Large scale field operation test on automated driving systems
for Strategic Innovation Promotion Program(SIP)

The research on Pedestrian Accident Reduction

FY 2018 Summary Report

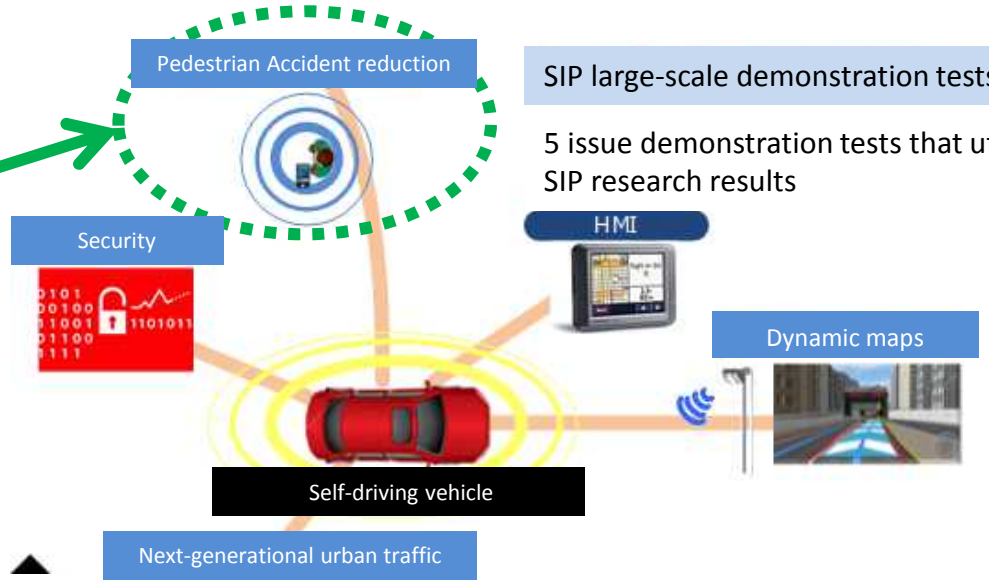
February 2019

NIPPON KOEI

1. Research overview

R&D overview	➢ **Conduct operation tests on "pedestrian Accident reduction"** in connection with SIP autonomous driving systems / large-scale test demonstrations. ➢ Conduct testing on mutual alert functionality of "vehicle-to-pedestrian communication technologies (V2P)" and "high precision pedestrian positioning technologies / action prediction technologies," **incorporating the technology in actual traffic environments and demonstrating the effectiveness at lowering pedestrian accidents.** ➢ **FY 2017 objective: To conduct functionality verification in a variety of settings and determine aspects of improvement in preparation for the next fiscal year.** ➢ **FY 2018 objective: To conduct demonstrations with general test-users and assess the effect on lowering pedestrian accidents in real traffic environments, determining issues with practical implementation.**
Research period	➢ FY 2017 winter pre-verification and FY 2018 autumn main demonstration are the control points of research. ➢ Maintain close collaboration with developers and remain flexible regarding schedule.

Demonstrating the effectiveness at pedestrian Accident reduction of "providing alert information" in real traffic environments



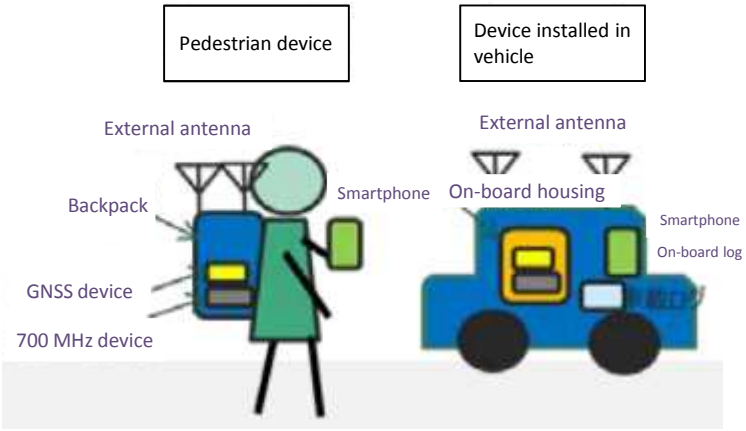
SIP large-scale demonstration tests

5 issue demonstration tests that utilize SIP research results

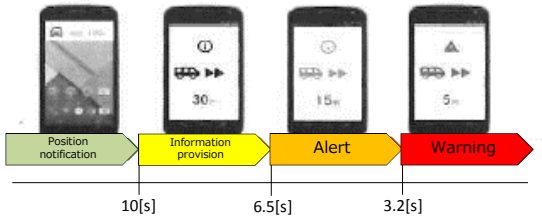
Ref) Equipment for Verification

Subject / Equipment

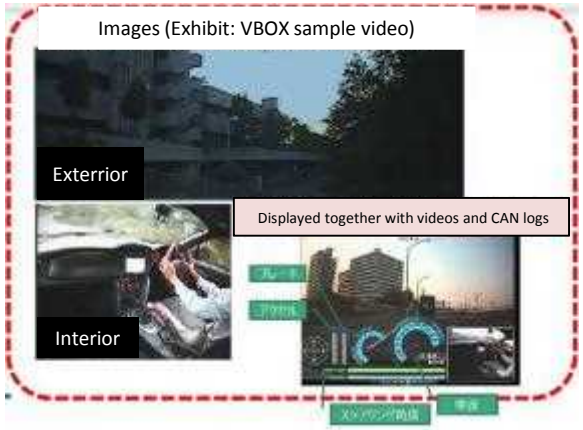
【Pedestrians: Pedestrian devices: 20 sets】
Smartphones with a “hazard detection app”
・Monitors the location data of its own device and another device (on-board device, etc.), calculates predicted Accident points, and issues stages of alerts based on danger level.
・Testing performed with the devices in backpacks.



【Drivers: On-board device: 5 sets】
Smartphones with a “hazard detection app”
・Install ITS antennas, GNSS antennas, etc.
・Power supply via the cigarette lighter socket.
・Video taken together with CAN data to monitor vehicle behavior.



Due to the specifications of the on-board equipment, the vehicles used are 3rd-generation Prius (XW30) 2010-2015.
⇒If the type can’t be used, other type would be substituted



2. Pre-Verification Result in FY2017

✓ - verify proper operation in scenarios requiring and not requiring support

(2018/2/13-15 ; Odaiba, Ariake)

Target accuracy was achieved, then phase successfully proceed to main verification

(i) Scenarios requiring support **(5 scenarios)** (ii) Scenarios not requiring support **(5 scenarios)**

Correct Operation Ratio
(# of correct operation samples/# of samples)

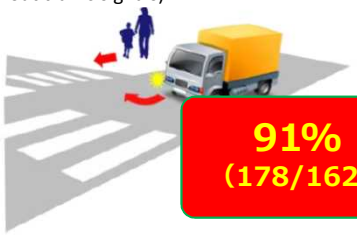
(1) Pedestrian crossing of non intersection part

94%
(231/247)

(2) Crossing of intersections with poor visibility

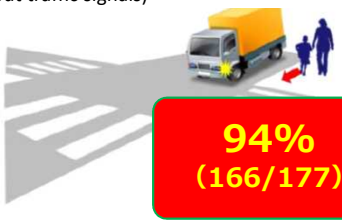
86%
(156/181)

(3) Right turns at intersections (both with and without traffic signals)



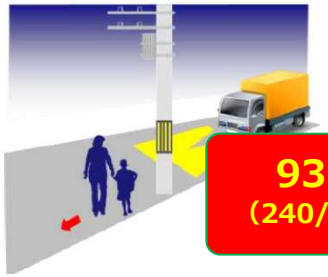
91%
(178/162)

(4) Left turns at intersections (both with and without traffic signals)



94%
(166/177)

(5) Roads without sidewalks



93%
(240/257)

Incorrect Operation Ratio
(# of incorrect operation samples/# of samples)

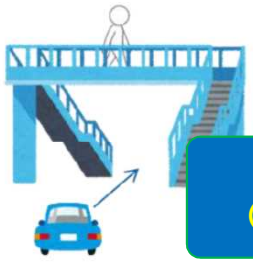
(1) Inside vehicles

1%
(1/132)

(2) Inside buildings

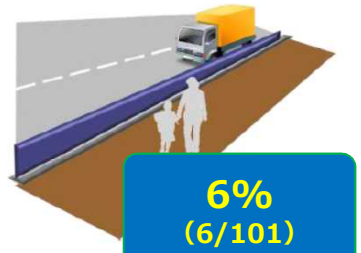
0%
(0/118)

(3) On pedestrian footbridges



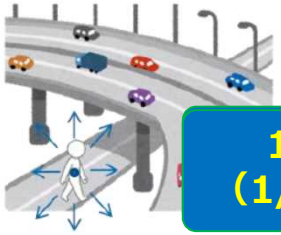
5%
(9/183)

(4) Sidewalks



6%
(6/101)

(4) Above and below elevated structures



1%
(1/94)

2. Pre-Verification Result in FY2017

Scenarios requiring support : approx.90% accuracy
Scenarios not requiring support : over 95%

Result

(i) Scenarios requiring support (5 scenarios)


Crosswalk of non intersection part


Intersection w/ Poor Visibility


Right Turns w/ Traffic Signal


Left Turns w/ Traffic Signal


Right Turns w/o Traffic Signal


Left Turns w/o Traffic Signal

(ii) Scenarios not requiring support (5 scenarios)


Inside Vehicle


Inside Building


On Pedestrian Footbridge


Sidewalk


Road w/o Sidewalk


Above/Below Elevated Structures

2. Pre-Verification Result in FY2017

Analysis

【Functional Problem】 Share with MIC/Panasonic

1)Improve mechanism of notifying “alert” “information provision” in right/left turn
- Too much notification of “intersection
  ⇒**Reduce frequency of support**
- No notification
  ⇒Improve Accident judgement cycle, **accuracy of tracking speed**

2)Review threshold of speed
⇒**Improve accuracy of tracking speed**

3)Improve accuracy of elevation; Reduce notification on sidewalk
⇒Try not to be operated improperly **(Reduce of notification frequency)**

4)Bad operation of equipment by bad connection
⇒**Improve USB connector etc.**

5)Big & heavy equipment
⇒**Reduce weight & size, school bag**

MIC ; Request to improve system another project “verification of V2P system using 700MHz” by Panasonic

【Operational Problem】

1)Flee-flow experiment is extremely difficult (Timing is not matched)
⇒**Adopting safer method**

2) Verification at high speed could not be conducted b/c of safety
⇒**Verification in test course**

3)Quantitative analysis under real traffic has some problems
⇒ **Verification in test course**
⇒ **Simulation implementation**

Main verification is conducted in test course(Jul.) & in public road(Nov.)

3.Main Verification Overview

Goal

- **Evaluate the effectiveness for pedestrian Accident reduction under real traffic, discover problems toward implementation by verification which subjects are ordinary people**

Expectation

①Visualize and analyze location of pedestrian/vehicle Information are provided correctly under dangerous situation?	・Visualize results by system (already developed)
②Compare behavior and awareness under dangerous situation Pedestrian, Vehicle Scenarios with/without the information	・**Main Verification①Analyze subjects' behavior modification in test course quantitively** ・**Main Verification② Analyze subjects' behavior modification in public road qualitatively by interviewing survey**
③Analyze behavior of pedestrian/vehicle in each scenario Compare behavior modification with the information	・Evaluate effect in 2 scenarios in which number of accidents is relatively high; "crosswalk of non intersection part", "intersection with poor visibility" in **Main Verification①**
④Select subjects considering age and attribute Compare behavior modification with the information	・Analyze results respectively; Pedestrian（child, adult, elderly）, vehicle(adult･elderly) ・Evaluate behavior modification with the information qualitatively based on age or attribute
⑤Estimate future effect	・Estimate future effect by simulation

※Verification in various traffic or bad weather was not conducted b/c of operation and safety

3.Main Verification Overview

Goal

- **Evaluate the effectiveness for pedestrian Accident reduction under real traffic, discover problems toward implementation by verification which subjects are ordinary people**
  - **Is notification provided to subjects properly?**
  - **Have subject's behavior changed?**
  - **Is there some difference by age ?**
  - **What is expectations and problems for implementation in society?**

2 verification tests were conducted

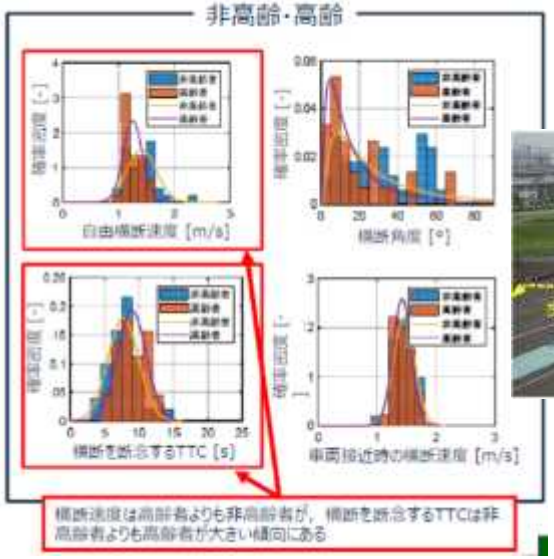
3 .Main Verification Overview

2 verification test

①Test Course 【Quantitative Analysis】

1)Conduct experiment at high speed. Analyze pedestrian & vehicle's behavior modification quantitively
1.Crosswalk of non intersection part（50km/h,30km/h）
2.Intersection with poor visibility (30km/h)

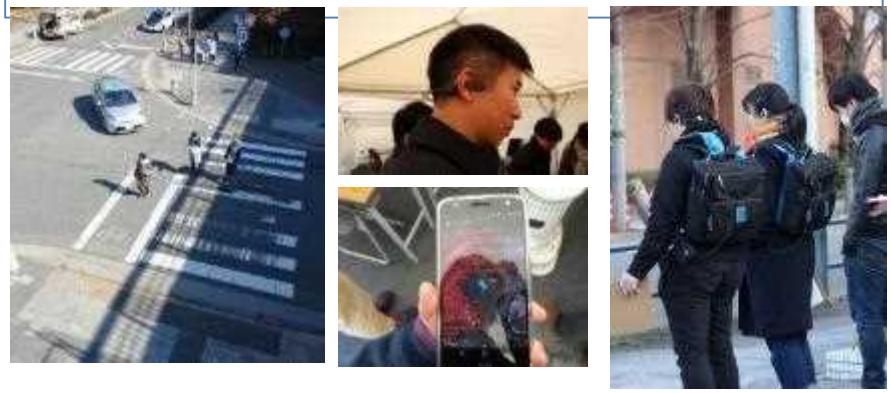
2) Acquire data to provide parameter to experiments by METI(JARI) "Development and Verification of Simulation to Estimate the Detail Effect of Pedestrian Accident Reduction"(2017, JARI)



※Verify by Pedestrian agent model using parameters vehicle/pedestrian with V2P devices

②Public Road（in Odaiba）
【Quantitative Analysis】

✓Verify effect of scenarios requiring support in public road
✓Conduct interview survey

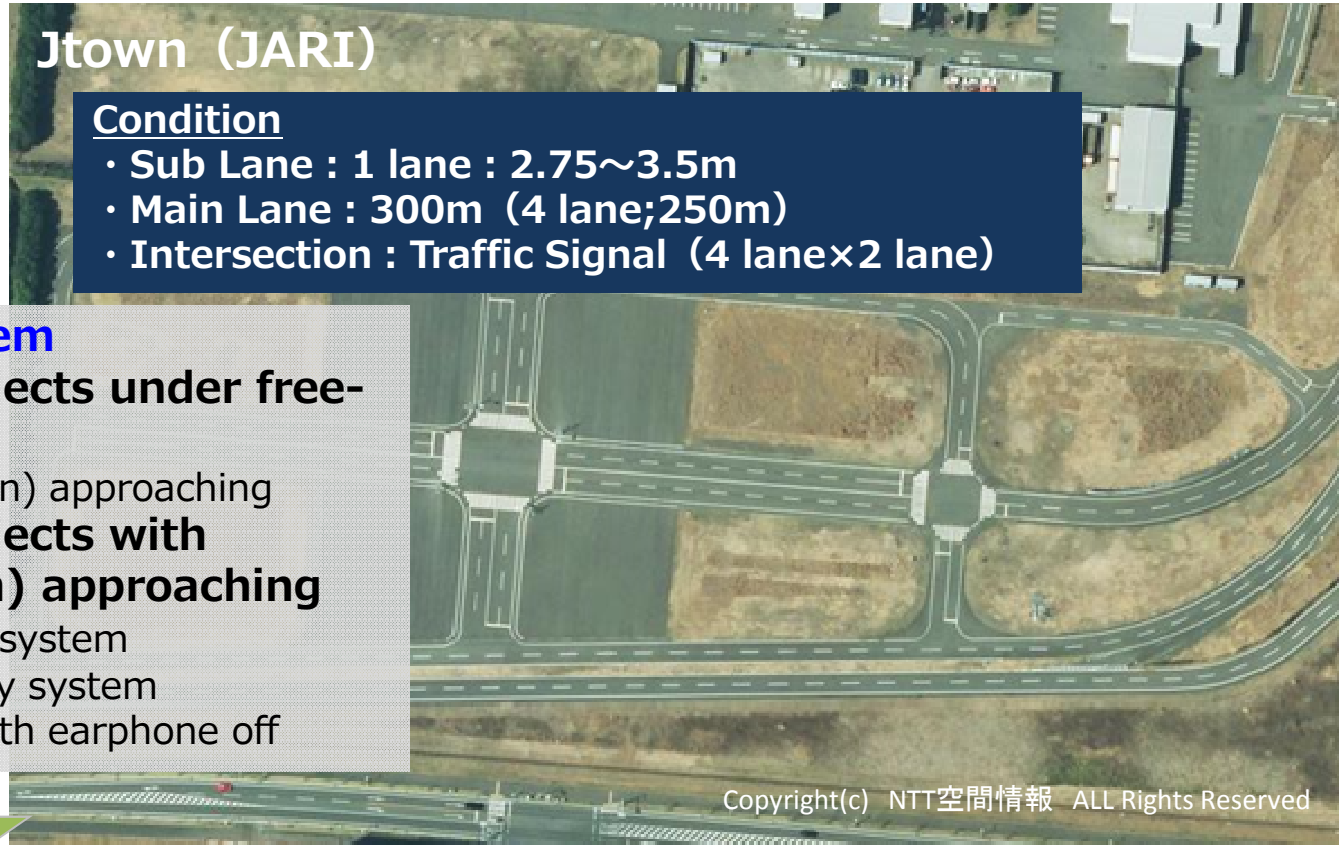


※Visualization system for V2P verification
By Nippon Koei Co., Ltd.

3.Main Verification Result（1）Test Course

① Test Course 【Quantitative Analysis】

▶Date
2018/7/20-22



■Experimental Item

①Attribute of subjects under free-flow
⇒No vehicle(pedestrian) approaching
②Attribute of subjects with vehicle(pedestrian) approaching
⇒w/ notification by system
⇒ w/o notification by system
※ Notification is off with earphone off

■Attribute

① **Pedestrian : Child ,Adult, Elderly**（16 persons each）
② **Vehicle : Adult, Elderly**
（ 16 persons each ）

■Parameter

① **Pedestrian** ：age, walking speed（free-flow/on crosswalk), ratio of confirmation of approaching vehicle
② **Vehicle** ： age, speed, timing of releasing accelerator/breaking, ratio of confirmation of approaching vehicle

3 .Main Verification Result（1）Test Course

■Scenarios

・Demonstrate scenarios below in which vehicle is approaching pedestrian, and monitor driver and pedestrian subjects' behavior modification

・Pay attention to safety measures（Establishment of ethics committee)

1)Crosswalk of non intersection part (50・30km/h)

2)Intersection with poor visibility (30km/h)

Experiment was conducted considering each driver and pedestrian subject's walking speed
Child: approx. 1.2m/s, Adult: approx. 1.4m/s, Elderly: approx. 1.3m/s

3 .Main Verification Result（1）Test Course

1)Crosswalk of non intersection part （30km/h） Pedestrian Verification

2)Intersection with poor visibility （30km/h） Pedestrian Verification

3)Crosswalk of non intersection part （50km/h） Vehicle(Driver) Verification

3 .Main Verification Result（1）Test Course

1)Crosswalk of non intersection part （30km/h） Pedestrian Verification

・Without Notification

3 .Main Verification Result（1）Test Course

1)Crosswalk of non intersection part （30km/h） Pedestrian Verification

・With Notification

3 .Main Verification Result（1）Test Course

2)Intersection with poor visibility （30km/h） Pedestrian Verification

・Without Notification

3 .Main Verification Result（1）Test Course

2)Intersection with poor visibility （30km/h） Pedestrian Verification

・With Notification

3 .Main Verification Result（1）Test Course

3)Crosswalk of non intersection part （50km/h） Vehicle(Driver) Verification

・Without Notification

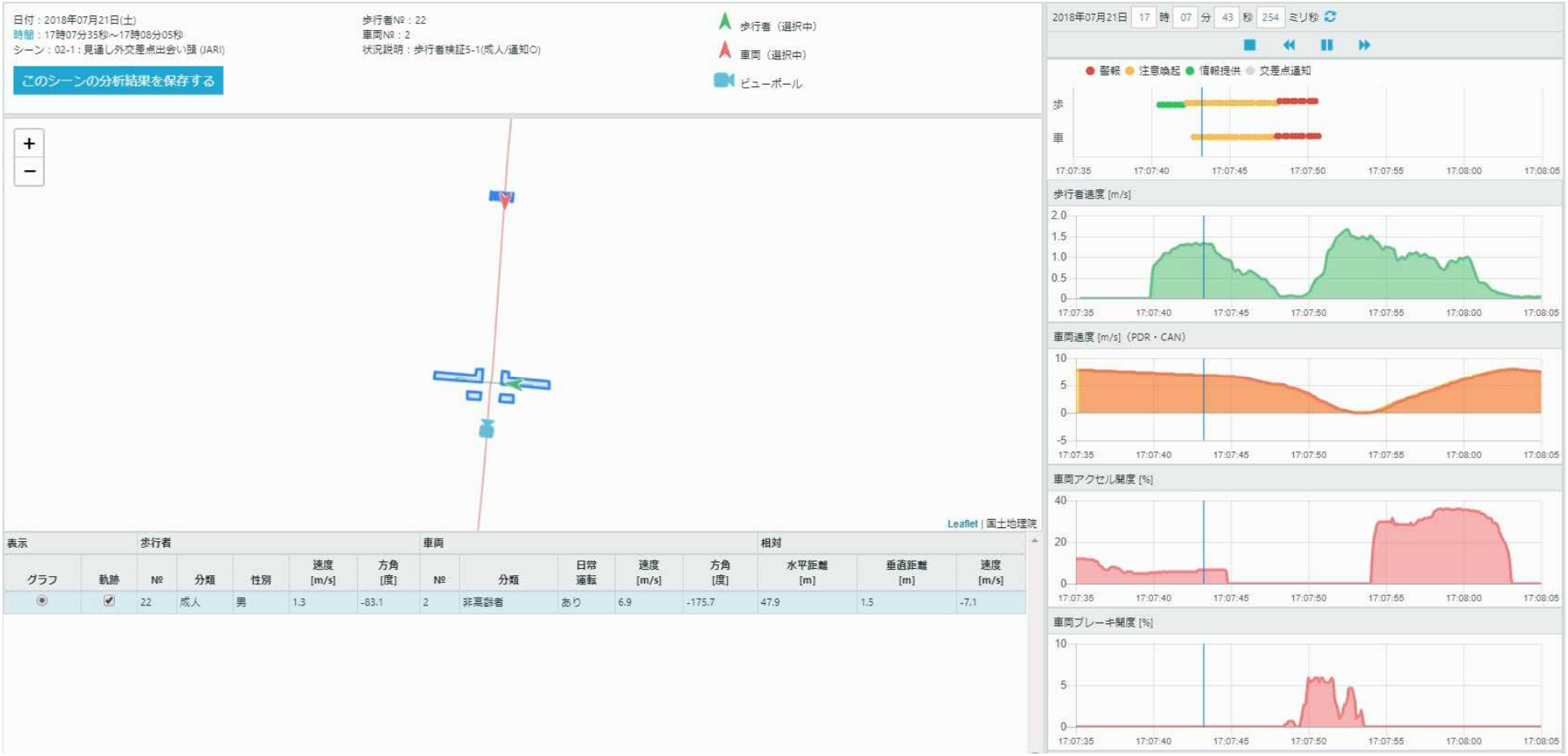
3 .Main Verification Result（1）Test Course

3)Crosswalk of non intersection part （50km/h） Vehicle(Driver) Verification

・With Notification

3 .Main Verification Result（1）Test Course

(Reference)



3 .Main Verification Result（1）Test Course

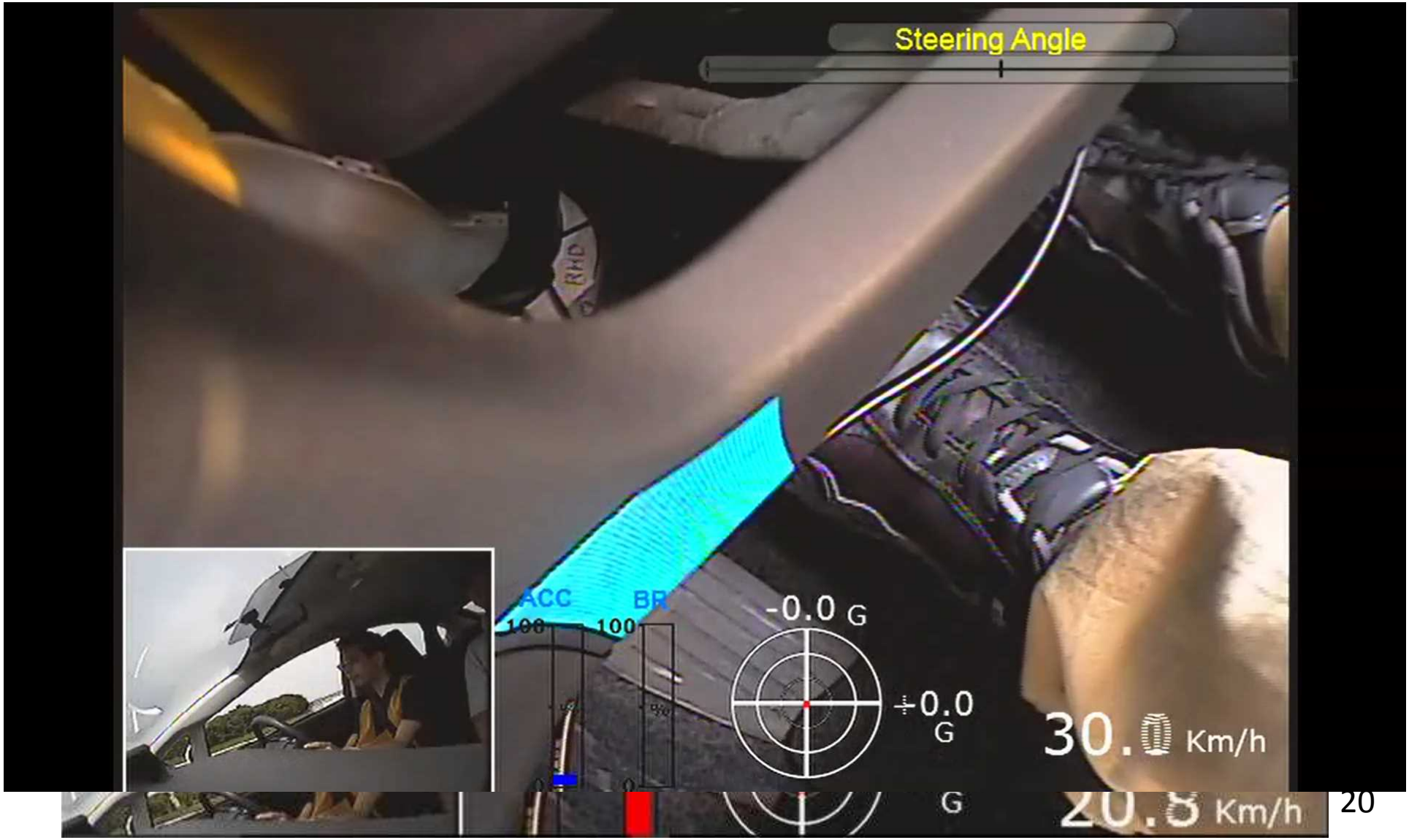
3)Crosswalk of non intersection part （50km/h） Vehicle(Driver) Verification

・With Notification

3 .Main Verification Result（1）Test Course

3)Crosswalk of non intersection part （50km/h） Vehicle(Driver) Verification

・Step on the brake with LEFT foot



3 .Main Verification Result（1）Test Course

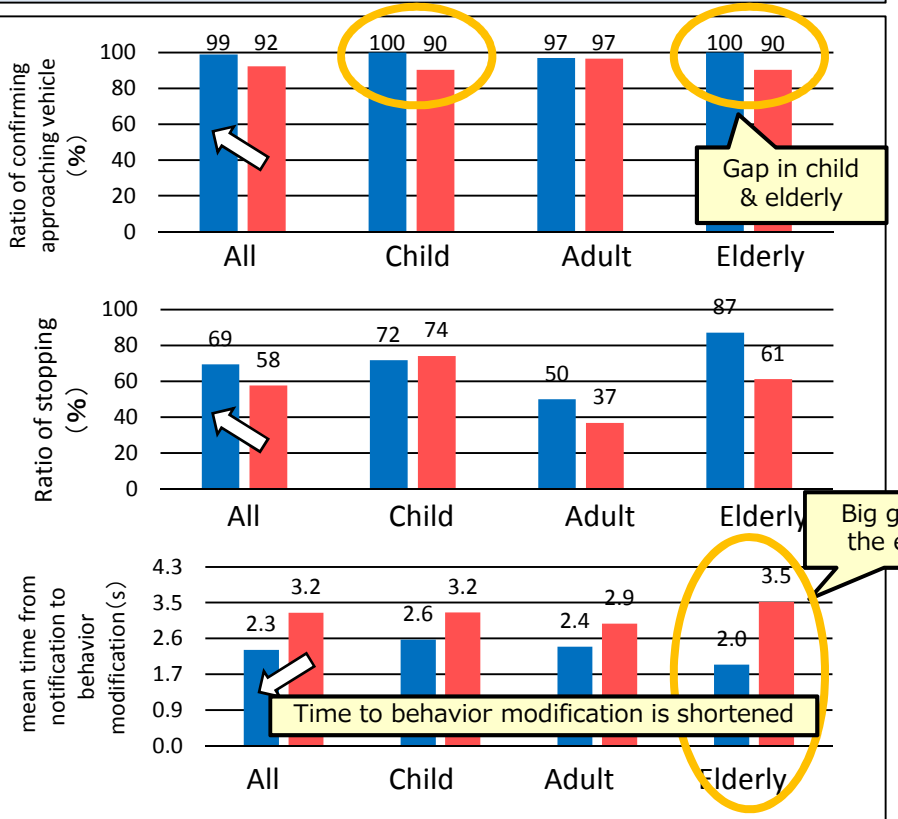
■ **Experiment (subject in a wheelchair) ⇒ Device is properly operated**

3 .Main Verification Result（1）Test Course

■Pedestrian Verification Result

■w/ Notification ■w/o Notification

1)Crosswalk of non intersection part（50・30km/h）



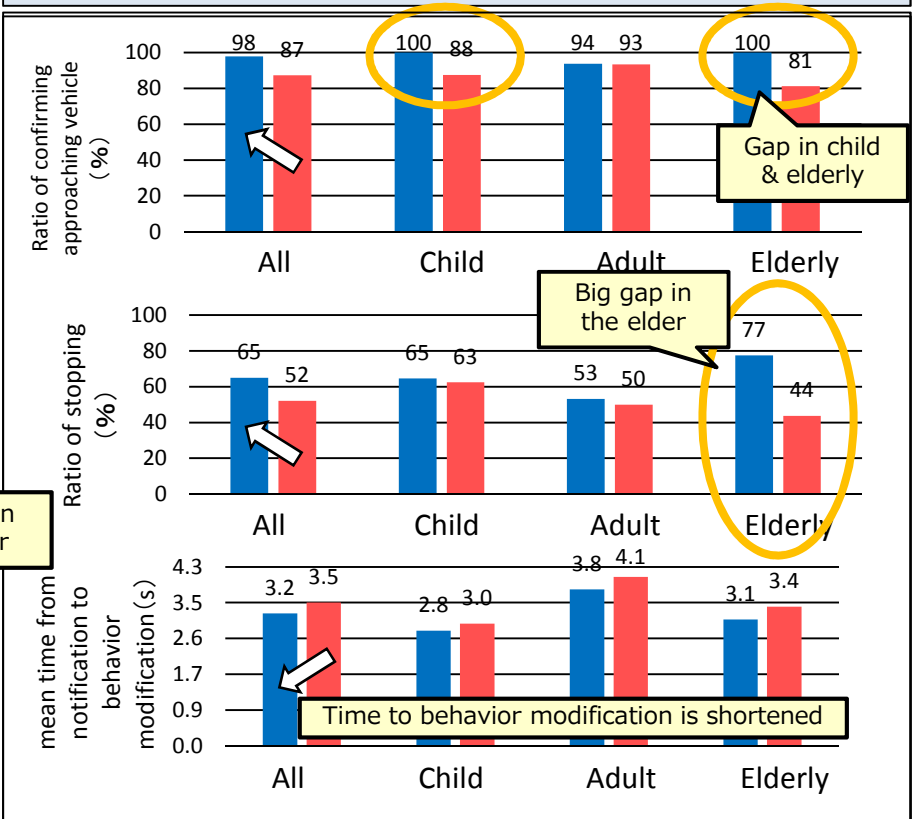
Time from notification to behavior modification（s）

	All	Child	Adult	Elderly
w/ Notification	2.3±1.4	2.6±1.7	2.4±1.5	2.0±1.0
w/o Notification	3.2±1.8	3.2±2.1	2.9±1.9	3.5±1.5

Average ± Standard Deviation

Dispersion is smaller w/ notification

2)Intersection with poor visibility（30km/h）



Time from notification to behavior modification（s）

	All	Child	Adult	Elderly
w/ Notification	3.2±1.2	2.8±1.1	3.8±1.2	3.1±1.0
w/o Notification	3.5±1.4	3.0±1.6	4.1±1.4	3.4±1.0

Average ± Standard Deviation

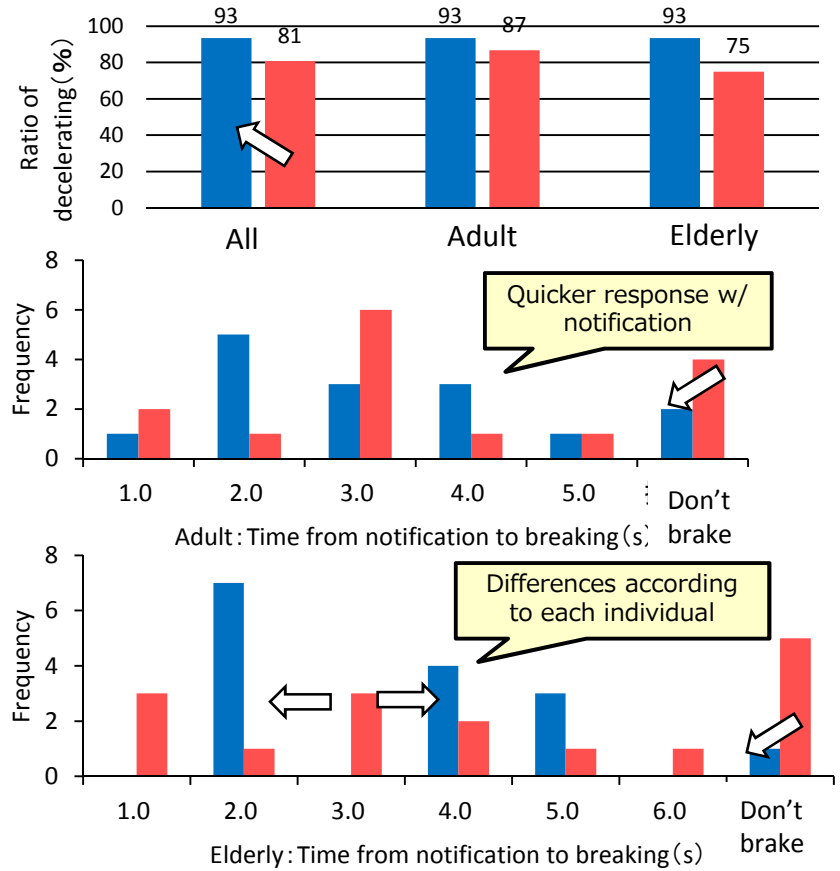
※”Behavior modification”=confirming approaching vehicle/stopping ※Record system log in both

3.Main Verification Result（1）Test Course

■ Vehicle(Driver) Verification Result

■ w/ Notification ■ w/o Notification

1)Crosswalk of non intersection part（50・30km/h）



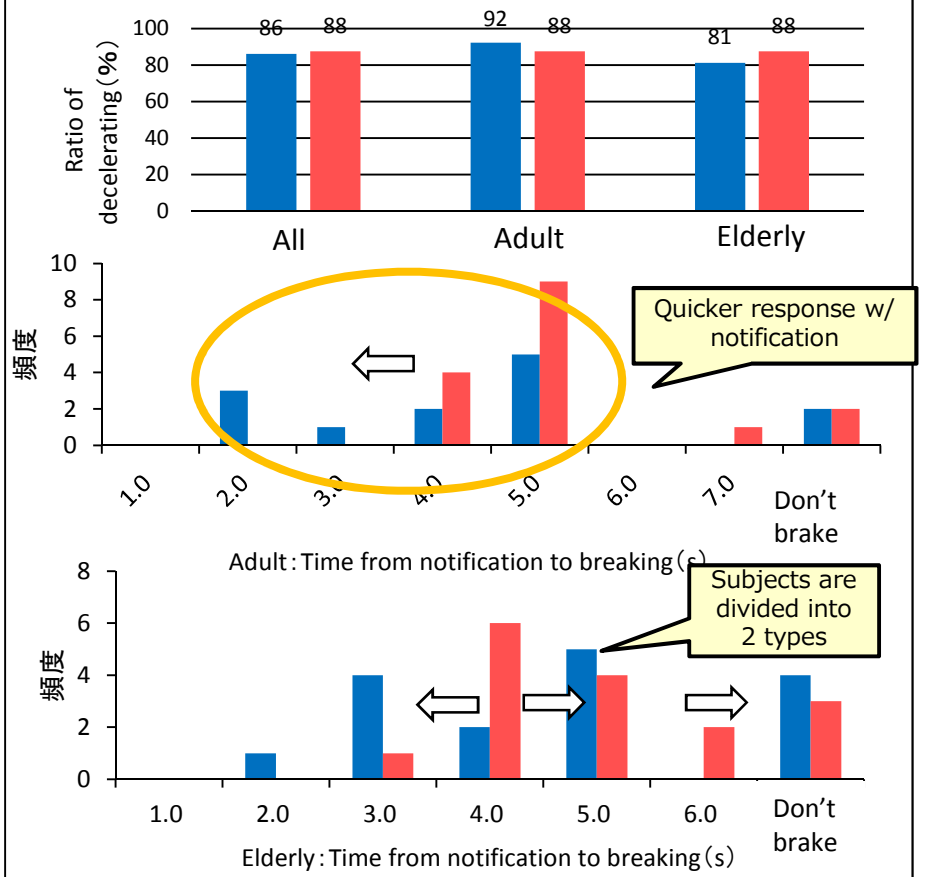
Time from notification to breaking (s)

	All	Adult	Elderly
w/ Notification	2.5±1.1	2.3±1.0	2.7±1.2
w/o Notification	2.5±1.3	2.3±1.1	2.6±1.6

Average ± Standard Deviation

Dispersion is not so big/differences according to each individual about elderly

2)Intersection with poor visibility（30km/h）



Time from notification to breaking (s)

	All	Adult	Elderly
通知あり	3.6±1.2	3.4±1.2	3.7±1.2
通知なし	4.3±0.8	4.4±0.7	4.2±0.8

Average ± Standard Deviation

3.Main Verification Result（1）Test Course

■Pedestrian

1)Crosswalk of non intersection part

- **Ratio of confirming approaching vehicle "w/ notification" is higher than that of "w/o notification" (Child, Elderly)**
  - Adult always confirm approaching vehicle
- **Time from notification to behavior modification is shorter** "w/ notification (Especially elderly)

2)Intersection with poor visibility

- **Ratio of approaching vehicle confirmation is higher w/ notification than that of w/o notification (Child, Elderly)**
  - Adult always confirm approaching vehicle
- **Ratio of stopping is higher "w/ notification" (Elderly)**
- W/ notification, time from notification to behavior modification is shorter
- Time from notification to stopping "w/ notification" is longer than that of "w/o notification（**Decrease of walking speed** could be affected)

■Vehicle(Driver)

1)Crosswalk of non intersection part

- **Ratio of decelerating is higher "w/ notification"**
- **Time from notification to breaking is shorter "w/ notification"**
- **Some elder people don't apply the brakes "w/o notification"**
- Ratio of breaking is higher "w/ notification"

2)Intersection with poor visibility

- **Time from notification to breaking is shorter "w/ notification"** (especially adult)
  - People tend to break more quickly w/ notification
- Ratio of decelerating "w/o notification" is higher than that of "w/ notification" (Elderly)
  - （**2 types of drivers**）

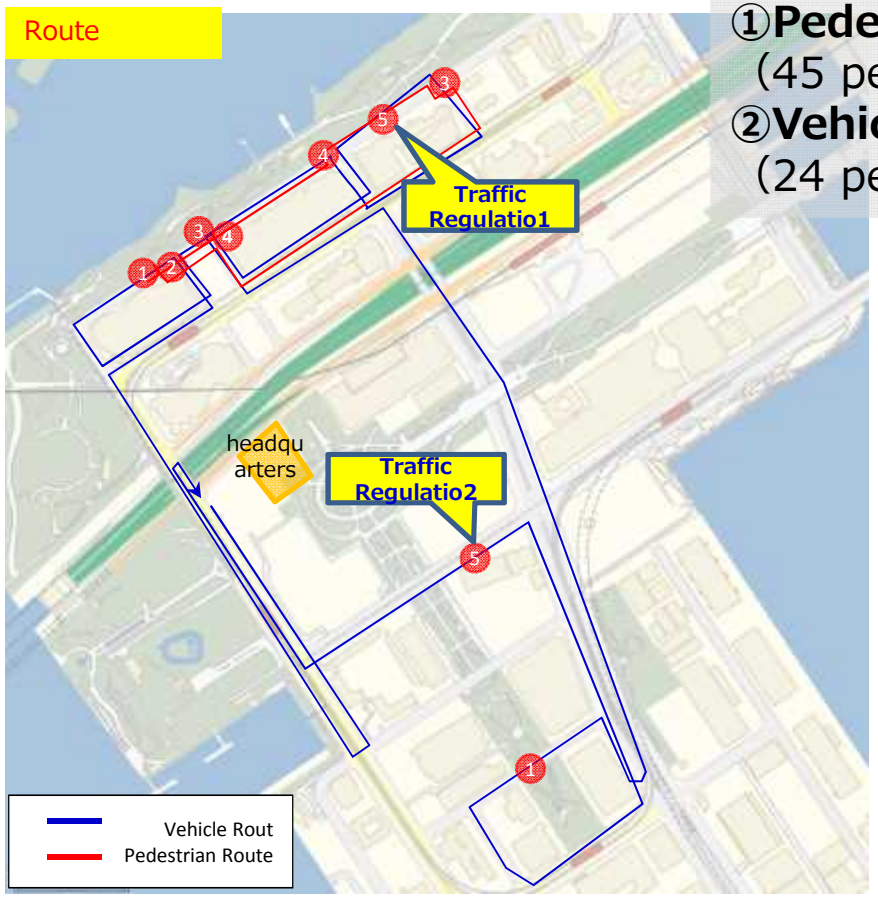
▼Providing information via V2P systems is effective especially for **child and elderly**
▼There are individual difference（Especially elder people）
▼Subjects tend to behavior **more safely with notification**

3.Main Verification Result （2）Public Road

Evaluate and analyze results in QUALITIVE approach

- ✓ **Date: Vehicle Verification（2018/11/13-14）、Pedestrian Verification（2018/11/15-17）**
- ✓ **Conduct interview survey during experiment in each scenario**

①Pedestrian : Elderly・Adult・Child
(45 persons each)
②Vehicle : Elderly・Adult
(24 persons each)




1Crosswalk of non intersection part


4Right Turn


2Intersection with poor visibility


5Road without sidewalk※

※Partialy regulated traffic for “5 road without sidewalk”

3.Main Verification Result （2）Public Road

②Public Road（in Odaiba） 【Quantitative Analysis】

Experimental Item

1) Analyze driver and pedestrian subjects' behavior modification in qualitative approach

-Verification conducted in 5 scenarios requiring support

①Behavior modification w/ notification
=Speed(pedestrian/vehicle)
=Video
=Interview survey

②Customer needs for notification service
=Interview survey
＞expectation
＞safety/anxiety
＞needs or wishes

(1) Pedestrian crossing of non intersection part sections

(2) Crossing of intersections with poor visibility

(3) Right turns at intersections (both with and without traffic signals)

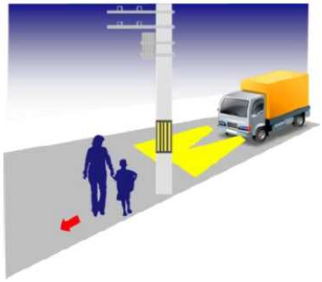
(4) Left turns at intersections (both with and without traffic signals)

2) Analyze log data and interview survey

・log data
・VBOX(CAN logger)
・view-poll camera
・on-vehicle camera
・interview survey

Conclude results of main verification for pedestrian Accident reduction

(5) Roads without sidewalks



3 .Main Verification Result （2） Public Road

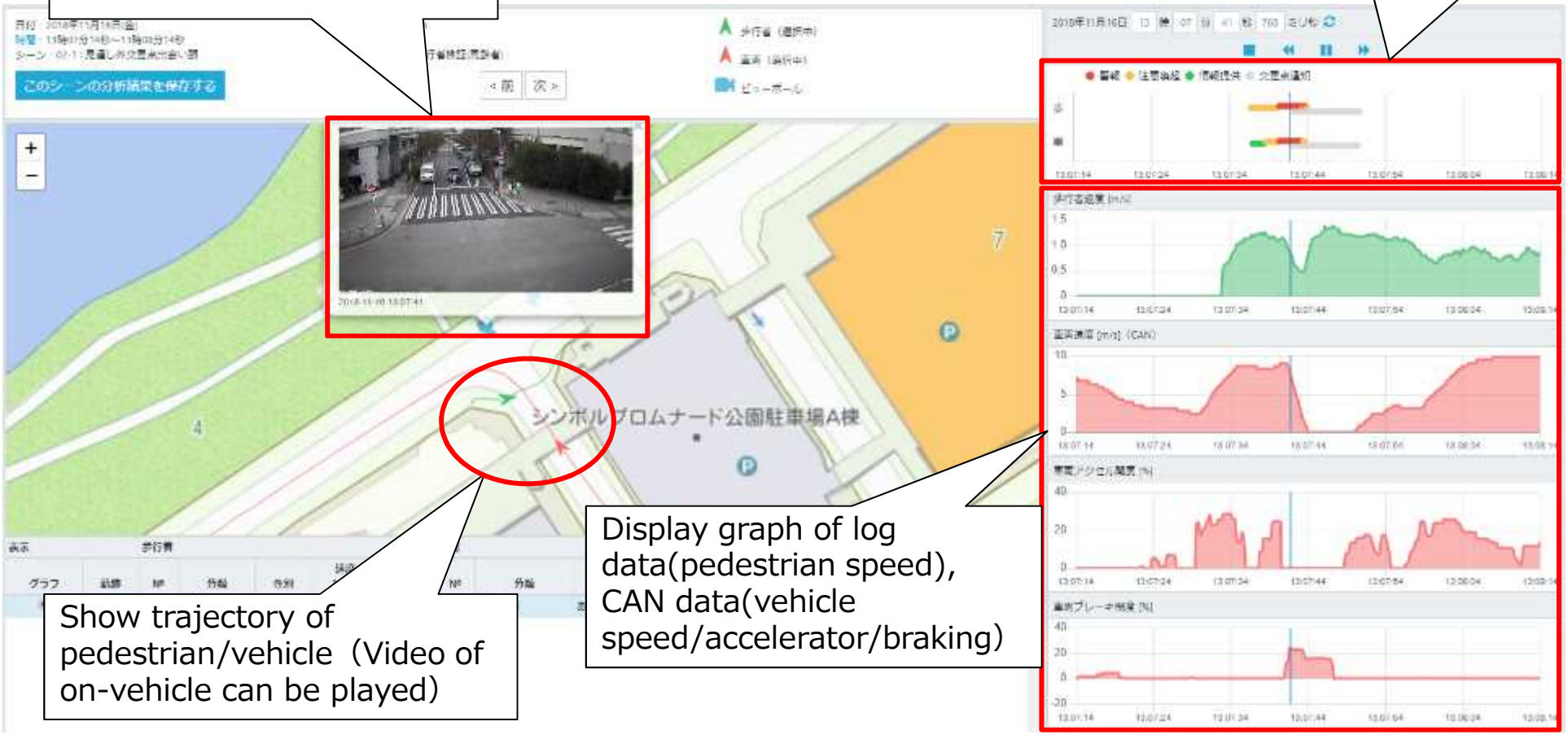
Contents

✓ Analyze driver and pedestrian subjects' behavior in each scenario with visualization system
✓ Evaluate subjects' impression during experiments with interview survey
✓ Conduct after-experiment interview survey

Crosswalk of non intersection part(Elderly)

3 .Main Verification Result （2）Public Road

■ **Evaluation with log data and visualizing system**



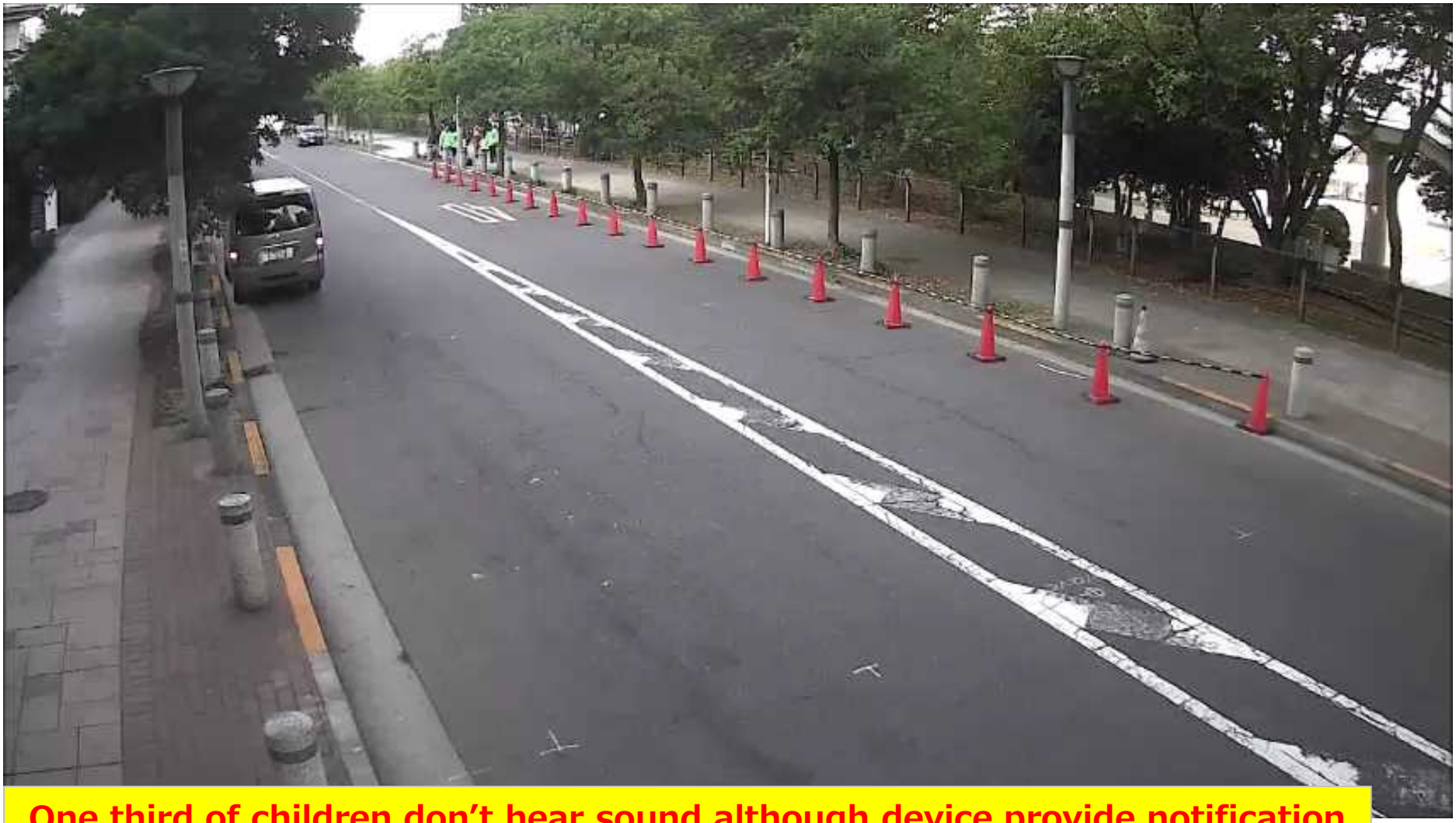
3 .Main Verification Result （2）Public Road

■Video（Elderly）

Subject confirm approaching vehicle and stop before crosswalk after notification

3 .Main Verification Result （2）Public Road

■Video（Child）



One third of children don’t hear sound although device provide notification
Subject noticing notification confirm the surrounding after notification

3 .Main Verification Result （2）Public Road

■ **Video（Vehicle）**

Example of driver's behavior : **Visualize by system**

Breaking after notification

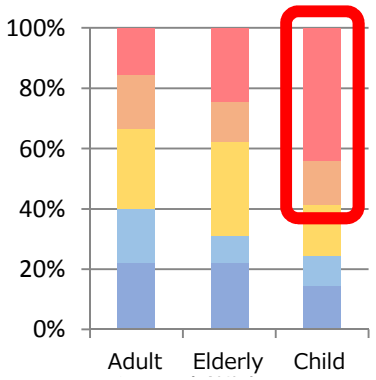
Behavior modification with notification are proved

3.Main Verification Result （2）Public Road

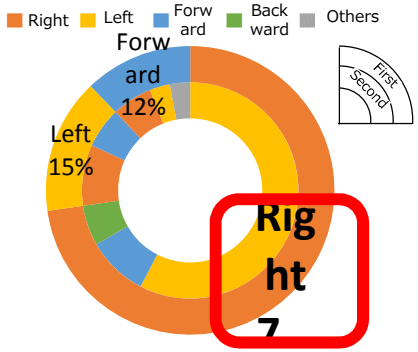
■Interview Survey（Pedestrian : ①Crosswalk of non intersection part)

- **60% of children answered “I confirm surroundings after notification” and “I walk in road safely w/ notification”**
- Many subjects check the road **from right to left after notification**

Did you confirm surroundings after notification?

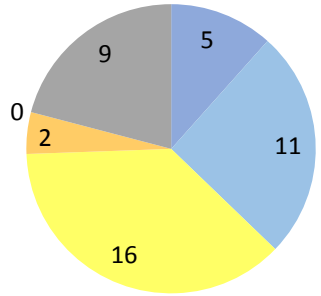
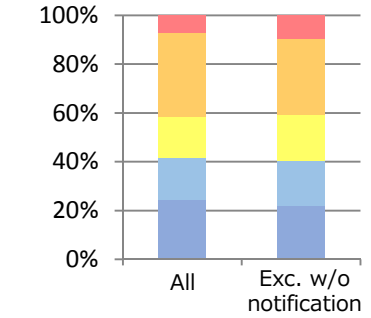
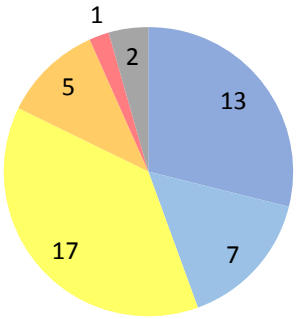
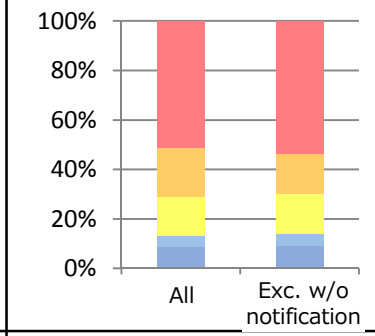
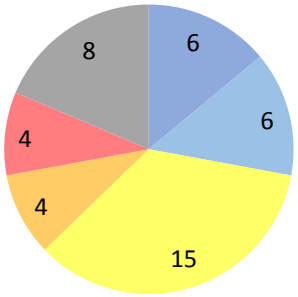
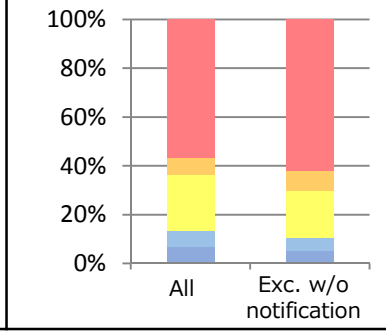


Which direction/in what order did you confirm?



I think so　I don't think so

Early　Good　Late　No Notification

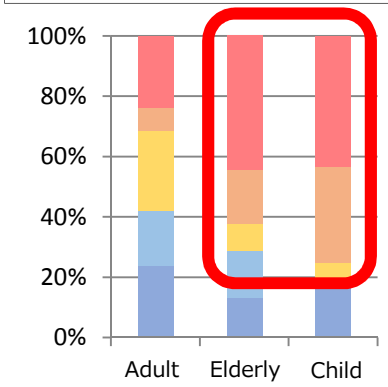
	Was the timing of notification good? (alert)	Could you cross the road safely w/ notification?
Adult		
Elderly		
Child		

3.Main Verification Result （2）Public Road

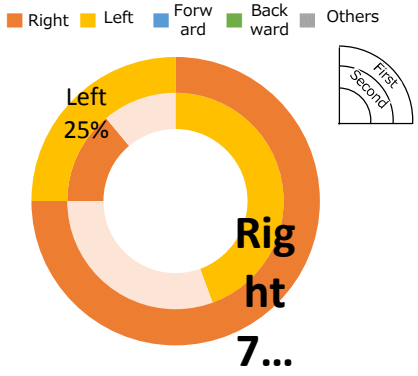
■Interview Survey（Pedestrian : ②Intersection with poor visibility)

- **More than 60% of elderly and children answered “I confirm surroundings after notification”**
- **Around half of adult cannot hear notification ⇒Some problem about how to notify**

Did you confirm surroundings after notification?

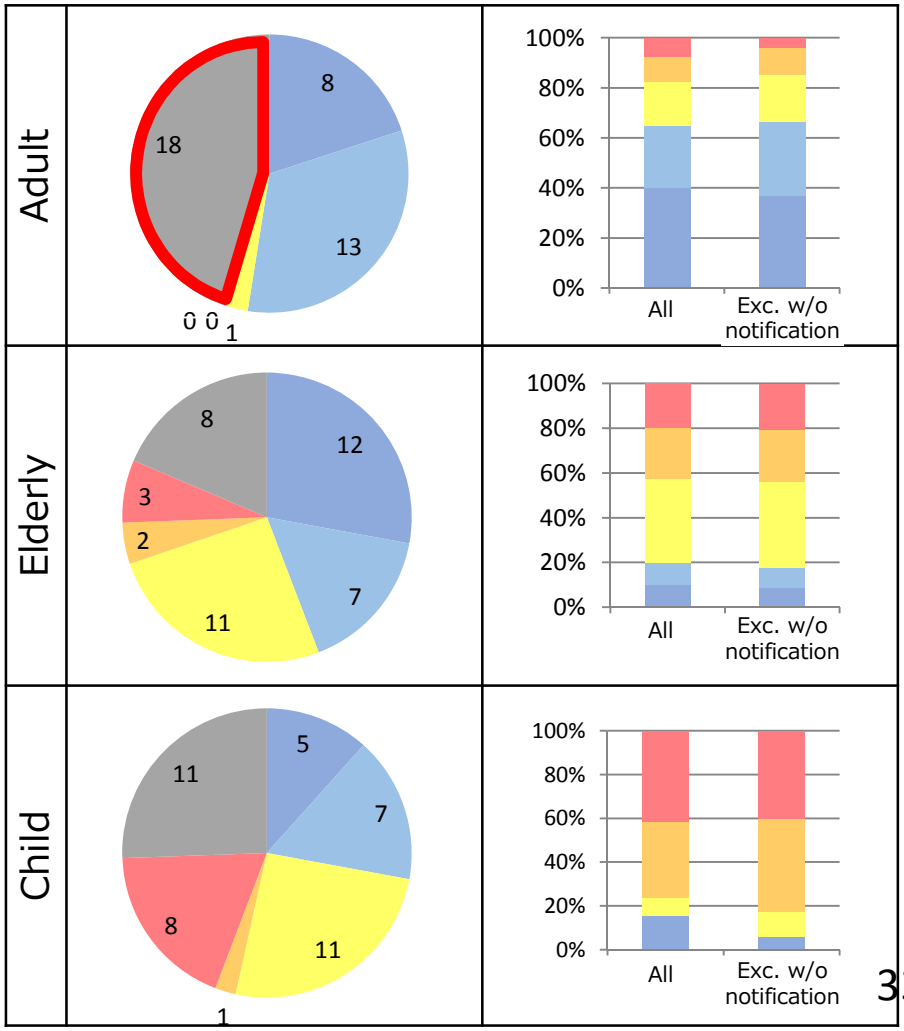


Which direction/in what order did you confirm?



Was the timing of notification good? (alert)

Could you cross the road safely w/ notification?

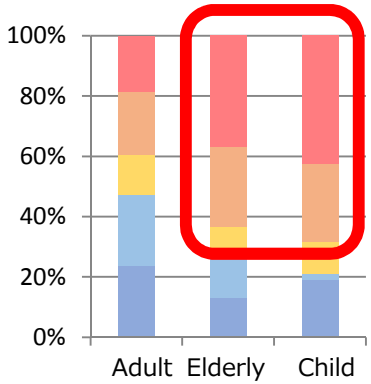


3.Main Verification Result （2）Public Road

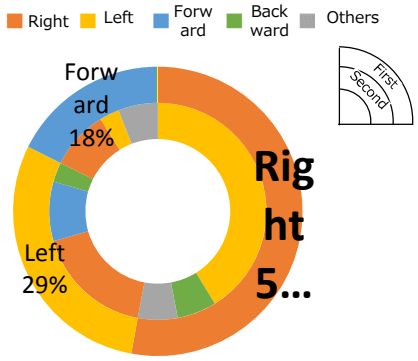
■Interview Survey（Pedestrian : ③-1 Left turn w/ traffic signal)

- **60% of elderly and children answered "I confirm surroundings after notification**
- Many subjects check the road **from right to left after notification**

Did you confirm surroundings after notification?

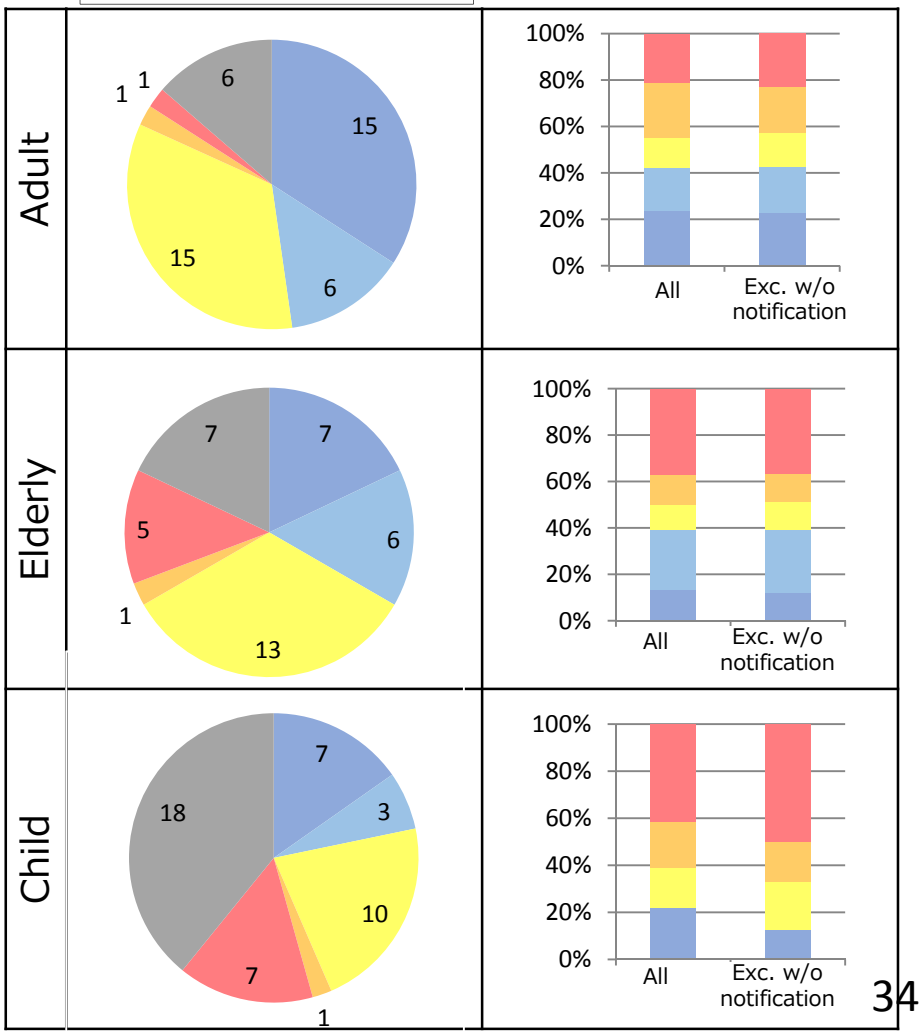


Which direction/in what order did you confirm?



Was the timing of notification good? (intersection existence notification)

Could you cross the road safely w/ notification?

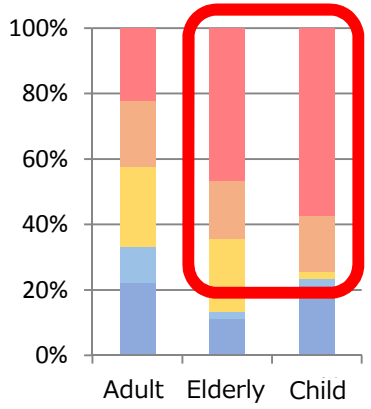


3.Main Verification Result （2）Public Road

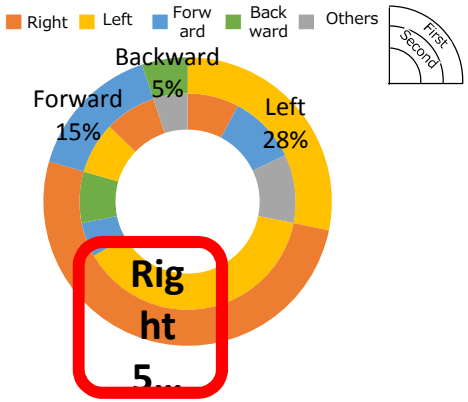
■Interview Survey（Pedestrian : ④-1 Right turn w/ traffic signal)

- **60% of elderly and children answered “I confirm surroundings after notification” and “I walk in road safely w/ notification”**
- Many subjects check the road **from right to left after notification, regardless of vehicle approaching direction**
  ⇒Some problem about direction notification

Did you confirm surroundings after notification?



Which direction/in what order did you confirm?

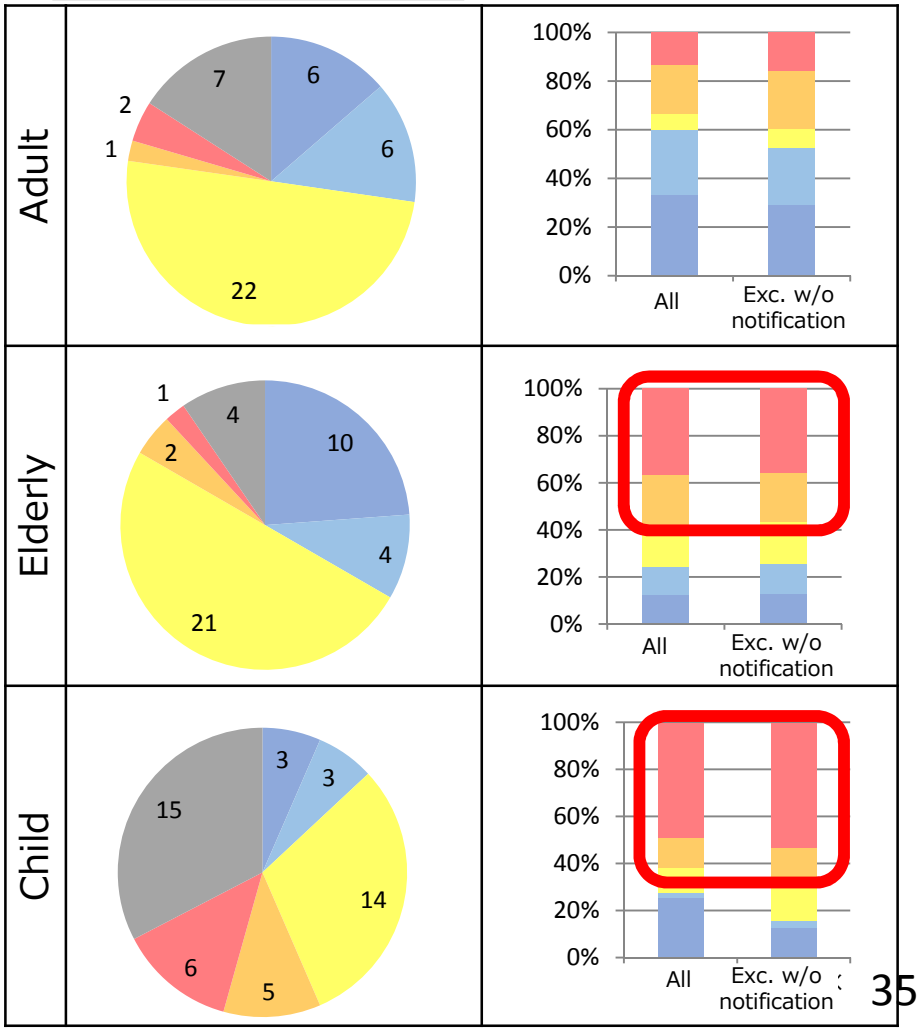


I think so / I don't think so

Early / Good / Late / No Notification

Was the timing of notification good? (intersection existence notification)

Could you cross the road safely w/ notification?

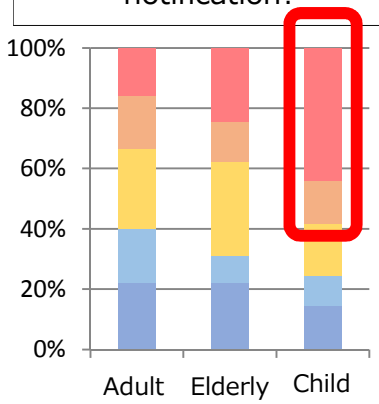


3.Main Verification Result （2）Public Road

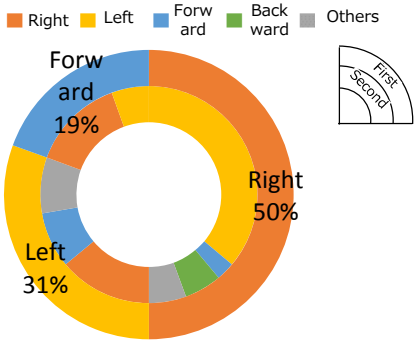
■ **Interview Survey（Pedestrian : ③-2 Left turn w/o traffic signal)**

- **60% of children answered “I confirm surroundings after notification” and “I walk in road safely w/ notification”**

Did you confirm surroundings after notification?

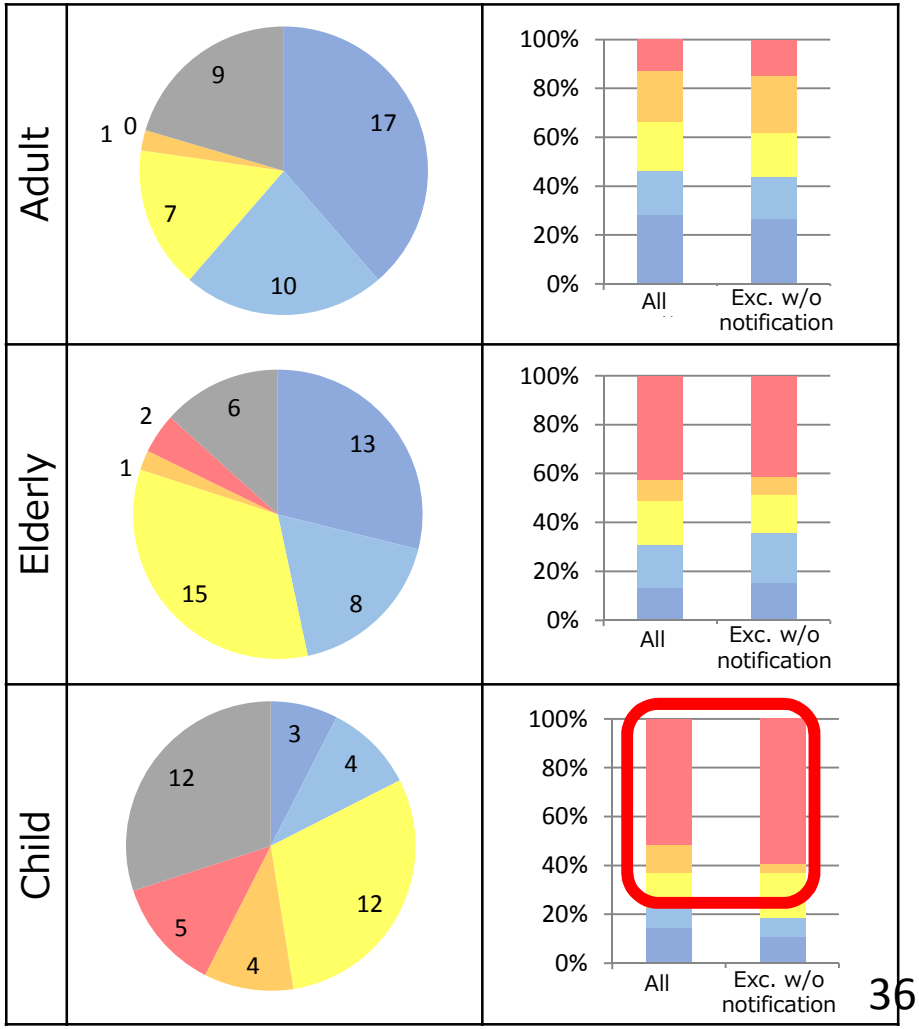


Which direction/in what order did you confirm?



Was the timing of notification good? (intersection existence notification)

Could you cross the road safely w/ notification?

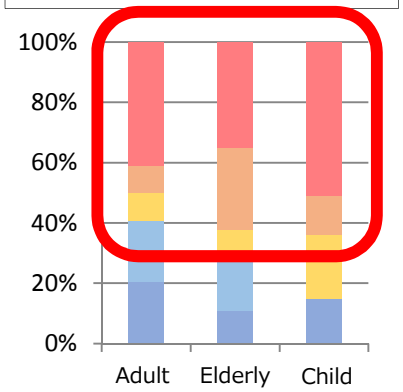


3.Main Verification Result （2）Public Road

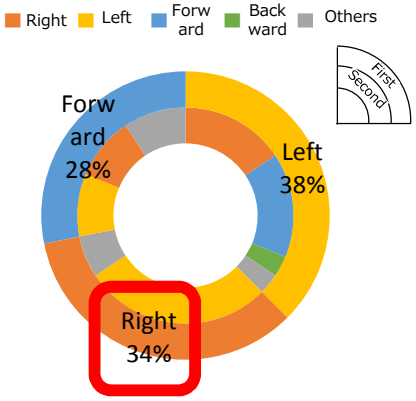
■Interview Survey（Pedestrian : ④-2 Right turn w/o traffic signal)

- **60% of subjects in all age answered “I confirm surroundings after notification”**
- **60% of children answered “I walk in road safely w/ notification”**
- **Some problem about direction notification**

Did you confirm surroundings after notification?



Which direction/in what order did you confirm?

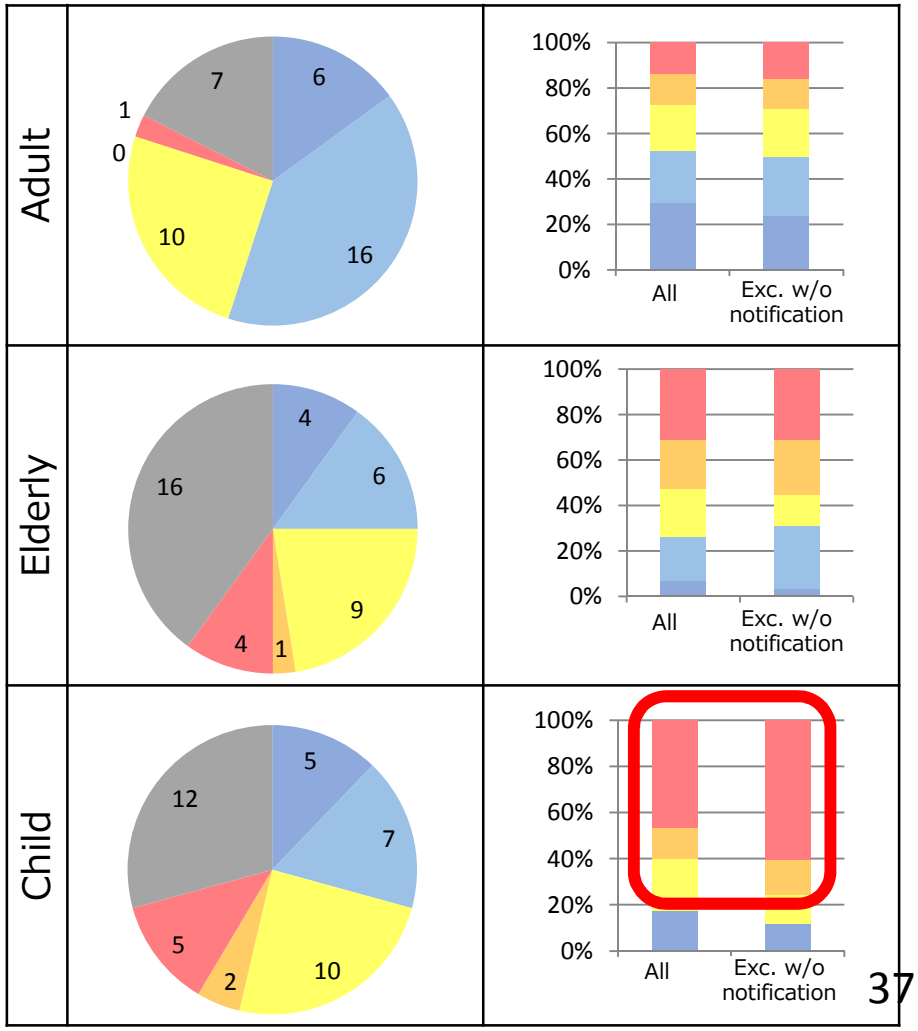


I think so / I don't think so

Early / Good / Late / No Notification

Was the timing of notification good? (intersection existence notification)

Could you cross the road safely w/ notification?



3.Main Verification Result （2）Public Road

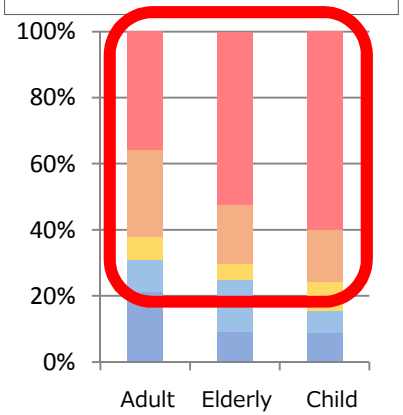
■ **Interview Survey（Pedestrian : ⑤Road without sidewalk）**

I think so　I don't think so

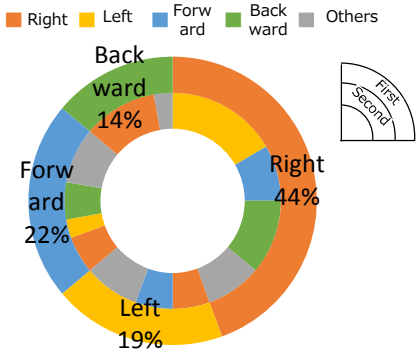
Early　Good　Late　No Notification

- **70% of subjects in all age answered “I confirm surroundings after notification”**
- **80% of children answered “I walk in road safely w/ notification”**

Did you confirm surroundings after notification?

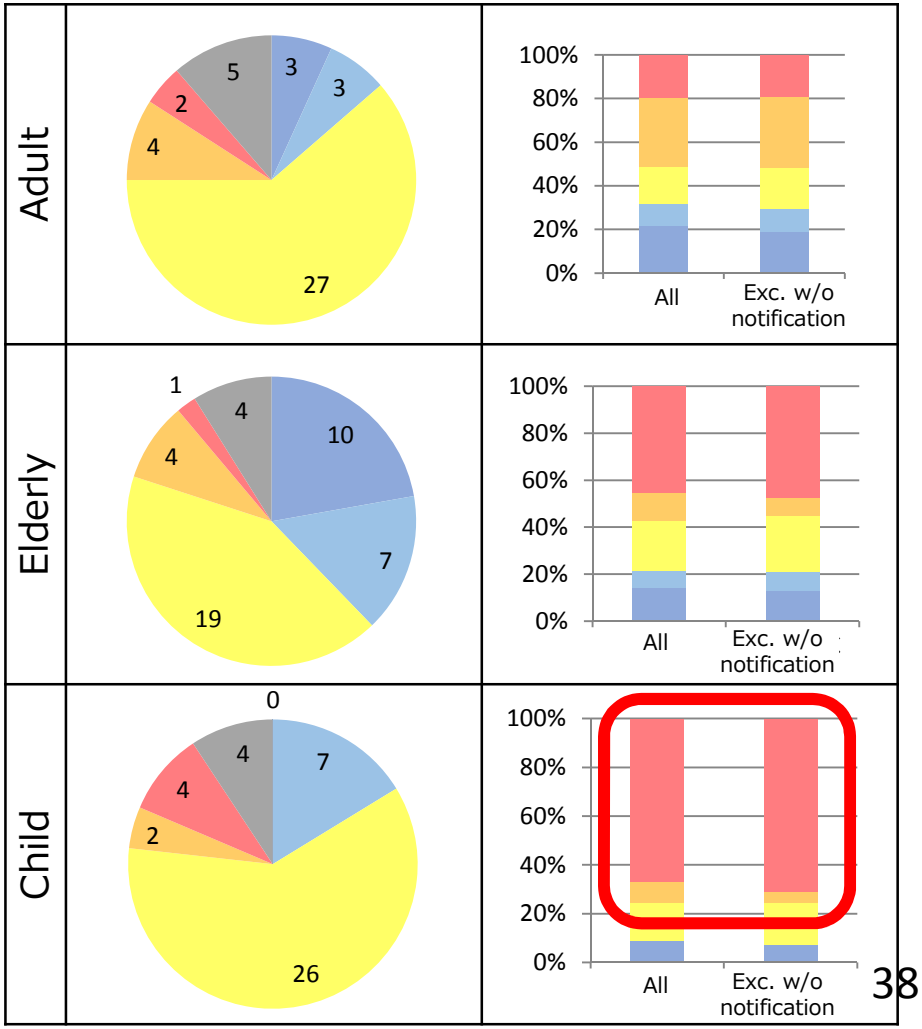


Which direction/in what order did you confirm?



Was the timing of notification good? (alert)

Could you walk in the road safely w/ notification?



3.Main Verification Result （2）Public Road

■ **Interview Survey（Pedestrian: after experiments ※Parents answered(Child)**

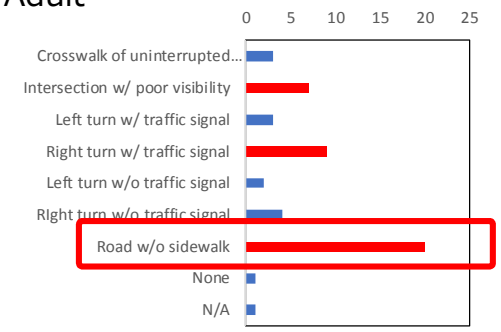
I think so　　I don't think so

Early　Good　Late　No Notification

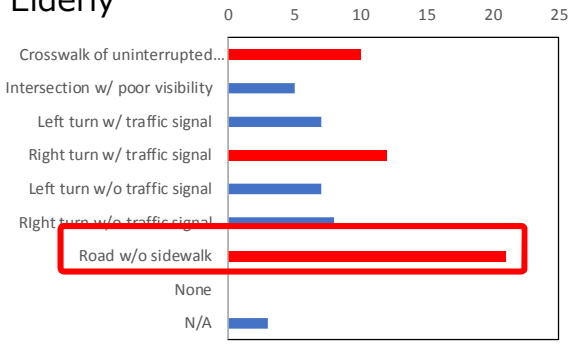
- **Notification is more effective in “intersection with poor visibility”, “right turn w/ traffic signal”, “Road without sidewalk”**
- People prefer installing app than carrying special device b/c it’s easy to use

IN which scenario was notification most effective? ※Multiple Answer allowed

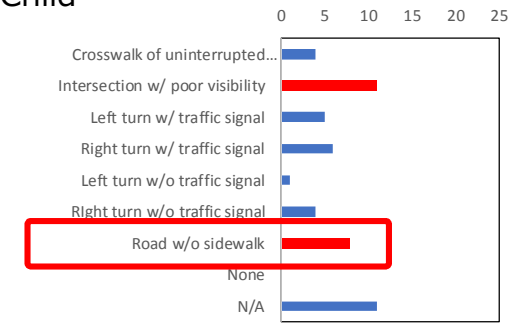
Adult



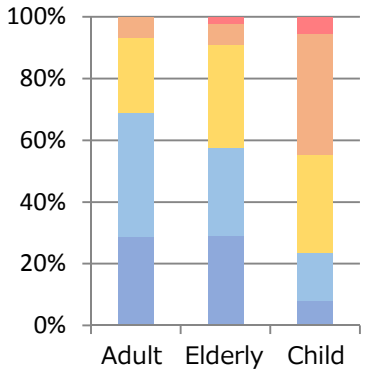
Elderly



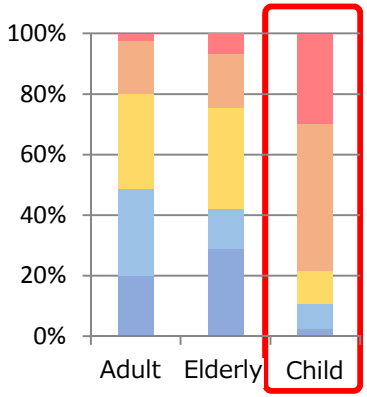
Child



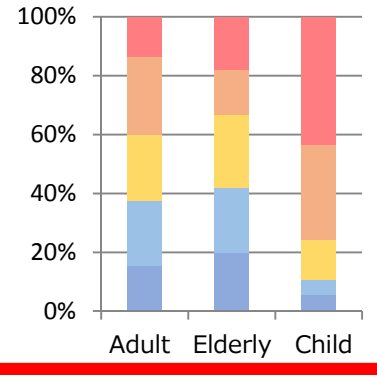
If the device was sold, would you want to buy it?



If you could rent the device, would you want to use it?



If the device was provided as app, would you want to download it on your smartphone?

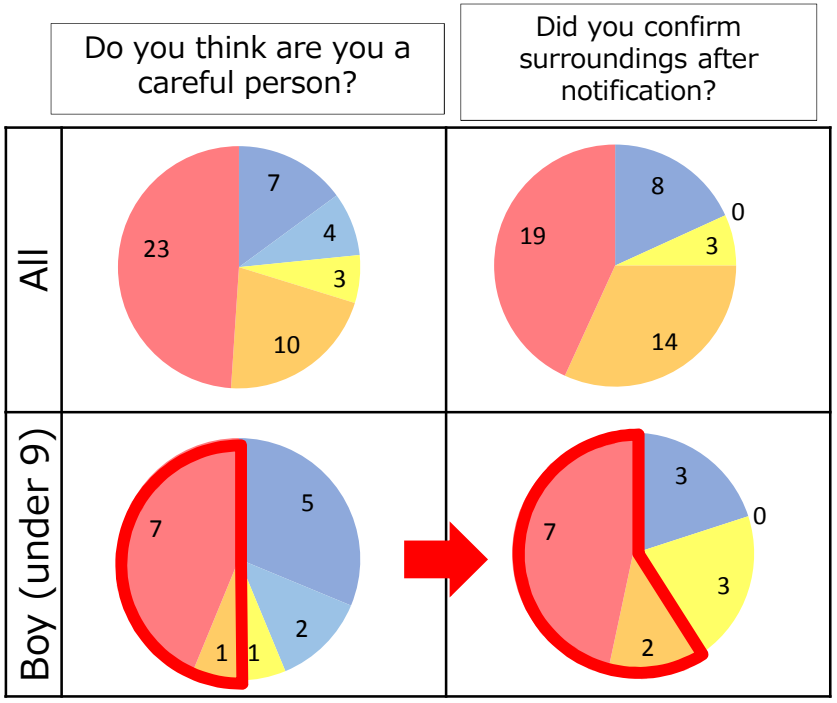


3.Main Verification Result （2）Public Road

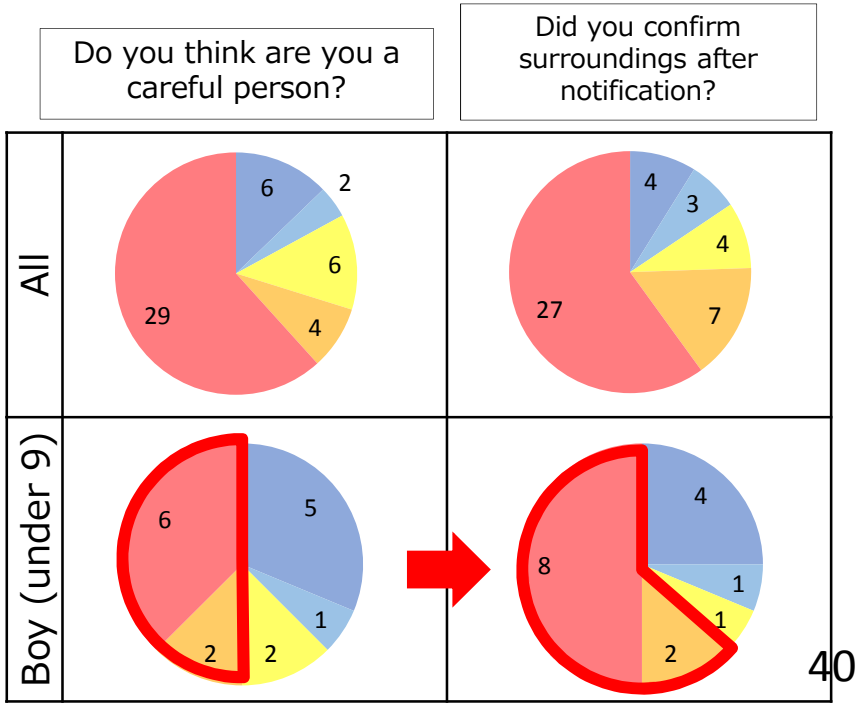
■Interview Survey（Pedestrian ; Child(Boy)）

- **With notification, more subjects pay attention to the surrounding more than usual**
  ⇒Notification can contribute to improve safety especially for boy in elementary school, who is most likely victim in traffic accidents

②Intersection with poor visibility



⑦Road without sidewalk



3.Main Verification Result （2）Public Road

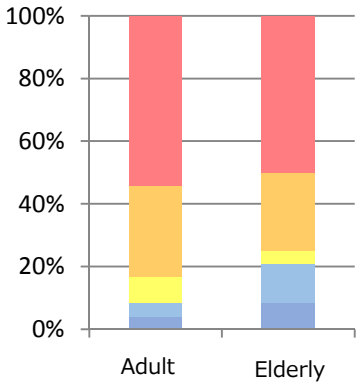
■ **Interview Survey（Driver : ①Crosswalk of non intersection part）**

I think so　　I don't think so

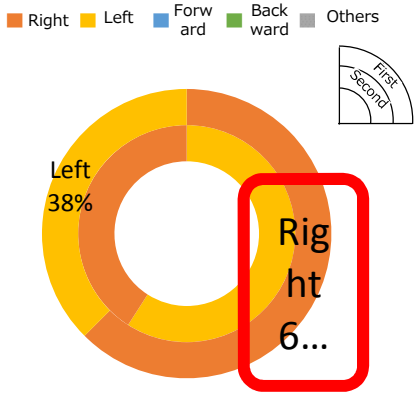
Early　Good　Late　No Notification

- **More than 60% of subjects answered “I drive safely w/ notification”**
- **More than 60% of subjects** check the road **from right to left after notification**

Did you confirm surroundings after notification?

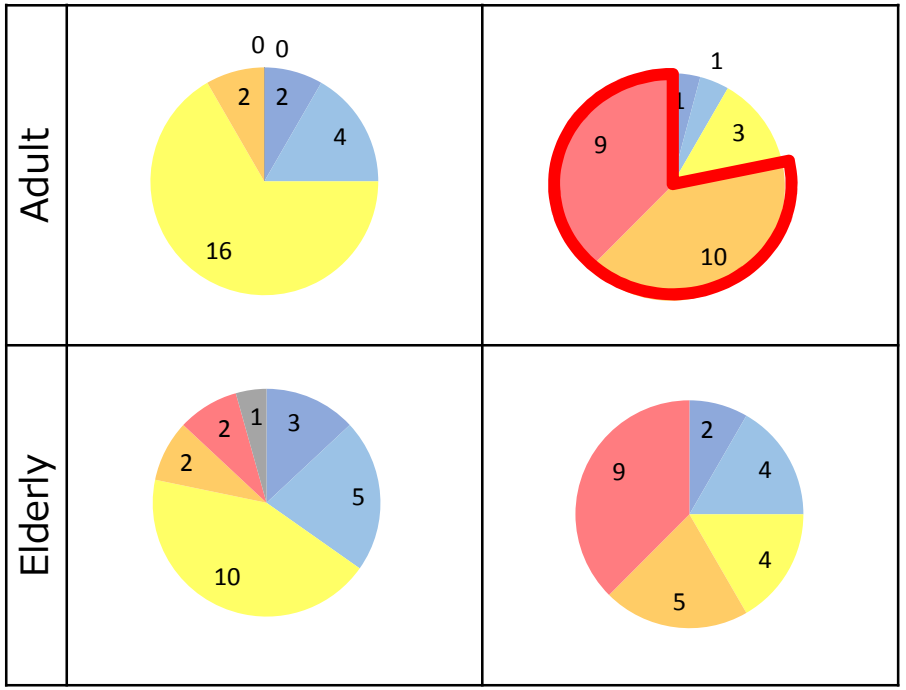


Which direction/in what order did you confirm?



Was the timing of notification good? (alert)

Could you cross the road safely w/ notification?



All　Exc. w/o notification

3.Main Verification Result （2）Public Road

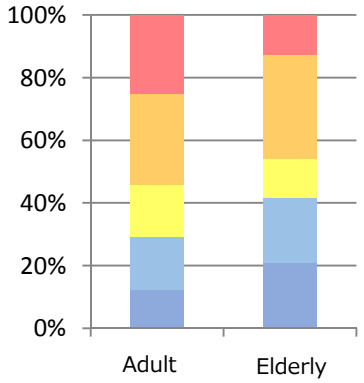
■Interview Survey（Driver：②見通し外）

I think so　　I don't think so

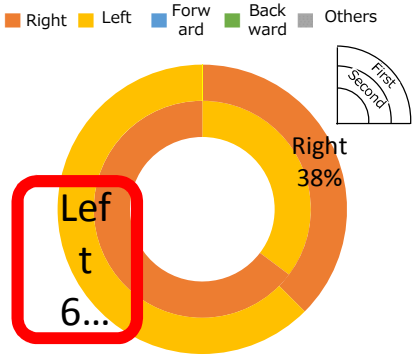
Early　Good　Late　No Notification

- **More than 60% of subjects check left side first** after notification
- **More than half of subjects answered “I drive safely w/ notification”**

Did you confirm surroundings after notification?

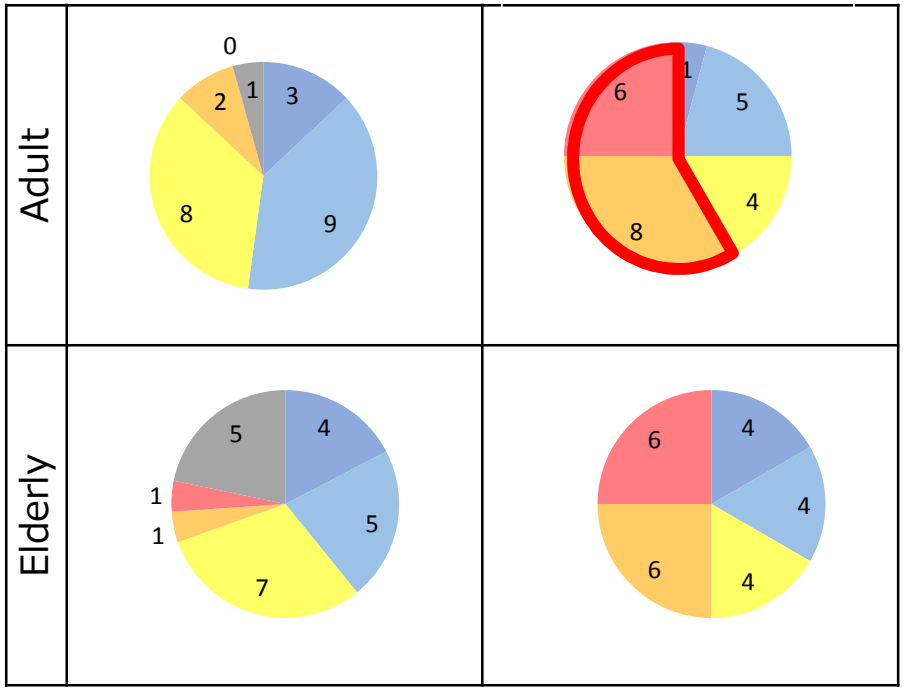


Which direction/in what order did you confirm?



Was the timing of notification good? (alert)

Could you cross the road safely w/ notification?



3.Main Verification Result （2）Public Road

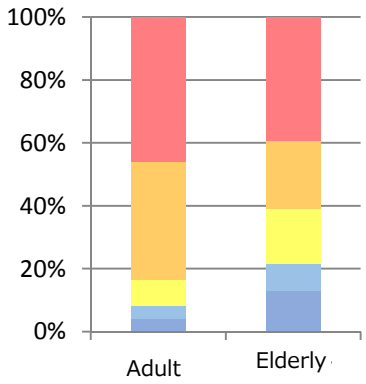
■ **Interview Survey（Driver： ③-1 Left turn w/ traffic signal ）**

I think so　　I don't think so

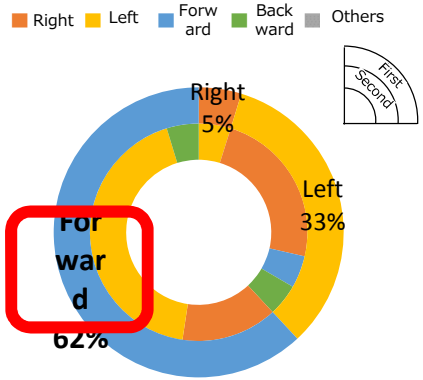
Early　Good　Late　No Notification

- More than 60% of subjects **check from forward to left side** after notification
- More than half of subjects answered “I drive safely w/ notification”

Did you confirm surroundings after notification?

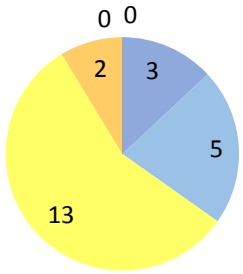
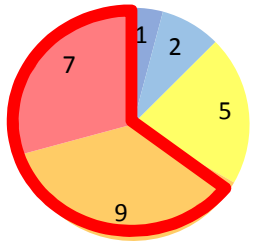
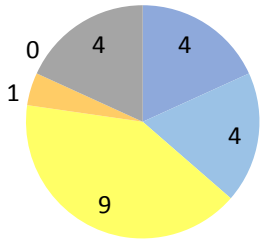
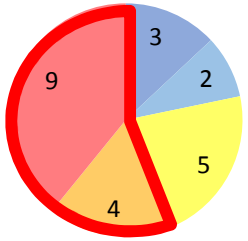


Which direction/in what order did you confirm?



Was the timing of notification good? (intersection existence notification)

Could you cross the road safely w/ notification?

Adult		
Elderly		

3.Main Verification Result （2）Public Road

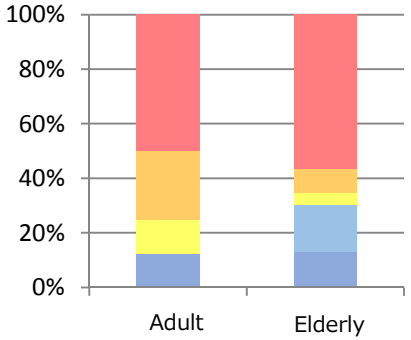
■Interview Survey（Driver： ④-1 Right turn w/ traffic signal ）

I think so　　I don't think so

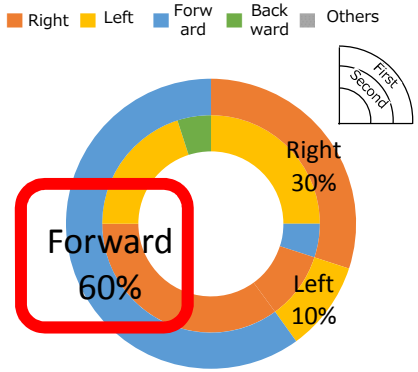
Early　Good　Late　No Notification

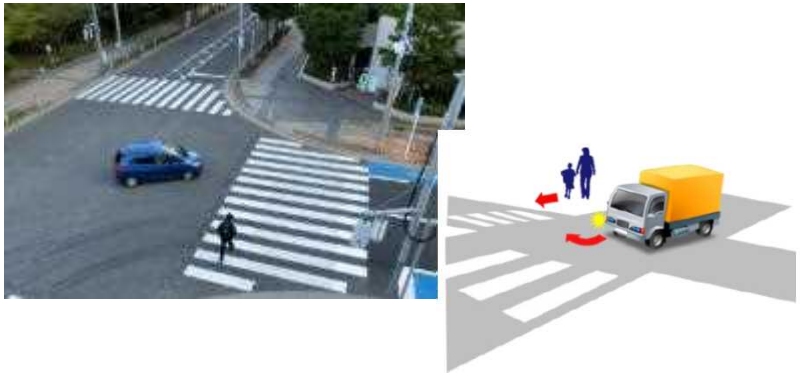
- More than 60% of subjects **check from forward to left side** after notification
- More than half of subjects answered “I drive safely w/ notification”

Did you confirm surroundings after notification?



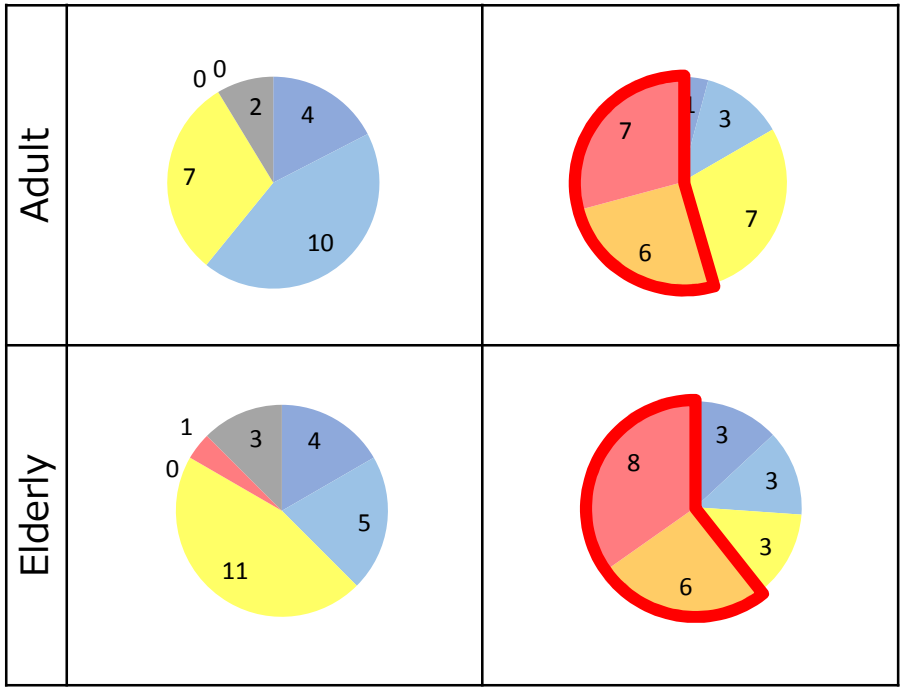
Which direction/in what order did you confirm?





Was the timing of notification good? (intersection existence notification)

Could you cross the road safely w/ notification?



3.Main Verification Result （2）Public Road

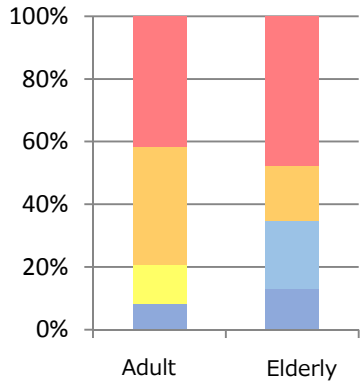
■Interview Survey（Driver： ③-2 Left turn w/o traffic signal ）

I think so　　I don't think so

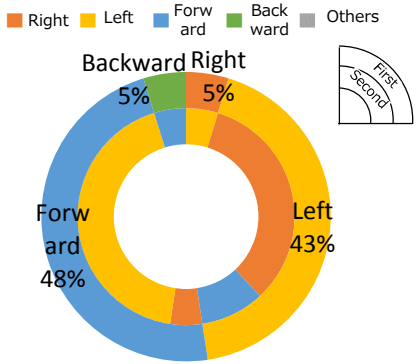
Early　Good　Late　No Notification

- In intersection w/o traffic signal, ratio of answer “I drive safely w/ notification” is **higher in left turn than in right turn**

Did you confirm surroundings after notification?

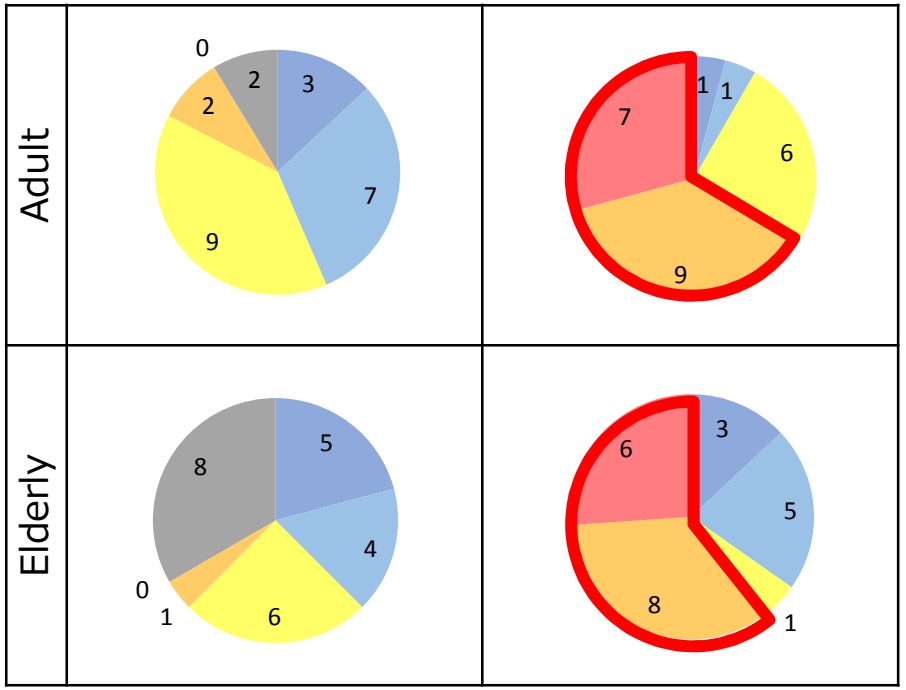


Which direction/in what order did you confirm?



Was the timing of notification good? (intersection existence notification)

Could you cross the road safely w/ notification?



3.Main Verification Result （2）Public Road

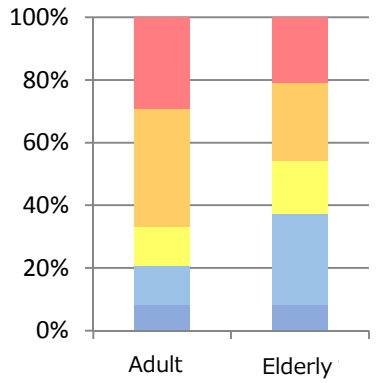
■Interview Survey（Driver： ④-2 Right turn w/o traffic signal ）

I think so　　I don't think so

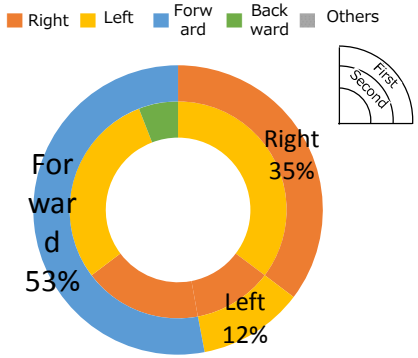
Early　Good　Late　No Notification

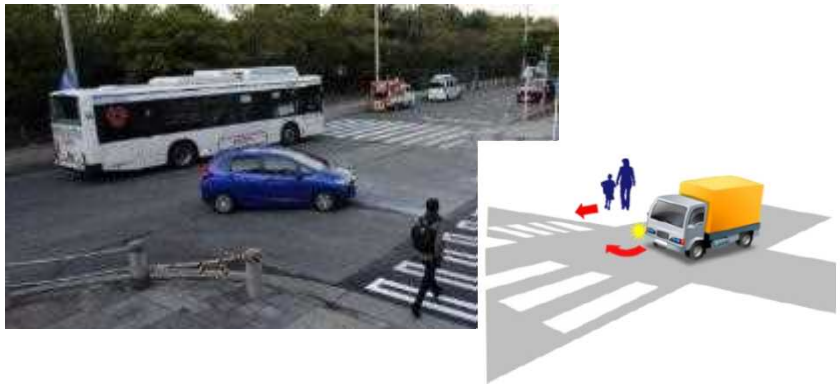
- In intersection w/o traffic signal, ratio of answer “I drive safely w/ notification” is **higher in left turn than in right turn**

Did you confirm surroundings after notification?



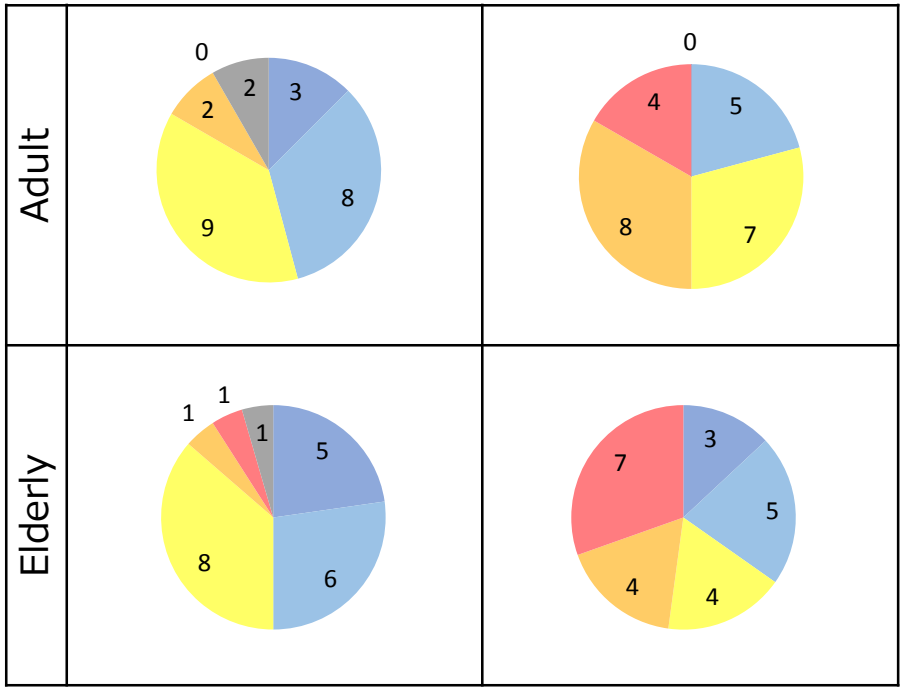
Which direction/in what order did you confirm?





Was the timing of notification good? (intersection existence notification)

Could you cross the road safely w/ notification?



All　Exc. w/o notification

3.Main Verification Result （2）Public Road

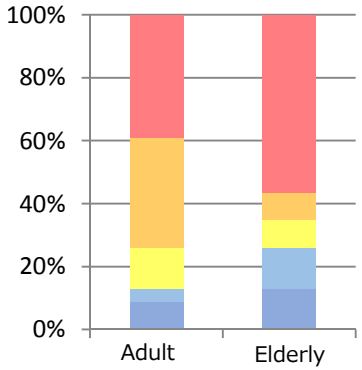
■ **Interview Survey（Driver： ⑤Road without sidewalk）**

I think so　　I don't think so

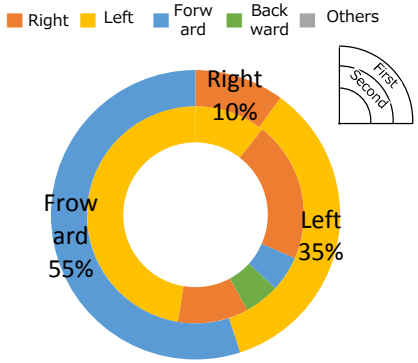
Early　Good　Late　No Notification

- **More than 60% of subjects answered “I confirm surroundings after notification” and “I drive safely w/ notification”**

Did you confirm surroundings after notification?

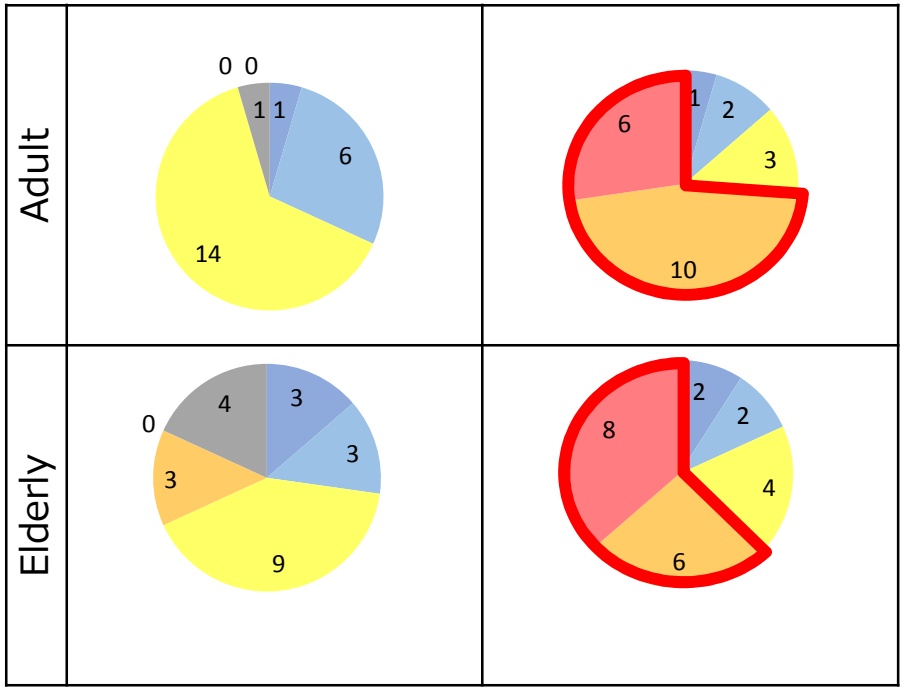


Which direction/in what order did you confirm?



Was the timing of notification good? (alert)

Could you cross the road safely w/ notification?



3.Main Verification Result （2）Public Road

■Interview Survey（Pedestrian）

- Various opinions about implementation of notification service are received

✓Acceptability of Service

・It could be effective especially in bad weather, night time, and backlight.
・It could be also applied in **Bicycle to Vehicle（B2V）, or Bicycle to Pedestrian（B2P) service.**
・I'd like to use it when I drive in area I visit for the first time or for long hours.
・I'd like **my children and parents to have this device.** (Adult)
・I think **vehicle needs this device b/c it would be assaulter.**

✓Consumer Demand

・I would buy the device for less than 10,000 yen. I want to buy it more with insurance or some other services.
・If the system implemented as an app in smartphone, it would become popular as safety service.
・I want my children to carry this device **like an personal alarm or mobile phone for child**.
・It would be better for vehicle to **have the device as standard equipment or optional service**.
➡**People would buy device as additional service, rather than as itself**

✓Comments from parents

・**Boy are always carelessness** and may not hear notification. It wouldn't be effective for them**.**
・Electric sound would be better than voice (for children).
・Mother's voice would be more effective for children to notice them danger. (**Especially mother's anger and loud voice**)

3.Main Verification Result （2）Public Road

Summary

✓ Behavior Modification

・**Both pedestrian and driver behavior modification with notification was verified**

・**However, some pedestrian subjects cannot hear notification b/c of surrounding noisy sound or lack of concentration**(Child, Elderly)

➡Need to change how to notify… Vibration notification

・**Some behavior were seen supporting these impression; notification is too late or approaching direction also should be notified**

ex. Some subjects confirm left side when vehicle approaching from right, behave as usual b/c notification is too late etc.

➡Need to improve notification timing and sound volume

・**Approx. 60% of subjects had behavior modification with notification in all scenario and all age**

✓ Evaluation Based on Interview Survey

・**Acceptability of V2P systems were verified«Condition for implementation»**

※Driver : Acceptable as additional service such as onboard device or discount of insurance

※Pedestrian : Acceptable as additional function of carrying device such as smartphone or personal alarm

・**Problems of current device were revealed«Problem for implementation»**

※Needs for notification timing, how to notify, notification of approaching direction, portability etc.

⇒There are big expectation for implementation based on problems and evaluation above

4.Future Plan（Summary）

Achievement	Effectiveness of “V2P communication system” and “pedestrian high-accuracy positioning and behavior predicting technology” were proved through verifications about “pedestrian Accident reduction” ➢ Verifying mutual alerting system applying “V2P communication system” **and “pedestrian high-accuracy positioning and behavior predicting technology” under real traffic world, expectation and problems for implementation in society were revealed（FY2017）** ➢ **Effectiveness of V2P system for pedestrian Accident reduction under real traffic were verified. The systems got good evaluation from general people and needs and problems for implementation were also revealed (FY2018)**
Future	We expected this achievement would be considered not only for developing automated driving system, but also for field below, in order to reduce risk of traffic accident ➢ **Application for safe driving of automated driving vehicle** ➢ **Application for supporting pedestrian safety** **Pedestrian : carrying devices, wearable service** **Vehicle : additional value of service for R2V, V2V** **Others : Application on bicycle, senior car etc.** ➢ **Application in educational/welfare field (safety education etc.)**