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Quantification of public acceptance and identification of acceptance factors on hydrogen fueling stations (HRSs) in Japan

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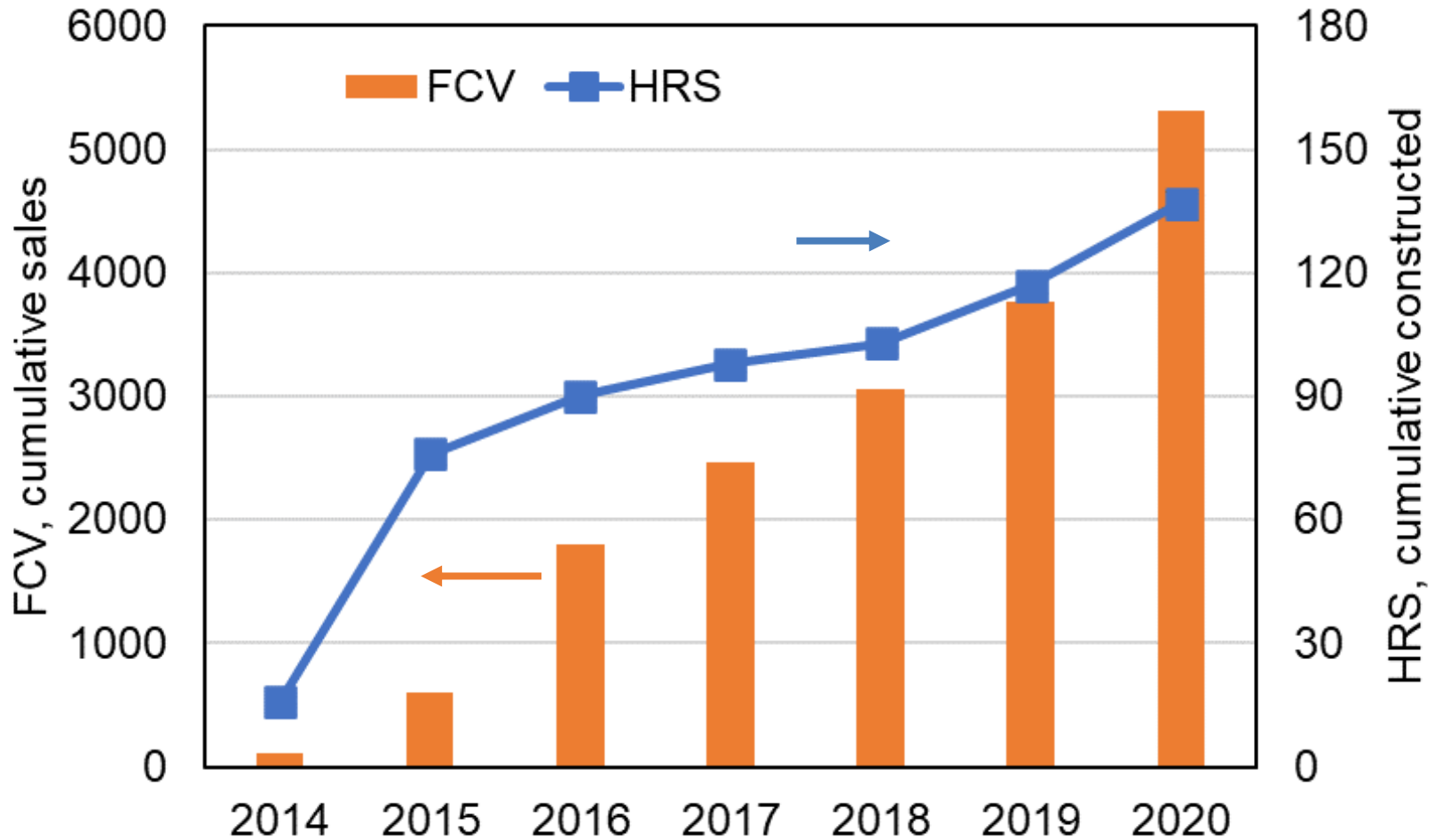
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Agenda

- Risk perception survey to for a hydrogen fueling station (HRS) and 20 technological hazards for Japanese general people
- Survey for social acceptance of HRS with or without risk information of HRS

Introduction

Time trends in FCV sales and HRS constructed



Data sources:

FCV sales: <http://www.cev-pc.or.jp/tokei/hanbai.html>

HRS constructed https://www.meti.go.jp/shingikai/energy_environment/suiso_nenryo/pdf/024_01_00.pdf

Research question


- How people perceive an HRS or new technology?
- How many people accept HRS which introduced in the society of Japan?
- Does risk/safety measure information change people's acceptance on HRS?
- What factors explains acceptance on HRS well?

Survey: Quantification of perceived risk for Japanese on 20 “hazards” including HRS

Online survey for quantifying perceived risk on 20 hazards

Respondents	Japanese citizens (18-60+), registered as online survey monitors, N=2000+
Survey Period	March 2014
Methods	<ul style="list-style-type: none">➤ Respondents were asked<ul style="list-style-type: none">- rating on risk characteristic, with a 7-point Likert scale- toward 20 hazards (next slide)- minimum information provided on the hazards

20 hazards rated in this survey



Gasoline, H2


Hazard/accident related to energy plant



Transportation accident



Natural hazard

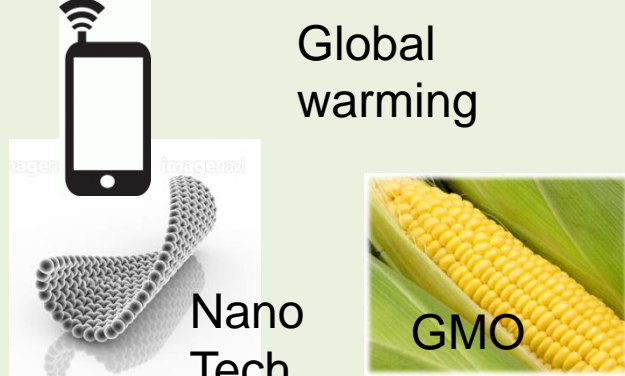


Food additives

X-ray

Asbestos

Traditional health hazard



Global warming

Nano Tech

GMO

Emerging hazard

Factor analysis result: Factor Loadings

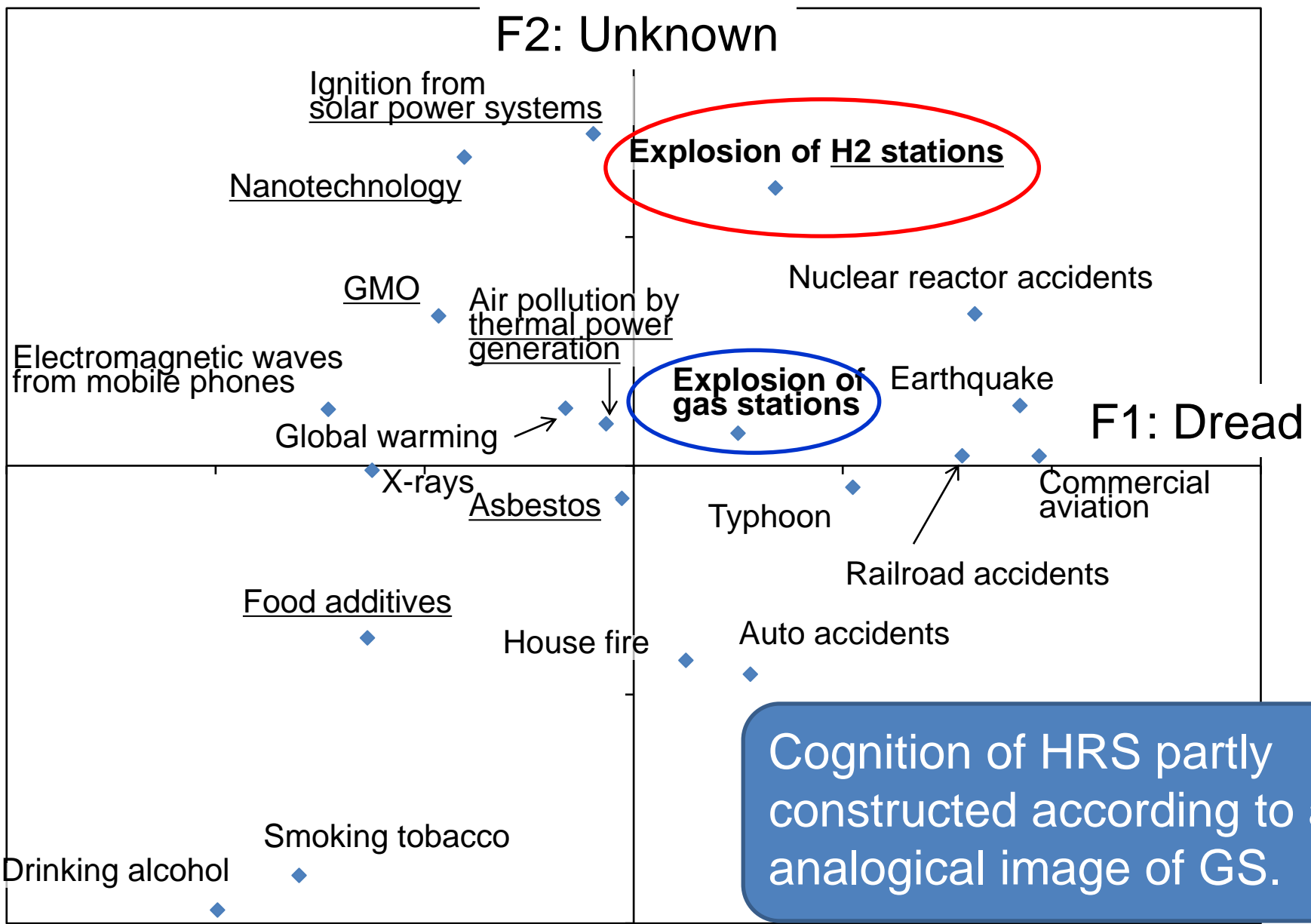
(Eigen value > 1, after promax rotation)

Dread

Unknown

Q: You feel XX to the hazard?	Mean	S.D.	F1	F2
Fatal (D)	4.83	1.56	0.705	-0.202
Dread (D)	4.48	1.67	0.643	-0.033
Catastrophic (D)	4.29	1.85	0.626	0.003
Effect delayed (U)	3.91	1.98	0.509	-0.078
Controllability (D)	4.51	1.95	0.422	0.335
Involuntary/voluntary (D)	4.57	1.72	0.317	0.280
Unknown to individual (U)	3.54	1.64	-0.106	0.701
New/old(U)	3.25	1.80	-0.168	0.505
Unknown scientifically (U)	2.94	1.48	-0.026	0.471
Eigenvalue			2.52	1.79
Cumulative contribution ratio (%)			20.6	33.6

Cognitive map for the 20 hazards



Cognition of HRS partly constructed according to an analogical image of GS.

Surveys on acceptance of HRS

Acceptance trend of HRS in Japan

Public acceptability of HRS with and w/o risk,
safety measure information

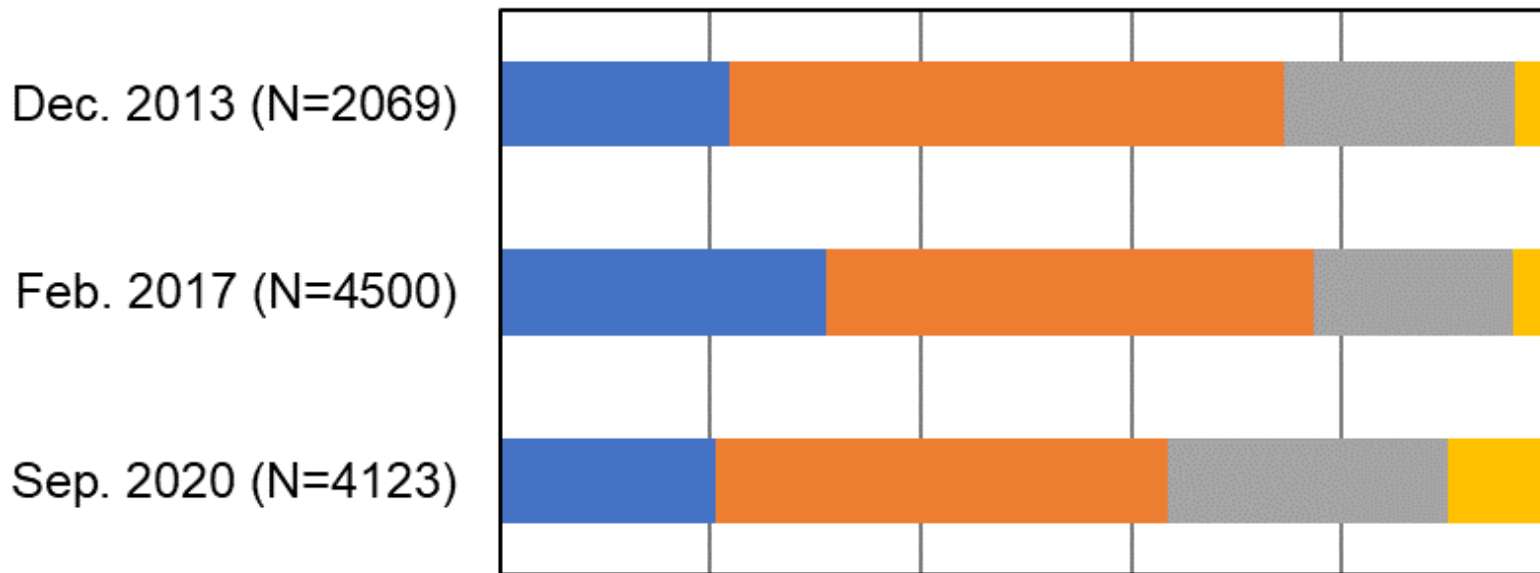
Acceptance trend of HRS

(in 2013, 2017, 2020, Japan, Online survey)

Question: Do you agree if a HRS was constructed at **nearest gas station to your home?**

■ Agree ■ Agree somewhat ■ Disagree somewhat ■ Disagree

0% 20% 40% 60% 80% 100%



Ono, 2021

Collective interview survey for asking acceptance of HRS

Respondents	Japanese citizens (18-60+), registered as survey monitors, total N=628
Questionnaire	Respondents gathered at a room in Tokyo. After orientation by a collaborator, he/she read Question, and respondents chose answer.
Survey Period	December 2017, November 2018
Methods	<ul style="list-style-type: none"> ➤ Respondents were asked <ul style="list-style-type: none"> - rating on degree of acceptance of HRS with a 4-point Likert scale. - risk dimensions toward HRS. - knowledge about H2 energy. - attributes (age, occupation, educational attainment, income, frequency of car use, distances from home to GS).

Provided information in the questionnaire

[What is HRS?]

HRS is a stand for H2 refueling. You can fill a fuel cell vehicle (FCV) with H2 there.

[Where is HRS?]

Hydrogen stands can be built within existing gas stations or they can be newly built ...

[How many HRSs are available?]

In Japan, (...) As of January 2017, there are 80 hydrogen stands in the Greater Tokyo Area, Chubu region,

[How H2 is generated and supplied?]

Hydrogen supplied at hydrogen stands are now obtained in two ways. One is (...).



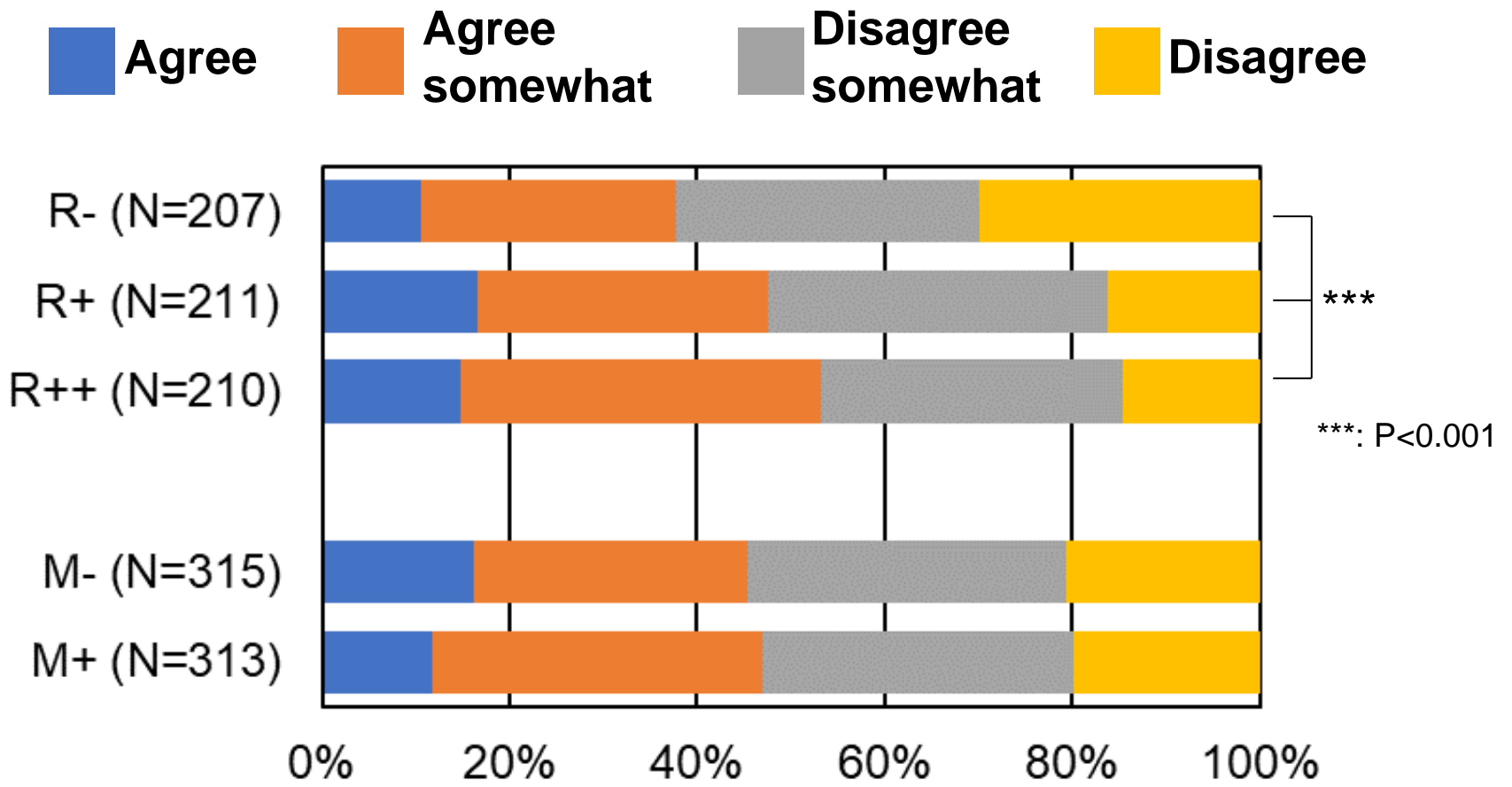
HRS available in Tokyo

Information Provided to respondents

Category		Information Provided to respondents	
Benefit	Lower emission of air pollutants and CO2	“Hydrogen-driven vehicles, including fuel cell vehicles (FCVs), can potentially reduce the negative effects of fossil fuel in transport. FCVs do not exhaust air pollutants in the process of driving.”	For all respondents (N=628)
Risk (R)	Adverse effect that accidental death or eardrum damage at the next to station	<p>Risk value (+) “If hydrogen leak followed by hydrogen explosion occurs, people in outside area of a H2 station will be negatively affected. Risk of eardrum damage is 10^{-5} per year (one in 0.1 million) but it leads no fatalities. Fatality Risk is much less than 10^{-12} per year (one in 100 billion).”</p> <p>Risk value plus reference (acceptable risk level) (++) In addition to above, “This risk is much less than social acceptable risk level (10^{-5} per year; one in 0.1 million).”</p>	<p>Risk info. (N=207)</p> <p>Risk & ref.(N=211)</p> <p>W/o info. (N=210)</p>
Safety measures (M)		H2 stations have built with a ventilation to disperse hydrogen gas, so that leaked hydrogen gas will be diluted to inflammable concentration. If hydrogen explosion occurs, a safety shield made by reinforced concrete will protect house walls or window glasses from shock wave.	<p>With info.(N=315)</p> <p>W/o info.(N=313)</p>

Public acceptability of HRS with and w/o information

Question: Assume you do not have an FCV, and you do not plan to own and use a FCV in the future. Do you agree if a HRS was constructed **NEXT to your home**?

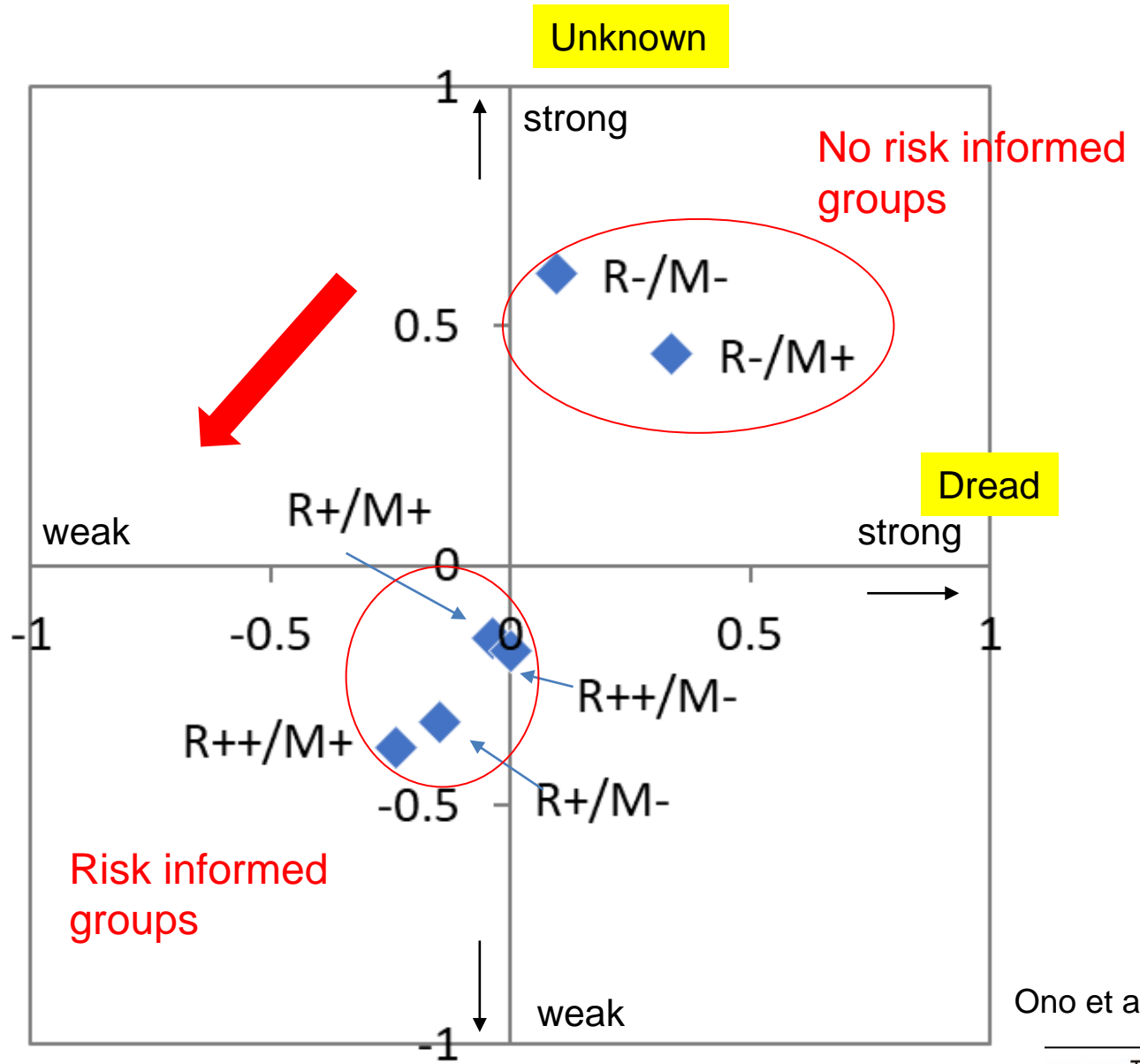


Factor analysis: Factor Loadings

(Eigen value > 1, after promax rotation, ML method)

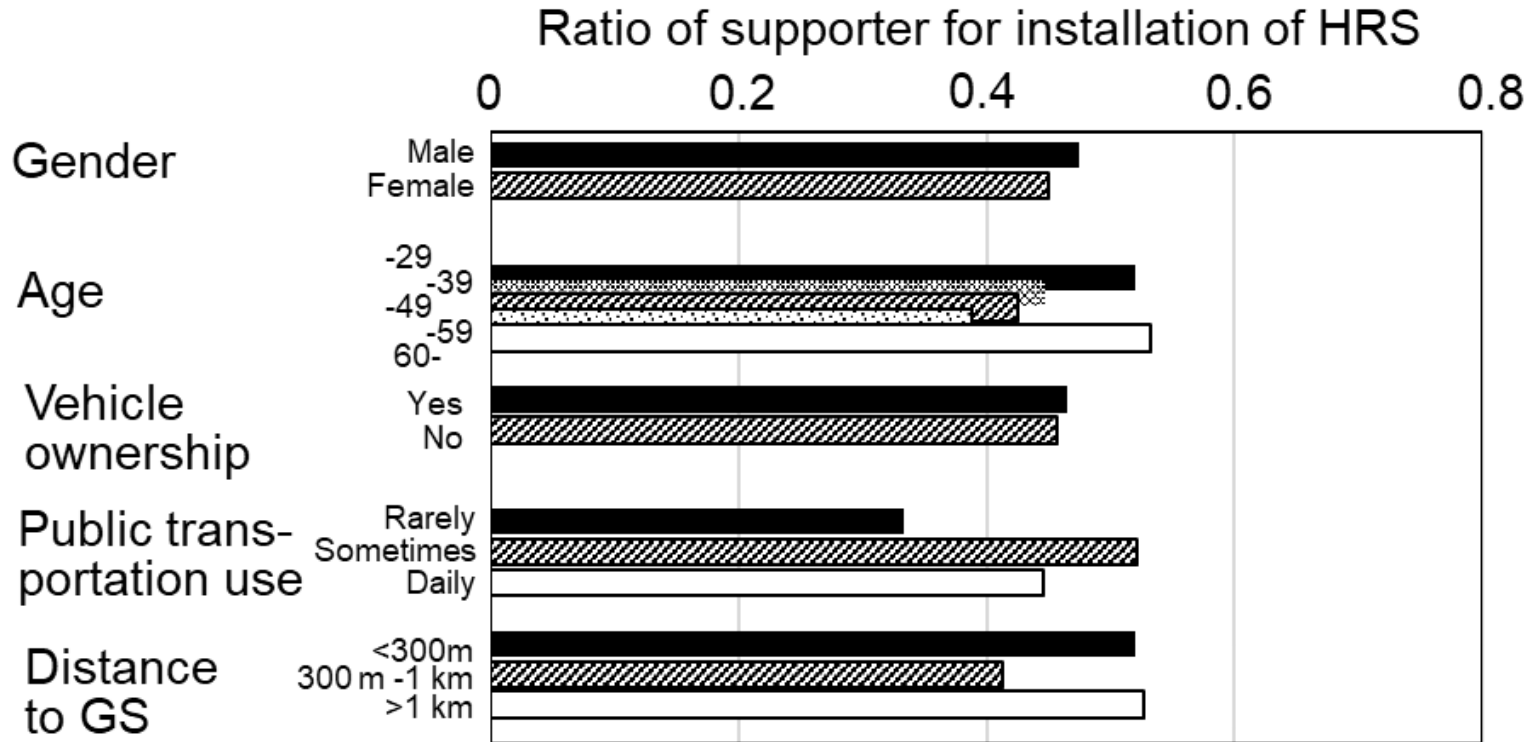
Question items	Mean	S.D.	Factor 1 (Dread)	Factor 2 (Unknown)
I intuitively dread a H2 station.	2.72	0.65	0.91	-0.08
Irreparable damage will be caused by a H2 station.	2.58	0.63	0.78	-0.16
Accidents related to H2 stations will increase when they become popular in society.	2.58	0.62	0.77	-0.10
A H2 station itself causes fear.	2.76	0.64	0.70	0.15
It is difficult to prevent accidents with H2 stations.	2.65	0.61	0.65	0.12
Reliability of the system is poor with a H2 station.	2.67	0.63	0.48	0.25
An accident in a H2 station affects a wide area.	2.45	0.71	-0.04	-0.03
An accident in a H2 station has serious consequences for its surroundings.	2.42	0.71	-0.00	-0.00
An accident in a H2 station results in a large number of victims.	2.42	0.71	0.05	-0.05
Even a small leak of hydrogen from a H2 station should be averted.	2.40	0.74	0.17	0.22
The potential for accidents caused by a H2 station is uncertain.	2.33	0.68	-0.04	0.85
Damage caused by an accident related to the installation of a H2 station is uncertain.	2.32	0.68	-0.07	0.82
Factor correlations for Factors 1&2			-	0.63
Eigenvalue			3.28	1.57
Cumulative contribution ratio (%)			27.3	62.9

Cognitive map on HRS



Ono et al. 2019

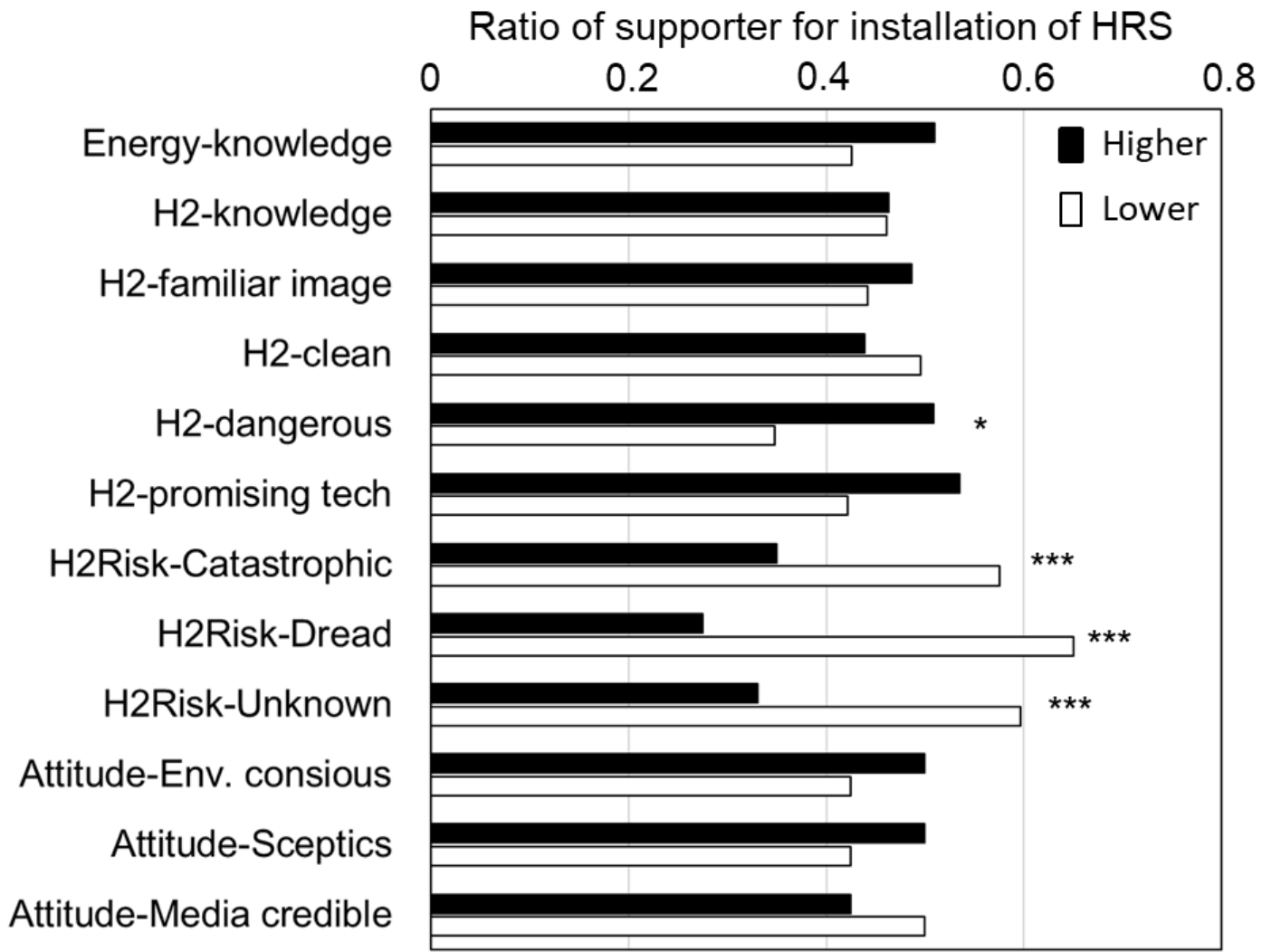
Characteristics of HRS supporter (1)



The ratio of respondents who answered “Agree” or “Somewhat agree” the construction of an HRS next to their home.

Ono et al. 2019

Characteristics of HRS supporter (2)



Ono et al. 2019

Summary

- Cognition of an HRS partly constructed according to an analogical image of a gas station.
- No drastic change has been observed on the acceptance of HRSs according the survey results of 2013, 2017, 2020.
- HRS acceptance survey results showed that
 - provision of the quantitative risk information increased the acceptability of HRS in proximity to the homes of respondents
 - risk information on HRS alleviates the respondents' feelings of dread or uncertainty, leading to better acceptance