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Do eye track devises help in understanding individual decisions process in stated preferences experiments?

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Background

Stated Preference methods are based on the assumption that individuals evaluate all the attributes presented in a compensatory way.

However, respondents often adopt decision processes that deviate from this assumption.

A growing literature on stated choice experiments has focused on the problem of attribute non-attendance (ANA), i.e. when individuals ignore some of the attributes presented:

- one attribute is much less important than the others
- attribute levels do not vary over a range that matters enough to result in a trade-off for the respondent
- respondent adopt simplifying strategies to reduce the mental effort required solving the problem (disengagement due to complex tasks)
- respondents choose based on other attributes not included in the design (simplified survey tasks perceived as unrealistic)

Background

In the attempt to improve the knowledge on how individuals make decision, researchers have recently tried to use eye tracking technology to identify which information respondents pay (visual) attention to.

The idea is based on the concept that there is a relationship between attention and cognitive process.

Looking at an object reveals the amount of processing applied to objects.

- the time spent fixating a location can be considered as an index of the encoding effort
- longer fixation durations are usually associated to more engagement in interpreting the component representations and relate them to internalized representations
- if a respondent has not looked at an attribute, she cannot have processed it either.

Background

Literature in visual attention in Stated Preferences (marketing, food economics) uses the time spent on each attribute inside DCM mainly to:

- detect ANA
- measure the importance of the attributes

Very few studies.

Results are discordant.

Literature in visual attention (neuro-psychology) – many studies:

- relative consensus that eye movements trace the process of information search,
- mixed views with regards to its ability to reveal the functioning of mental processes, i.e. the deliberation process itself, the processing that follows the encoding of information.

Objective

With this work, we aim to add some evidences to the short literature on the role of visual attention to reveal individual decision process in stated preferences experiments.

We included the analysis of the transitions and the scan-path.

Transitions inform on the pairs of attributes that each respondent look at back and forth. This visual process hints to the presence of a trade-off between that pair of attributes.
Scan-path informs on the overall search and evaluation process.

We will focus on understanding the individual decision process that is revealed from the eye-tracker measures, rather than on the role of these eye-tracker measures in the model estimation.

Survey experiment

SP Experiment:

- is based on a previous experiment (Jensen et al., 2014).
- consists of a binary choice between an electric vehicle (EV) and an internal combustion vehicle (ICV), with the addition of a “no choice” option.

The experiment was customised based on:

- the type of vehicles that respondents intended to buy within the next 5 years or have recently bought (in the last five years)
- the range of prices for their next or past purchase.

As screening questions, respondents:

- needed to have a drive licence and have recently driven
- drive less than 150 km a day
- live in an area where it is realistic to install recharging station at home, and close to the main road network and/or city centre
- not EV owners or have participated previously in studies about EV.

A sample of 30 participants was randomly selected from members of a panel.

Survey experiment

Task 2	Petrol Car	Electric Car
Price Price for a standard version without special equipment	£. 22,000	£. 27,500
Drive Cost Fuel or electricity expenses	0.11 £./mi	0.07 £./mi
Operating Range The distance it can drive on a full tank or fully charged battery in optimal conditions	340 mi	105 mi
Emissions Total emissions at the exhaust	306 g/mi	48 g/mi

Car choice scenarios

Assume that the car dealership has only a diesel car and a comparable ele

The two cars are assumed to be otherwise identical.

	Dies	
New car, Medium class 1		
Price *Price for a standard version without special equipment*	26	
Driving cost *Cost of fuel or electricity*	0.13 euros/km *Corresponding to 1 euros for your daily transportation needs*	0.03 euros/km *Corresponding to 1 euros for your daily transportation needs*
Driving range *The distance it is possible to drive on a full tank or fully charged battery in optimal conditions*	992 km	164 km
Carbon emission *The total emissions per km of driving*	156 g/km	0 g/km *All electricity is produced mainly from renewable energy sources*
Infrastructure		
At home *We assume that a private charging facility is installed at home*	Not available	Full capacity obtained in 7 hours
In public spaces *General access to filling/charging stations in public spaces*	Not available	In 20 minutes **25 km** of driving is obtained Available in CITY CENTRES
Stations in the road network *Access to filling/charging stations in the road network*	Full capacity obtained in 5 minutes. Available at ALL service stations	Full capacity reached in 5 minutes Available at 30 charge stations
What car would you purchase in this situation?	●	●
or		
If these alternatives are the only options available, I would not choose any of them	●	

We chose to adopt a simple framework. This, of course, reduces the realism of the experiment, but it gains in precision for the metrics computed from the eye tracker.

Metrics for visual attention

To identify the visual attention related to specific information, the displayed stimulus need to be divided in areas of interest (AOI).

The visual attention metrics will then be computed for each AOI.

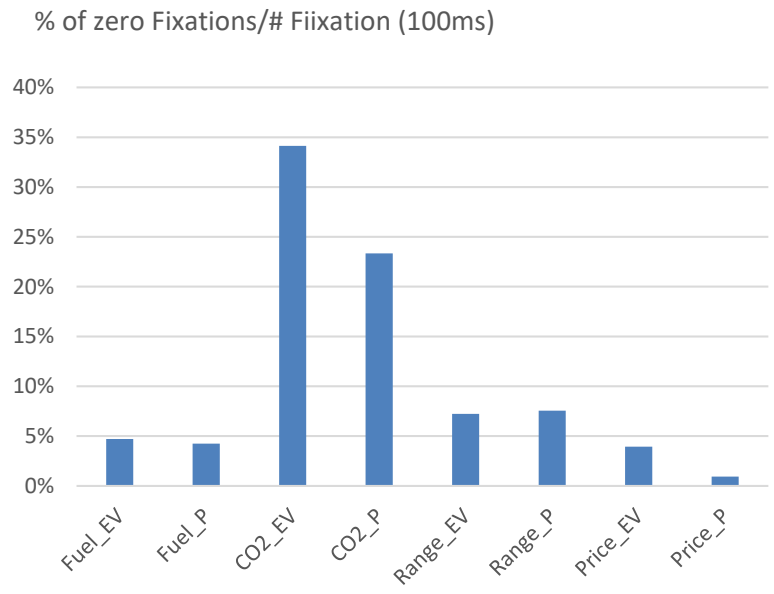
Metrics for the visual attention:

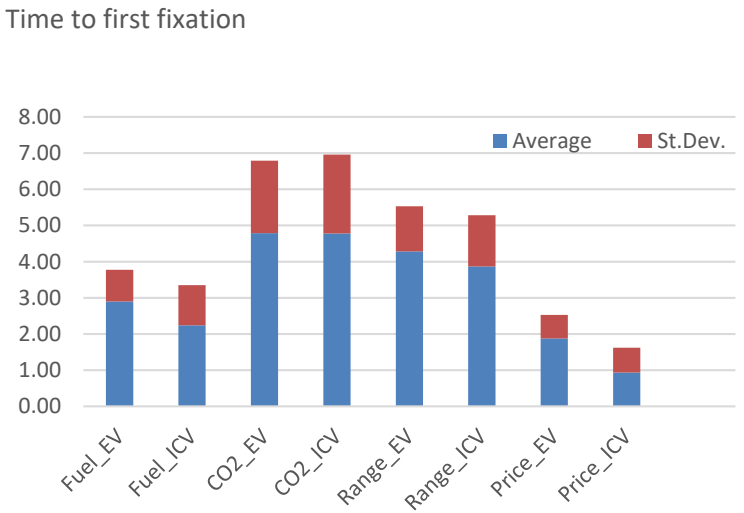
- the number and duration of fixations, i.e. how many time and for how long a respondents has fixated a particular AOI.
- the number of visits in each AOI, i.e. how many time a given AOI is revisited and how long for. Each visit to the same AOI typically includes more than one fixation.
- the transitions, i.e. the number of times a pair of AOI is looked at consecutively, as this reveal potential trade-offs between pairs of attributes.

Cut-off 100ms (50ms):

information needs to be fixate for a certain amount of time in order for the stimulus to arrive to the brain and being elaborated.

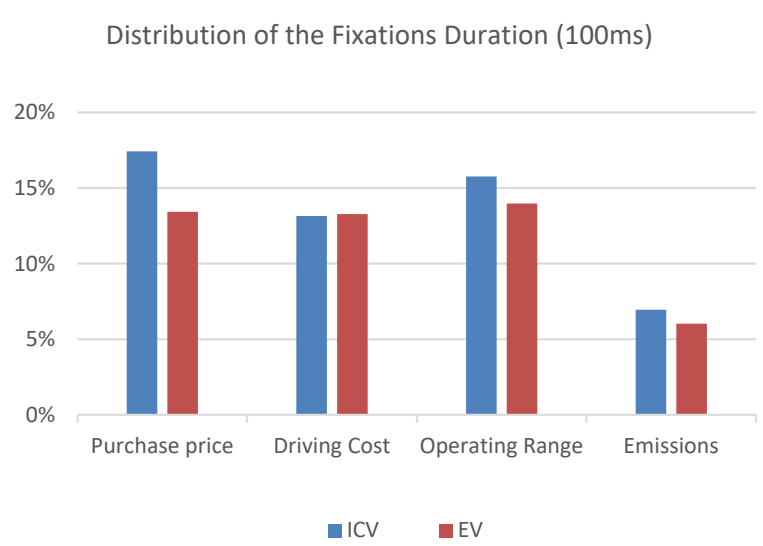
I. Attribute attendance

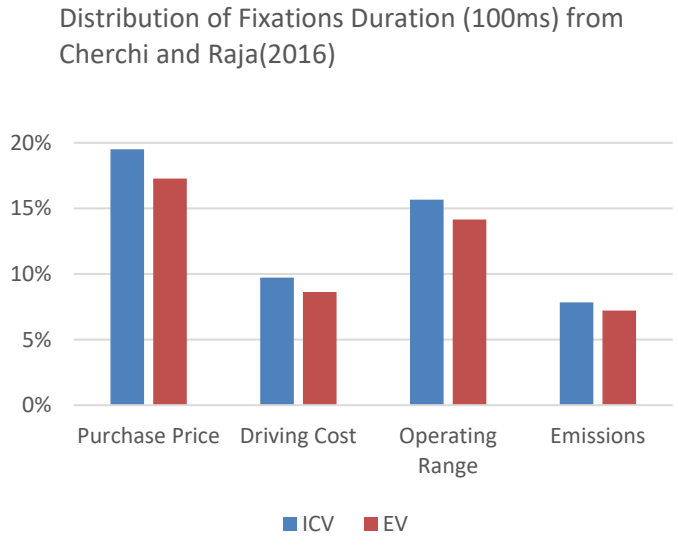




- We found a high number of ANA, also in the first choice task. The number of ANA vary greatly among the different studies.
- The result seems to reflect the position of the attributes in the stimulus. Attributes on the top left (Price_ICV) are looked at first and the least non-attended.
- There is no correlation between the time to the first fixation and duration of the fixation for each attribute (position in the stimulus does not affect the visual attention, importance of the attribute matters)

I. Attribute attendance

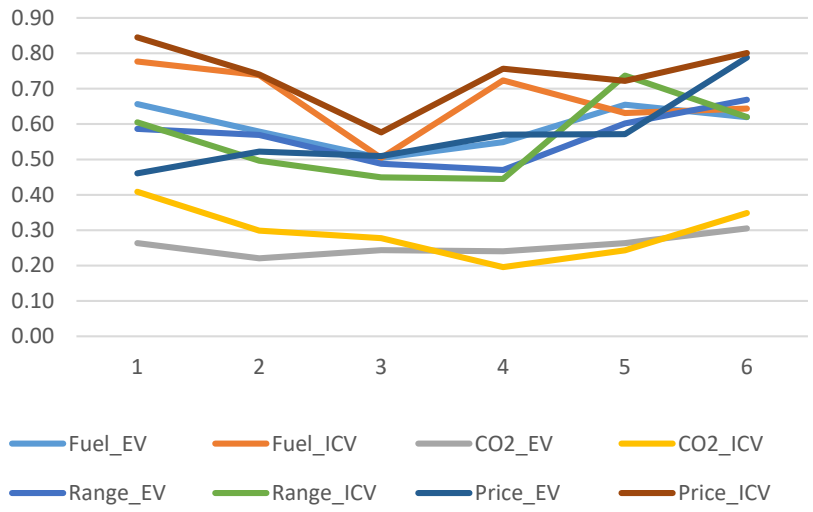




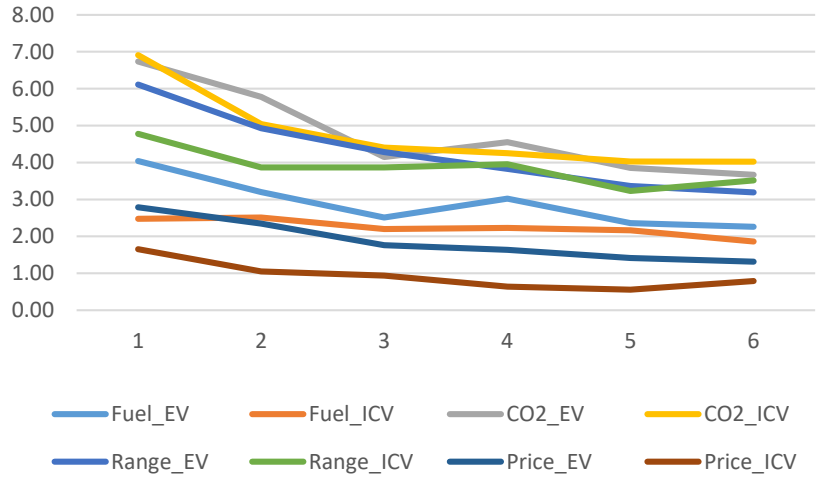
- Overall respondents spend more or less the same amount of time in the common characteristics of ICV and EV, but there is a significant difference among attributes.
- Interestingly respondents fixate longer all the ICV attributes than the corresponding EV attributes
- The pattern is similar to the one observed in Cherchi and Raja (2016),
- It might be, that respondents look at the ICV alternative to evaluate how distant this is from the ICV car they have in mind to buy (reference point), before comparing it with the new EV alternative. Re-think the SP designs for new products, at least those for EV?

I. Attribute attendance

Fixation Duration 100ms (average)



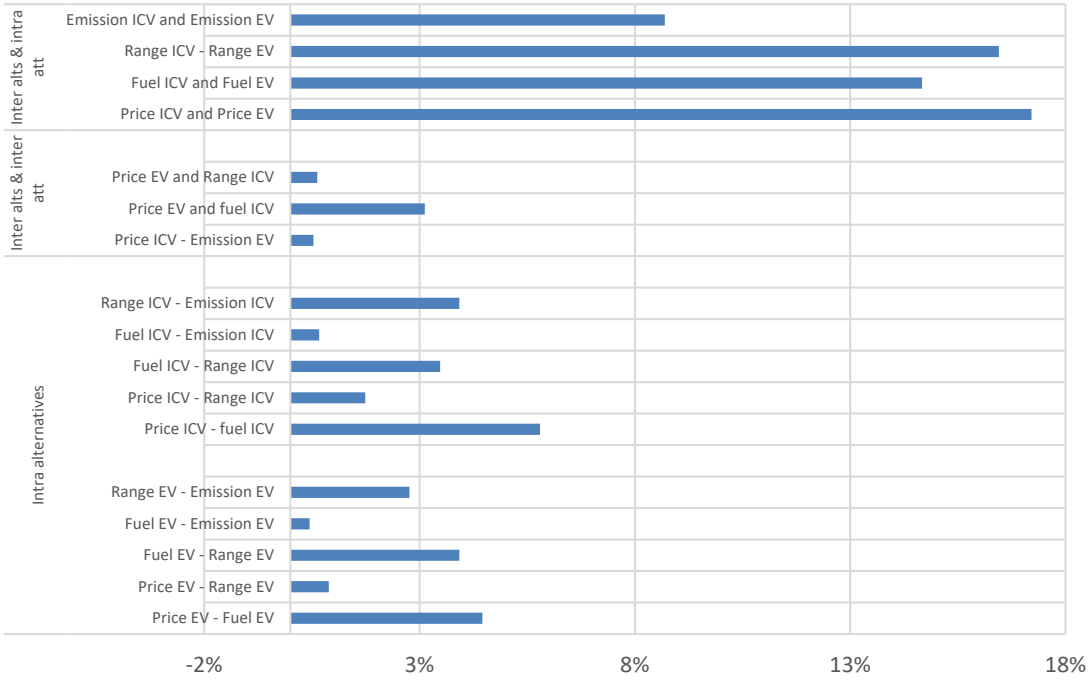
Average time to first fixation across SP tasks



- Fixation time is typically found to decrease from the first to the last choice task presented, reflecting the experience gained by the respondents over the SP exercise.
- We found that the time to the first fixation reduces of approximately 1/3 between the first and the sixth choice task, but the duration of the fixation reduces along the first 3 tasks and then increases again.
- There is no correlation between level of the attribute and the time it is fixated

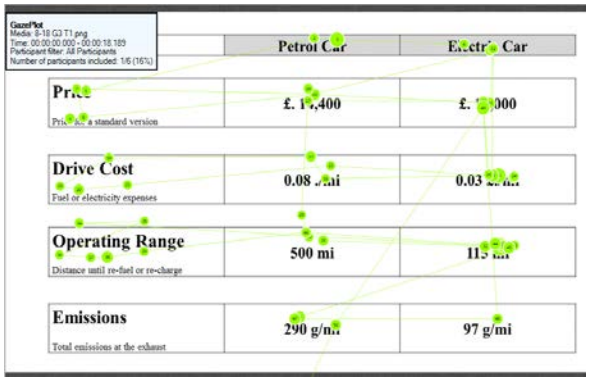
II. Transitions and trade-offs

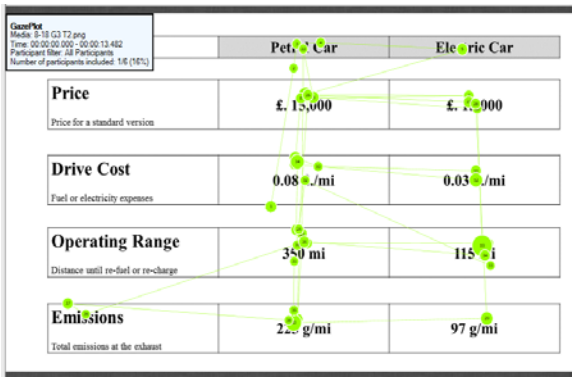
Distribution of transitions among pairs of attributes

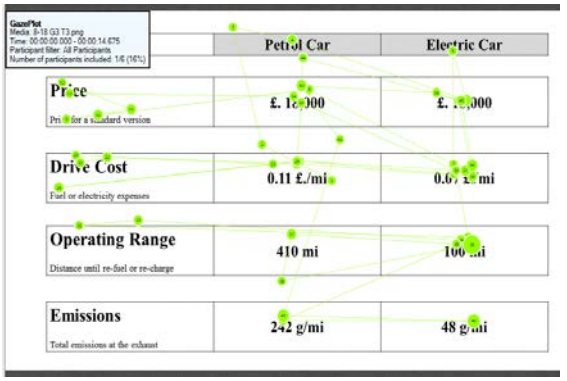


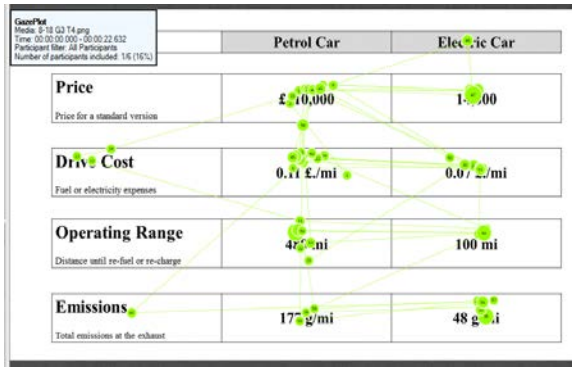
- individuals mainly compared the same attribute between alternatives (inter-alternative trade-off), and in particular the price, followed by range and fuel cost.
- the trade-offs intra alternatives, i.e. between attributes of the same alternative, is much less frequent and occurs mainly between purchase price and fuel cost (probably because both are expressed in monetary value),
- transitions are more frequent within the ICV alternative than the EV alternative
- results of Cherchi and Raja (2016) shows a very similar pattern.

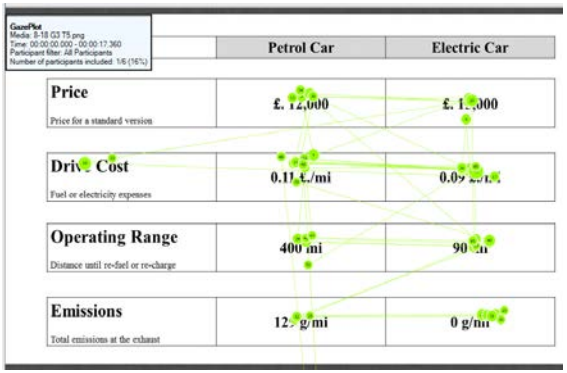
III. Heterogeneity in the decision process

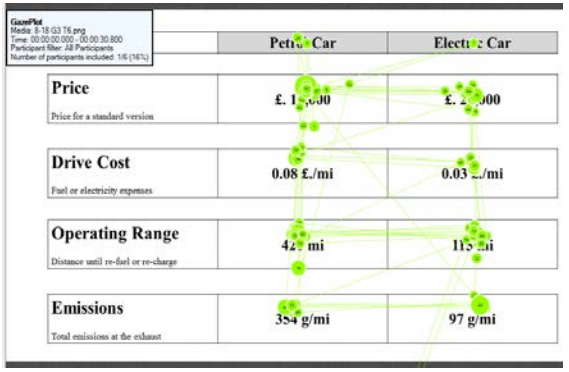








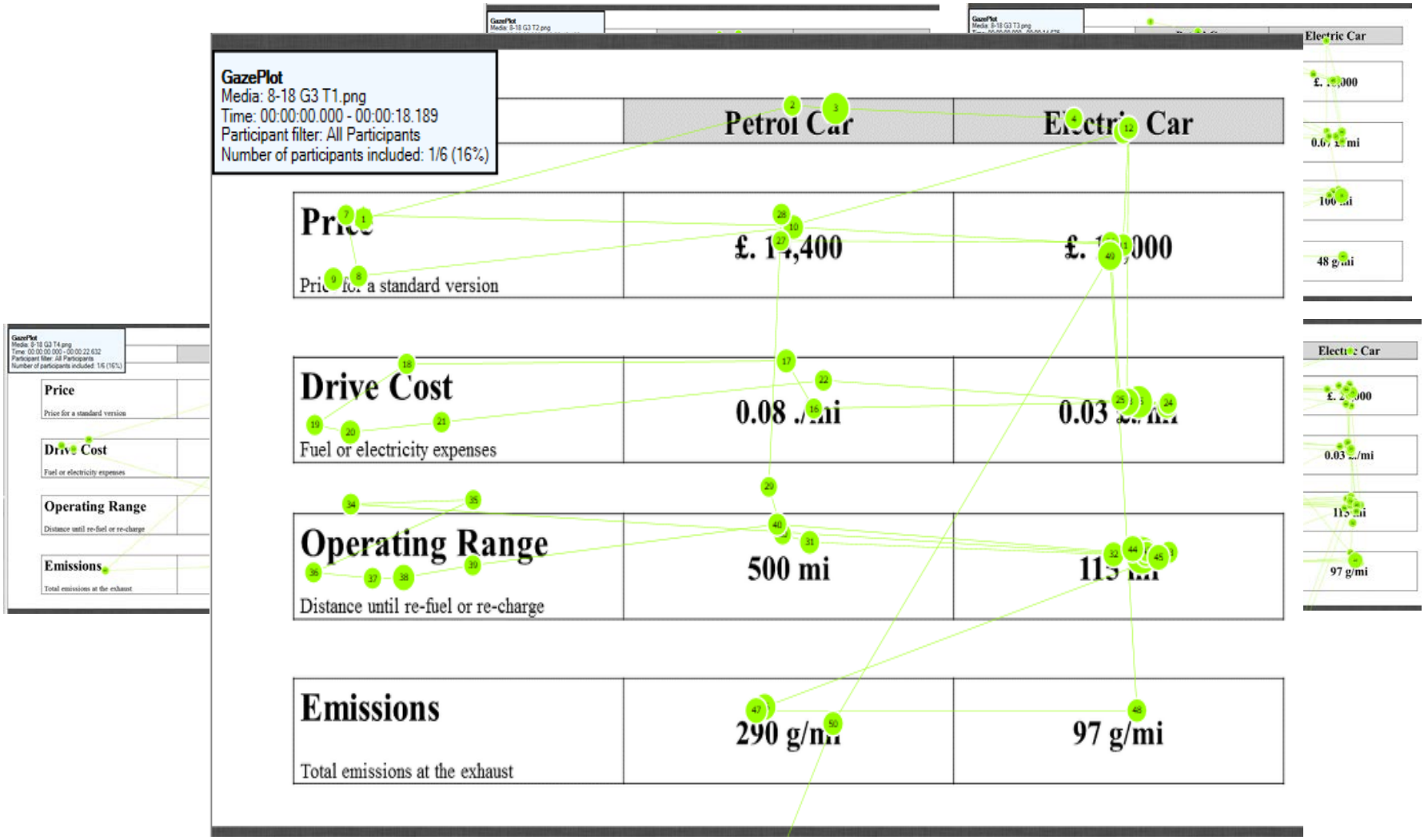




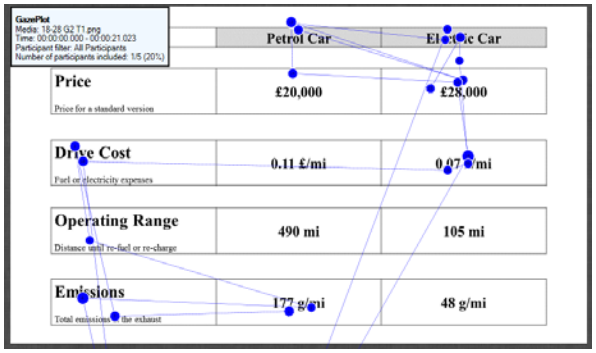
- Scan-path can reveal how efficient is the search for information
- How the search process evolves over tasks

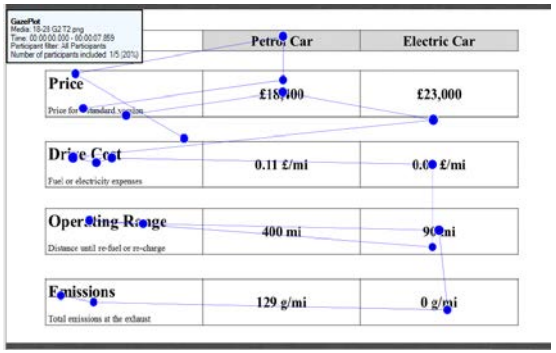
Very regular and consistent scan path through all the tasks. She looks at all the attributes, with the attention strongly stable at the center of the AOI. It seems to be an “ideal” decision process,

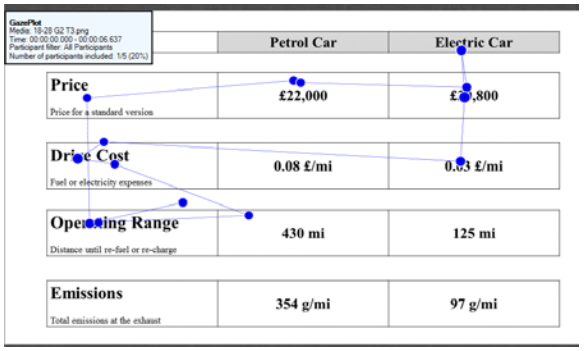
III. Heterogeneity in the decision process

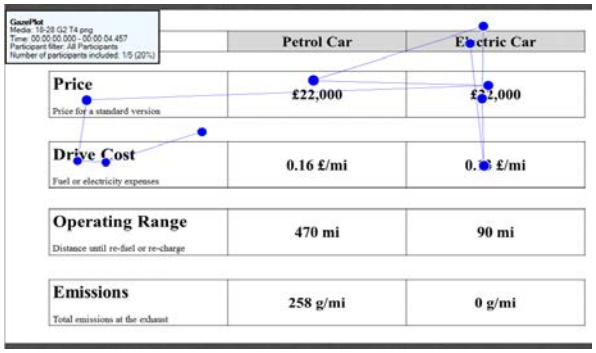


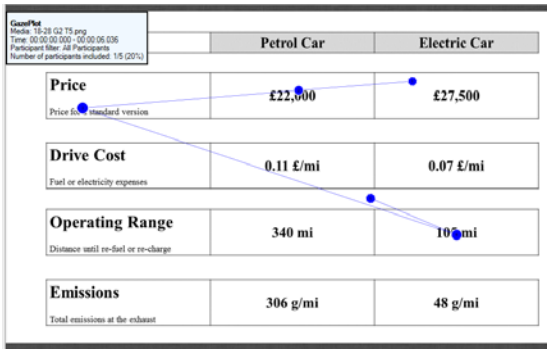
III. Heterogeneity in the decision process

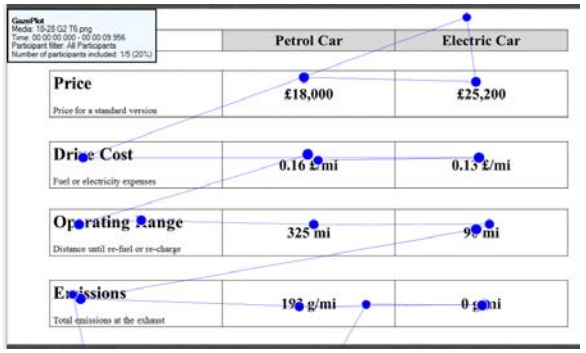










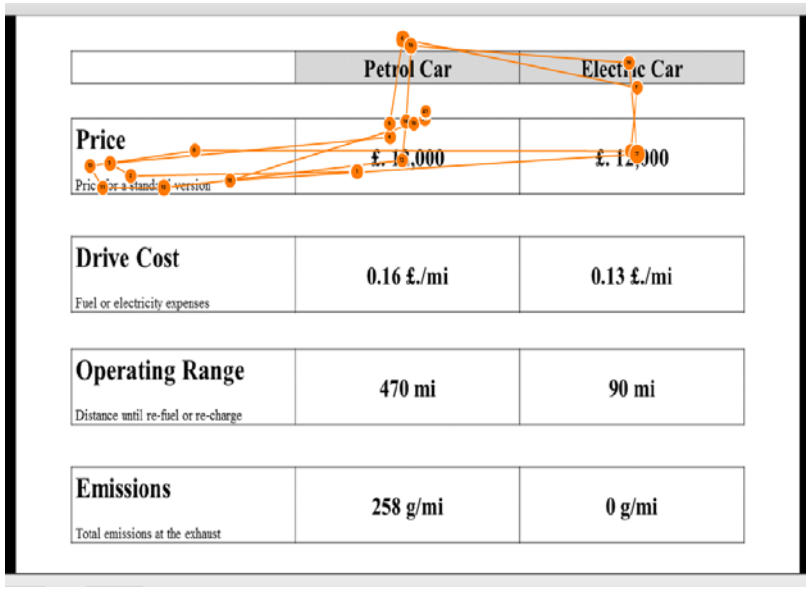


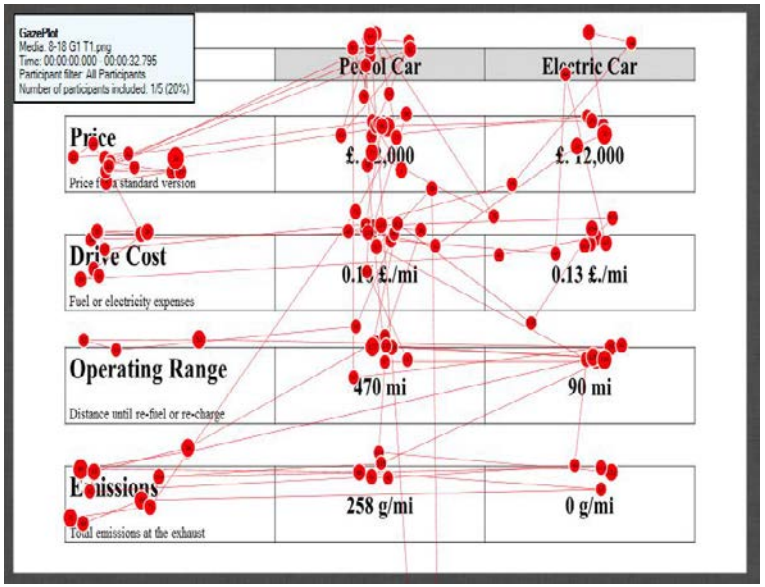
Quite different scan-path:

This respondent did not look at all the attributes, since the very first choice task. ANA are different among the 6 tasks. The focus is often in between AOI or outside the screen.

If we cut-off the first fixations (considered searching process not evaluation), we can reasonably conclude that this respondent was not engaged in the exercise (this obs. was indeed removed)

III. Heterogeneity in the decision process





Heterogeneity observed is much more …

Visual attention & Preferences

Is the relationship between visual attention and preferences for attributes?

$$U_{jqt} = \sum_k \theta_{kj} X_{kjqt} VA_{kjqt} + \varepsilon_{qjt} + \mu_{qj}$$

- None of the visual attention measures proved to allow explaining better individual preferences for specific attributes.
- Based on the analysis of the scan path we chose to eliminate 4 respondents, which proved to significantly improve model estimation. Unfortunately, for larger samples this “ad-hoc” analysis is not recommended and it is important to identify a metric to measure why those scan path should be removed.
- The current metrics based on the fixations or non-attendance did not seem to be able to capture the full complexity of the link between visual process and decision process or between visual attention and value to attributes.

Conclusions

Our results:

- reinforce the evidence that fixations are not a good (or probably not sufficient) measure for the importance of the attribute.
- highlight huge heterogeneity of the individual's visual process
- raise the importance of the analysis of the transitions in revealing trade-offs between attributes
- raise the importance of the analysis of the scan path in revealing individual visual process.

Many more studies and validation tests are of course needed before some conclusion can be drawn.

Different tests need to be performed to understand the link between visual attention and attributes importance.

Conclusions

Challenges:

- it is not clear whether the movements of our eyes can be informative on the nature of higher-level mental processes.
- if a respondent looks at an attribute does not guarantee that she is processing it or that this has a particular value.
- response times indicate how long a task takes, but not the nature of processing that occurs during that interval.
- allocation of visual attention to a stimulus may not always be sufficient to render that stimulus consciously visible to the observer.

Many thanks

Reference:

Cherchi, E. (2018) Using eye track devises to understand individual decisions in stated preferences experiments: an application to the choice of electric vehicles. *Transportation Research Procedia* (*forthcoming*)