
– Driver preferences, learned from previous behavior:
  - Fuel type
  - Average lowest fuel level
  - Accepted deviation from route
  - Price sensitiveness
  - etc.

New feature in exchange:
With access to this data, the system can provide fuelling recommendations that are optimized to time, distance, brand, and price.

Information	Privacy section first	Functionality section first
Like this feature*	**98%**	**86%**
Feature is rated as valuable (1-5, 3 is neutral)*	**4.52**	**4.08**
Proactive notification is rated as acceptable (1-5)	4.64	4.32
Willing to provide payment preference	70%	74%
Willing to have average lowest fuel level monitored	92%	92%
Willing to have price sensitivity tracked	92%	90%

Survey results: Rating functionality – Intelligent navigation
* Bold font and asterisk marks significant differences between the two groups

Overall, participants were positive about this idea, and were willing to share the necessary information. As mentioned above, it's unclear why there are these differences between the groups, but the numbers show that despite this, most are still interested in this concept.

Intelligent parking suggestions

Situation:
The driver asks for parking options.

System knowledge requirements:
– Car specifics (e.g. height)
– Driver preferences, learned from previous behavior:
  - Parking type: lot, street, garage parking
  - Price sensitiveness
  - Accepted distance from destination
  - etc.

New feature in exchange:
With access to this data, the system can provide optimized parking recommendations:
– Unsuitable parking options (e.g. height requirements) are filtered out or deprioritized.
– Best guess for parking is offered up front.
– Optimized list is presented if best guess is rejected.

Information	Groups pooled
Like this feature	78%
Feature is rated as valuable (1-5, 3 is neutral)*	3.92
Recommendations are rated as acceptable (1-5)	4.12
Willing to have distance/pricing monitored	82%
Willing to have parking type (lot, street) monitored	76%

Survey results: Rating functionality – Intelligent parking

This, once again, shows a new feature that participants were excited about. When presented in this format, most users are willing to share the required information to make this use case a reality.

Intelligent contact suggestions

Situation:

There are three contacts named Ashley. The driver just listened to an incoming message from one of them. The driver then says “Call Ashley.”

System knowledge requirements:

– Knowledge about recent contacting actions
– Access to contacts information
  - Driver preference, learned from previous behavior: Contact the recently contacted person

New feature in exchange:

With the current solution, the system has to ask the driver which Ashley to call. For the new feature, AI learning technology is integrated. The system can then provide a best guess based on the driver’s behavior and directly offer to call the Ashley who just sent a message.

Information	Groups pooled
Like this feature	63%
Feature is rated as valuable (1-5, 3 is neutral)*	3.42
Willing to have contact’s Facebook profile pictures displayed for incoming calls	44%
Willing to have geolocation monitored for best guess	47%

Survey results: Rating functionality – Intelligent contact suggestion

While still leaning positive, this is the first use case presented that had mixed results. Further investigation is warranted to determine why this may be the case.

Intelligent food suggestions

Situation:

The driver performs a search for a coffee shop or restaurant and receives a list of results.

System knowledge requirements:

– Knowledge about coffee shops and restaurants from the navigation history
– Data from Yelp rating, personal Yelp reviews, etc.
– Driver preferences from a user profile:
  - Cuisine preferences
  - Price range
  - etc.

New feature in exchange:

With access to this data, the system can provide optimized food recommendations:
– Best guess for coffee shop / restaurant is offered up front.
– Optimized list of coffee shops / restaurants is presented if best guess is rejected.

Information	Groups pooled
Like this feature	61%
Feature is rated as valuable (1-5, 3 is neutral)*	3.31
Recommendations are rated as acceptable (1-5)	3.57
Willing to link car to Yelp or similar services	52%
Prefer to enter preferences in profile	24%
Prefer to let system learn from search history	25%
Willing to update profile by search history	22%
Refuse the system to have the information	29%

Survey results: Rating functionality – Intelligent food suggestion

While this is similar to the parking use case above, this is viewed slightly less positively, but still shows some value.

However, we see something else interesting here. Users are given the choice between four categories:

– Setting up a profile
– Having the system learn
– Creating a profile and then have it updated through learning
– Refusing to share the information

The results show that users are split almost evenly between the four categories. This seems to indicate that for about three quarters of people, allowing the user to select the method is ideal; the other quarter is less convinced about this use case.

Intelligent calendar management

Situation:

– Situation a) The driver receives a message from a meeting facilitator saying that she will be late and that the meeting is postponed by 30 minutes.
– Situation b) The driver's journey takes longer than expected and they might be late for a meeting.

System knowledge requirements:

– Knowledge about navigation details
– Access to calendar, contacts, etc.
– AI technology to connect the information and draw conclusions

New feature in exchange:

With access to this data and the integration of AI technology, the system can offer following:

– Situation a) Ask the driver if they wanted to update their calendar to the new meeting schedule.
– Situation b) Offer to notify other parties that the driver might be late.

Information	Groups pooled
Like this feature	57%
Feature is rated as valuable (1-5, 3 is neutral)*	3.58
Willing to sync calendar	66%
Proactive proposal to send notifications is OK	53%

Survey results: Rating functionality – Intelligent calendar management

Participants were again slightly positive about this idea, but were nearly split evening on if it was OK to proactively send a notification. We have growing data that users have mixed feelings on how and when it's acceptable for a system to be proactive.

One other consideration is that people in many different types of jobs may not use a calendar in this way, and may not use a digital personal or work calendar. It is possible that investigating this with people who rely more heavily on their calendars would result in a better acceptance.

Conclusion and outlook

A final set of questions investigated the willingness to share data with the knowledge about who may have access to the data. For many participants it makes a difference whether data is only stored in the car or whether it is accessible by OEMs, tech partners or marketing.

A score of 5 would indicate that users were much more likely to share data in this circumstance, while a score of 1 would indicate that they were far less likely to share it than they previously reported. The results show, not surprisingly, that participants are more reluctant to share their data when more parties are involved in using this data. Specifically, when they know it stays in the car, they become even more likely to share data. When the OEM is the only party accessing data, they are no more or less likely to share it. When tech partners and marketing get involved, they become less likely to share the data.

Condition	Groups pooled
Data is deleted every time I leave the car	3,48
Data stored in the car only, never sent to the cloud	4,11
Data sent to OEM, no tech partners, no marketing	3,03
Data sent to OEM, shared with tech partners, no marketing	2,57
Data sent to OEM, shared with tech partners and marketing	1,56

Survey results: Sharing data with multiple parties

This tendency is in keeping with the rest of the survey: Users become less willing to share their data when sharing feels like they may be handing over control. This is obviously the case when data is very personal and when it is accessible to many parties.

Still, answers to the questions about data-dependent functionality also show that users are interested in many new features and experiences. The key is that the framing – or the way we present *why* we want data – matters. Their willingness to share data increases when they know how it will be used, and it increases further if they view the feature as valuable. This is especially true when data sharing concerns less confidential matters like connecting planned mileage and fuel level or learning about parking preferences.

To summarize, even though users are protective of their data, they are willing to share details and preferences that are not too personal, especially when they understand how we will use it. When they view a new feature as valuable their willingness to share data increases.

To venture an outlook on the future development: User expectation of the in-vehicle experience while driving are constantly rising and advanced features that include NLU and AI technology must become more prevalent. Having this in mind and considering how attitudes have changed rapidly over the past few years, how much users share with social media today, it is quite safe to assume that users will become more and more open to sharing their data in the automotive environment as well. In separate research, we've seen users becoming more and more open to sharing this data when they start talking through the implications, or when they consider how much data technology companies such as Google are already collecting. This builds on the idea that both the perceived value of what a user gets for sharing data and the way we frame our requests for data will influence the information drivers will share with their cars in the future.

Company background

About Nuance

Nuance Communications, Inc. (NASDAQ: NUAN) is seen as the leading provider of voice and language solutions for businesses and consumers around the world. Its technologies, applications and services make the user experience more compelling by transforming the way people interact with information. Every day, millions of users and thousands of businesses experience Nuance's proven applications and professional services.

Nuance is reinventing the relationship between people and technology through speech and language solutions driven by advances in Artificial Intelligence and cognitive computing. It has pioneered the evolution of speech recognition technology that today integrates Artificial Intelligence (AI) to transform the way people interact with the devices, systems, apps, and services that surround them. Every day, millions of people and thousands of organizations experience our technology through intelligent systems that can listen, understand, learn, reason and facilitate life and work. Our clients span large companies and organizations, including hospitals, banks, airlines, carriers and car manufacturers that leverage our technologies and services to make businesses and products run more smoothly and create a better experience.

Speech is one of the most natural and intuitive ways to interact with devices, applications and systems, lessening our reliance on the mouse, keyboard and touchscreen. We have developed a broad portfolio of speech recognition and Natural Language Understanding (NLU) technologies that integrate machine learning and big knowledge for the variety of systems and services that leverage virtual and collaborative assistant offerings across devices and services in the Mobile, Enterprise and Healthcare industries. Further, our Document Imaging business drives increased productivity and security for the world's largest enterprises that need to gain control over document capture and workflows.

About Nuance Automotive

Speech recognition, NLU, AI and predictive touch solutions from Nuance have pioneered many of the personal assistant technologies and intelligent systems in the devices we use every day from the world's leading brands – including mobile devices, cars, televisions, wearable devices, and now the emerging ecosystem of the Internet of Things. We deliver a more human experience with technology, keeping consumers better connected and informed – consistently adapting to and predicting their needs.

The Nuance Automotive business delivers automotive-grade solutions enabling drivers all over the world access to information and services and providing the safest, smartest and most natural user experience. Nuance's voice technology has been shipped in more than 160 million cars from Ford, Toyota, BMW, Mercedes, Fiat and other major automakers and is at the heart of over 14 million connected car experiences on the market today. Nuance's Dragon Drive provides the industry's most comprehensive suite of solutions for the connected car, giving automakers and suppliers the ability to integrate a natural language voice interface, content, and connectivity that is customized for their individual brand.

About Nuance DRIVE Lab

Opened in September 2017, Nuance's new user experience (UX) research center, the **D**esign, **R**esearch, **I**nnovation and In-**V**ehicle **E**xperience (DRIVE) Lab, is a hub for research and learning, and advancing user interfaces in cars, ultimately providing drivers with safer, smarter, more delightful in-vehicle experiences and giving automakers the ability to differentiate with excellent user experiences.

The DRIVE Lab serves as the core of Nuance's efforts to improve the user experience for both current and future automotive assistants. Key areas of the DRIVE Lab's research include driver needs and preferences, unique driver experiences and technologies, best design practices, and consultation of car makers and suppliers.