Blaise

Innovating person surveys using mobile devices within research program WIN. The role of CBS' Blaise®

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Communication tools and styles have changed drastically over the last ten years and are anticipated to continue to change in the years to come. Online communication has become the norm and the number of online devices, both fixed and mobile, has multiplied. Internet access is growing steadily as well as population coverage. Surveys have always followed communication trends with some time lag. Modes or devices are candidates for a survey, when they are adopted on a large scale by individuals, become a standard in formal communications and have personal identifiers that can be listed in some way.

In response to the emerging modes and devices, Statistics Netherlands and Utrecht University established in 2016 a joint research program on ICT innovation in person and household surveys. The program is named "Waarneem Innovatie Netwerk", which translates to Data Collection Innovation Network and is abbreviated WIN. WIN is linked to a special professor chair at Utrecht University, and IT and methodology researchers at both institutes make up the core WIN team. For specific topics, the core team is supplemented by substantive experts from Statistics Netherlands.

As a start, WIN focuses on the use of mobile devices in surveys. This focus is twofold: As tools to conduct online surveys and as tools to enrich survey data with sensor data. Online questionnaires that are fit for smartphones and tablets are already reasonably standard, but optimization for the smaller screen sizes and different navigation is still on-going. The evolution of mobile device questionnaires goes hand in hand with the migration of surveys to such responsive questionnaire designs and the evaluation of the consequences of measurement. Mobile devices also carry a range of sensors that allow for (semi-)automated collection of data that may enrich survey data. The use of sensor data in surveys is still in relatively early stages, but a number of topics such as health, time use and travel seem apparent areas where they may be useful. Furthermore, mobile device sensors may open up the door for hybrid forms of data collection where surveys are combined with existing (big) data sources, for instance by linkage based on location.

Naturally, ICT innovation in surveys leans heavily on survey tools. As one of the most often used tools by statistical offices, Blaise® is a valuable player and component. The survey tool plays a role in both future directions of innovation: as a tool to support mobile device surveys and as a tool to support sensor measurements.

In this paper, we discuss the role of Blaise 5. We give specifications of what functions and features it must and could have in the future. In the next two sections, we elaborate on the two directions, surveys and sensors. In the last section, we present an overview of the near and long-term prospects.

Mobile device surveys

Modes and devices affect answering behavior and may lead to method-specific measurement bias, item-nonresponse bias and break-off. These are all threats to the accuracy of survey statistics.

Comparing mobile devices to more traditional modes, two features strike as most disparate: screen size and navigation. Smaller screen sizes affect the visibility of survey items and the need to scroll. Partial invisibility of survey items may lead to confusion, underreporting of particular answer categories and respondent fatigue. Especially, very space demanding survey items such as grid/matrix questions have turned out problematic on smartphones. Touch navigation invokes a conflict between visibility on the screen and the simultaneous need to use the screen for navigation. Such navigation may lead to typing errors and respondent fatigue. Table 1 shows a number of criteria with which the fitness of surveys for smartphones can be assessed as Schouten, Blanke, Gravem, Luiten, Meertens and Paulus (2018) proposed in ESSnet MIMOD. Apart from screen size and navigation, they also consider interview duration.

Table 1: Fitness criteria

Dimension	Criterion	Operationalization
Screen size	Introductions	Number of items with introductions
		Number of items with instructions included
	Grid questions	Number of grids
		Average number of items per grid
	Question text	Number of items with > 20 words (excluding introduction text)
	# answer cat's	Number of items with > 5 answer categories
	Answer text	Number of items with > 10 words in at least one category
Touch navigation	Open question	Number of open questions
	Many answers	Number of items with > 25 answer categories
Duration	# of items	Total number of items
		Average duration of survey per respondent
	Household	Is survey a household survey? Yes/no
	Database	Does survey require interaction with a database? Yes/no
	Complexity	Number of (anticipated) items that require calculations by an average respondent, i.e. are cognitively burdensome
		Number of (anticipated) items that require consultation of personal documentation by an average respondent
	Enj-Rel-Bur	Response rate to traditional online devices

Average interview duration is considered to be a critical criterion in official surveys. They tend to be relatively long. To date, empirical findings show that surveys take longer on smartphones. Causes for this are the larger number of questionnaire screens and the navigation between them, which are indirect consequences of the smaller screen sizes.

What is the role of Blaise® in facilitating mobile device surveys? We see four such roles: First, as interview duration is critical, it is imperative that loading and processing of web pages happen at a speed respondents expect. Second, technical solutions for the most spacious survey items need to be supported. We think especially about grid questions where spreading all items over multiple screens as well as positioning them on one screen may lead to errors and/or break-offs. Third, as mobile device design is still evolving, Blaise® needs to support qualitative analysis of mobile device survey data by means of audit trails and other paradata. Such development tools are very useful to questionnaire designers and survey analysts. Fourth, Blaise® needs to continually enrich and supplement its style sheets and provide a range of templates.

Mobile device sensors

Mobile devices have a wide range of sensors, ranging from motion to location to humidity and pressure. These sensors can be combined, called sensor fusion, in order to obtain more advanced measurements. Examples are the volume of a room measured by the echo of an ultrasonic sound and the type of physical activity measured by motion sensors and location. Mobile devices may also interact with wearables such as smartwatches and activity trackers. Finally, mobile device sensors may be activated by near field communication or Bluetooth beacons. The sensor data that results may be very useful for survey topics that generally require great cognitive effort such as travel or time use, that demand for esoteric knowledge such as various forms of internet usage or that are hard to translate to questions such as health status. For this reason, survey institutes have started to explore the use of sensors. The appendix presents an overview of sensors.

Sensors can be initiated either through browsers or dedicated apps. The first is easier as no external program needs to be downloaded and activated, but is more limited in the employment of sensors. Furthermore, browsers vary mutually in what sensors they can talk to. Also for high-frequency longitudinal data such as time use or leisure, it is not logical to use a browser. Apps have been used to tailor measurements and interaction with respondents, but require an extra step through the app stores.

How can Blaise® assist? We see three roles. The first is with its standard (online) questionnaires. Currently, Blaise 5 questionnaires facilitate plug-ins that can derive and store sensor data to a limited memory size. Blaise® should support more extensive sensor data such as images, movies and sound. Second, it should also be explored what the boundaries in activating multiple sensors simultaneously through fusion are. The third role is more advanced and is in apps. Blaise 5 allows questionnaires to be translated to an app, but the resulting app has limited functionality and design options. For longitudinal measurements and more advanced navigation and data entry, the current app needs extension.

The near and longer future

In the preceding two sections, we noted seven activities in which Blaise® may expand its functionality and assist users and researchers. These activities have different complexity and urgency, and, consequently, a different schedule. For the coming year, we see the following as necessary:
1. Enabling Blaise 5 questionnaires to store larger sensor measurements;
2. Supporting more advanced presentation of matrix questions;
3. Ensuring fast loading of web pages on mobile devices;
4. Exploring the boundary of sensor fusion in browser-initiated measurements;

For the coming years, the following may be additionally achieved:
1. Enriching questionnaire styles sheets;
2. Constructing data analysis tools for smartphone response data;

In the long run, we see:
1. Expanding Blaise's app functionality to cover dedicated data collection and processing;

Blaise® and WIN are actively collaborating on the first two activities. This collaboration may and should expand to activities 4, 5 and 7. Activities 3 and 6 are more general and not specific to smartphones.

APPENDIX: Overview of sensors in mobile devices

Overview of the most common sensors and feedback mechanisms found in wearables and cell phones.

3D touch: This sensor measures the pressure exerted on the screen. Small objects up to 385 grams can be weighted. Only in iPhone 6S and 6S plus.

Accelerometer, gravity, gyroscope: A set of sensors measuring motion, acceleration and position of the device. Used for position tracking or step counters.

Ambient Light: Measures the intensity of the ambient light. More advanced versions also determine the light color or –temperature. Commonly used to adapt the screen brightness and color to the ambient conditions.

Bluetooth: Wireless communication protocol. Can connect to small low energy devices, such as wireless headphones, key fobs, smartwatches or smart scales. Also detects the presence of Bluetooth beacons.

Camera: Takes pictures or videos, or measures light intensity. Usable for image- or pattern recognition, scanning of QR- or barcodes and color analysis. Can also coarsely measure gamma rays, a form of radioactivity.

Camera Flash: Usually used as a flashlight or as illumination for pictures or videos. Can create stimuli that can be picked up by other sensors.

Cellular: The core of all cell phones. Used to make and receive calls and text messages. Strength and ID of cell tower broadcasts can be measured. With the knowledge of tower positions, the user location can be determined with a precision of ~500 meters. More advanced cell phones – almost all cell phones today – can also connect to the internet. The presence of the internet connection, as well as its speed (upload, download and responsiveness/ping), can be determined. Not often found in wearables yet.

Fingerprint: Some devices are capable of detecting fingerprints. The raw data is not accessible, but it can be used as identification or simply as a button.

GPS: The Global Positioning System. Dozens of GPS satellites circle the earth and broadcast beacon signals. By measuring the time-of-flight of the satellite signals, the distance to that satellite can be calculated. With four or more satellites visible, the position on earth can be triangulated. The precision is ~5 meters outdoors. Indoor performance is poor. The satellite signals also include time information.

Heart Rate: Measures the heart rate, usually optically on the finger (cell phone), wrist (smartwatch) or in-ear (headphones).

Humidity: Measures ambient humidity. Not very widely used yet

Magnetic Field: Usually used as a compass, but can also measure the strength of magnetic fields or can be used, within limits, as a metal detector.

Microphone: Detects speech and sounds that can be saved, streamed or analyzed. Can also determine loudness and detect ambient noise. Multiple microphones in one device allow for determining the directionality or distance of sound sources. This is used to filter out ambient noise in phone calls. Microphones can also be used to record the heartbeat or estimate lung function/spirometry.

NFC (near field communication): The same technology as contactless payments. Can be used to pay with the cell phone or smartwatch, as "contactless QR code" / "NFC tags" to change phone settings (muting) or trigger the start of specific apps. A phone can be a tag as well, so two devices can identify each other and initiate a data channel for communication.

Pressure: This sensor measures the ambient air pressure and functions as a barometer. The precision is so high, that height differences of a few meters (ground floor vs. first floor) can be detected. It is also used in combination with GPS for more precise height determination.

Proximity: Measures the presence of objects close to the screen, usually binary (object present or not). Switches off display and touchscreen during phone calls.

Screen: Display of static or dynamic images. Can also illuminate the surroundings. Commonly used for user interaction.

Speaker: Plays sounds or speech. Can be used for feedback to the user or in combinations with other sensors such as microphones.

Thermometer: Usually placed in or near the battery to prevent overheating. Measures the battery/cell phone temperature which might be higher than the ambient temperature.

Vibration: Feedback mechanism, induces vibration in the device. Can be used as feedback or combined with other sensors such as the accelerometer.

Wi-Fi: Usually used for internet access. Can detect the presence and strength of different wireless networks in different frequency bands. Measuring of connection speed (upload, download and responsiveness/ping) is possible.

Wireless Charging: Neither sensor nor feedback, strictly speaking. Some devices can be charged wirelessly over very short distances (1-2 millimeters). There are competing non-compatible standards, such as Qi and PMA for cell phones. The device can detect the presence of a certain charging station.

About WIN

In 2016, Statistics Netherlands and Utrecht University established a joint research program on ICT innovation in person surveys called WIN (an acronym for Waarneem Innovatie Netwerk in Dutch). The focus of WIN is on the use of mobile devices in surveys in two ways: To complete online questionnaires and to enrich survey data with passive and active sensor data. Questionnaire tools such as CBS' Blaise play a crucial role in such innovation. In this paper, we discuss the role of Blaise® now and in the near future.

About Blaise®

Blaise® is a software platform for survey data collection and survey processing and is designed to handle governmental and scientific surveys. Statistics Netherlands (CBS) is a highly regarded National Statistics Institution and the producer of Blaise. Stationed at the CBS offices in Heerlen, Netherlands, a team of dedicated software engineers and survey specialists make up the heart of Team Blaise. Together with CBS' methodologists, data analysts, questionnaire developers and survey managers they continuously work on innovating Blaise® while supporting their vibrant user community.

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