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Ambiguity Attitudes in decision-making for others

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Abstract

This thesis investigates whether the two components of *ambiguity attitudes*, *ambiguity aversion* and *a-insensitivity*, differ in individual decision-making from decision-making for others. For measuring ambiguity attitudes, the method of Dimmock, Kouwenberg, and Wakker (2016) is used. Further, it looks at whether the decision makers' relationship with the others affects the decisions made for others. The findings of this thesis show no significant difference in ambiguity attitudes when deciding for oneself than when deciding for others. However, the findings did show evidence that decision-making for a boss decreases individuals' ambiguity aversion. This paper is an addition to the literature by emphasizing the relevance of examining 'self – other' decision-making differences for ambiguity attitudes.

Keywords: ambiguity attitudes, a-insensitivity, ambiguity aversion, decision under ambiguity, decisions for others

Table of contents

1 Introduction

Ambiguous situations can be found in all aspects of today's society. Ambiguous situations are situations under uncertainty where in contrast to risk, the probabilities attached to decisions are unknown. In real life, everyone encounters ambiguous situations, from CEO's to consumers to political leaders. Decisions that are made in these ambiguous situations can be innocent but can also be crucial. For instance, decisions related to the environment. Decisions related to the environment are regularly made under ambiguous situations: the exact impact of decisions on the environment is unknown most of the time. Nevertheless, the consequences of these decisions are extremely important. A topical example of a real-life situation in which many decisions have to be made under ambiguity is the current Covid-19 pandemic crisis. Just like many decisions related to the environment, probabilities attached to outcomes of decisions related to the corona-crisis are often unknown. As the Prime Minister of the Netherlands acknowledged: "*We want to prevent overloading our hospitals. However, we do not know exactly what the right approach is. With 50 percent of the knowledge, we have to make 100 percent of the decisions"* ("Nederland verhoogt de," 2020). There has never been a pandemic like the coronavirus before in the current complexity of our globalized world. This makes decision-making about the corona-crisis ambiguous; it is unclear what consequences of certain decisions will be. However, political leaders and government institutions need to make the optimal decisions in a highly uncertain situation. Hence, making optimal decisions in ambiguous situations can be significantly important and can even have an added value for the entire society. In this bachelor thesis, ambiguity is investigated and decision-making for oneself compared to decision-making for someone else in ambiguous situations is examined in order to improve decision-making under ambiguous situations.

The importance of ambiguity has been raised within behavioural economics. Behavioural economics is an emerging field in economic which studies the gap between rational and actual behaviour. Decisions under ambiguity are decisions under uncertainty that are characterized by a lack of knowledge about the probabilities attached to various outcomes (König-Kersting & Trautmann, 2016).

Ambiguity attitudes affect individuals' behaviour in ambiguous situations. Ambiguity attitude can be described as the change of behaviour between risk and ambiguity. Ambiguity attitude is composed of *ambiguity aversion* and *ambiguity-generated likelihood insensitivity* (a-insensitivity) (Wakker, 2008). The tendency of subjects preferring to bet on events involving clear probabilities (risk) rather than betting on events involving unknown probabilities (ambiguity) is known as *ambiguity aversion* (Ellsberg, 1961). *A-insensitivity* measures individuals' understanding of an ambiguous situation. The

higher the a-insensitivity of an individual, the bigger his/her lack of sensitivity to changes in likelihoods (Dimmock et al., 2016). In order to improve ambiguity neutral decision making, it is an important and relevant contribution to previous research to examine ambiguity attitudes in deciding for others. Information about the effects of decision-making for others on both components of ambiguity attitudes provides a clear overall insight into the effects of decision making for others on ambiguity. If decision making for others has an impact on ambiguity attitudes, this could lead to useful new insights in conducting theories in order to reduce ambiguity aversion and a-insensitivity, and consequently increase rational decision-making. The consequences of increased rational decision-making could affect the society positively as the aforementioned examples make clear. The research question of this thesis is:

Do ambiguity attitudes change in decision making for others?

The rest of this paper is organized as follows. Section 2 presents the related literature regarding the relevant concepts of this paper. The next section describes the research methods used. Section 4 presents the results. The paper then finishes with a discussion into the limitations and the future opportunities for further research in the field, followed by a conclusion.

2 Literature

2.1 Decision-making for others under uncertainty

Decision-making for others under uncertainty consists of decision-making under ambiguity (where attached probabilities are unknown) and under risk (where attached probabilities are known). Literature related to ambiguity attitudes in decision making for others is limited. Decision-making for others under risk is better known as it has been studied more often in literature.

Chakravarty et al. (2011) found that agents tend to be less risk-averse when they make decisions over another person's money, compared to decisions that they make over their own money. Both decisions reflect risk aversion, but when people are asked to decide for others, they make decisions consistent with lower risk aversion (Chakravarty et al., 2011, p1). Andersson et al. (2016) stated that when losses under risk are possible, decision-makers are less loss-averse when they decide for someone else. Andersson et al. (2016) mentioned that in this way, decision making on behalf of others can reduce loss aversion and can therefore bring decisions closer to rationality. Also, Pollmann, Potters, and Trautmann (2014) found a difference in self – other decision-making under risk. Pollman et al. (2014) found that in the absence of accountability, agents choose less risk-averse investments for the principal than investors who invest for their own account.

Due to the similarities of ambiguity and risk, it is plausible that the differences in decision making for others under risk could also appear under ambiguity. There is only one relevant paper that examined this hypothesis. König-Kersting and Trautmann (2016) state that ambiguity attitudes are not affected by agency situations. There needs to be more scientific evidence besides this single paper of König-Kersting and Trautmann (2016) to actually make the statement that ambiguity attitudes do not change when someone chooses for another. This paper only examined ambiguity aversion and did not look at a-insensitivity. However, I will look at both components of ambiguity attitudes, ambiguity aversion and a-insensitivity. In the treatment of König-Kersting and Trautmann (2016), participants were asked to decide for another participant. In this empirical treatment the participants did not have an emotional connection with the other participant for whom they needed to make a choice.

2.2 Ambiguity attitudes

As stated in the introduction, ambiguity attitudes reflect individuals' behaviour under ambiguous situations. Knight and Keynes first acknowledged the relevance of ambiguity in 1961. Knight (1961) made a distinguishing between measurable uncertainty and unmeasurable uncertainty. With measurable uncertainty, Knight (1961) referred to risk: options involving clear probabilities of events. With unmeasurable uncertainty Knight (1961) referred to options involving vague or unknown probabilities, these options are later defined as ambiguity. Keynes (1961), on the other hand, distinguished between probability, the balance of evidence in favour of a particular option, and the weight of evidence, representing the quantity of evidence supporting that balance (Fox & Tversky, 1995).

At first, the importance of a-insensitivity was not yet established, and only ambiguity aversion was recognized as a component of ambiguity attitude. In a wide range of sectors, ambiguity aversion may cause irrational decisions regularly. A real-life example of ambiguity aversion is the fact that individuals avoid participating in the stock market because of unknown probabilities (Easley & O'Hara, 2009). An example in health economics is the situation where individuals avoid medical treatments when attached probabilities are vague (Berger, Bleichrodt & Eeckhoudt, 2013). Decisions with moral importance, as decisions related to the environment or the corona-crisis as mentioned in the introduction may experience irrationality because of ambiguity aversion as well.

Ellsberg (1961) used Ellsberg-Urn tasks to demonstrate subjects' ambiguity aversion. An Ellsberg-Urn task is a task where subjects have to decide between two urns. The two urns consists of black and red balls. For the first urn: urn Known (urn K), the proportion of black and red balls are known. For this urn K, there is exactly the same number of balls for each colour. The subject knows that this distribution of black and red balls is exactly 50/50 for urn K. However, the proportions for the second urn, urn Unknown (urn U) are unknown. All the subject knows about urn U is that this urn consists of black and red balls. A subject is then asked to choose an urn to draw a ball from. If the subject draws a red ball, the subject wins a prize. The option for urn K is an option under risk. The option for urn U is an option under ambiguity. The tendency of subjects to prefer to draw a ball from urn K compared to urn U is known as ambiguity aversion. Again in this thesis, the Ellsberg Urn tasks are used to elicit subjects ambiguity aversion.

Ambiguity aversion is a violation of classical decision models that use expected utility (Dimmock et al., 2016). An important example of such a decision model is the Expected Utility Theory of Savage (1954). Expected Utility theory assumes that individuals base their decisions on their subjective probabilities. The violation of expected utility can be illustrated with the use of mathematical formulation.

Equations 1 and 2 illustrates preferences a subject could have. $Prize_{R_k}0$ denotes for example a *prize* a subject wins if he/she draws a red ball from the known urn (R_k) and noting (0) if he/she draws a black ball. Likewise, $Prize_{B_k}0$ denotes a *prize* a subject wins if he/she draws a black ball from the known urn. R_u denotes drawing a red ball for the unknown urn and B_u denotes drawing a black ball for the unknown urn. In both situations, the subject prefers to draw from the known urn despite the colour of the ball.

$$Prize_{R_k}0 > Prize_{R_u}0 \qquad \textit{Eq. 1}$$

$$Prize_{B_k}0 > Prize_{B_u}0 \qquad \textit{Eq. 2}$$

In equations 3 and 4 P(•) stands for the subjective probability for drawing "•". "•" can for example be "R_k": drawing a red ball from urn K. Equations 3 and 4 are the probabilities derived from the subjects' preferences (equations 1 and 2). For example, equation 3 displays that the subjects' probability for betting on drawing a red ball out of urn K is higher than its probability for betting on a red ball out of urn U.

$$P(R_K) > P(R_U) \qquad \textit{Eq. 3}$$

$$P(B_K) > P(B_U) \qquad \textit{Eq. 4}$$

According to Expected Utility theory, the sum of the probabilities of two complementary events must be 1 (Savage, 1954). Thus $P(R_K) + P(B_K)$ should be 1 and $P(B_K) + P(B_K)$ should be 1. However, according to the probabilities in equations 3 and 4, the complement of $P(R_K)$ and $P(B_K)$ is higher than the complement of $P(R_u)$ and $P(B_u)$. There is a contradiction (1 > 1) and thus, a violation of the Expected Utility theory.

When rational decision-making is taken as an equivalent to optimal decision-making. Then, in order to make optimal decisions, decision making should be rational and therefore adhere Expected Utility Theory. With this reasoning, ambiguity aversion could negatively influence optimal decision-making (rational decision-making).

In measuring ambiguity aversion beliefs must be taken into account. People have beliefs about the likelihood of ambiguous events and can therefore assign subjective probabilities. For example, an

individual that prefers betting on winning 10 euros under risky event A over betting on 10 euros under ambiguous event B. This individual does not necessarily need to be ambiguity averse. It could also be the case that this person is ambiguity neutral but assigns a lower subjective likelihood to this ambiguous event because of beliefs this person has about the ambiguous event. Consequently, in measuring ambiguity, there should be controlled for subjective likelihoods.

An advantage of the Ellsberg Urn task is that there is controlled for beliefs. The symmetry of the Ellsberg Urn tasks leads to the plausible assumption that subjects perceive both urns as equally likely. In real-life decision-making under ambiguity, there is hardly ever symmetry. Consequently, it is more difficult to measure ambiguity attitudes in natural events.

Nevertheless, when there is control for symmetry, the majority of the subjects still prefer the known urn over the unknown (Ellsberg, 1961). Thus, the majority of subjects are ambiguity averse.

The second component of ambiguity attitude that has been recognized in later studies as an important component of ambiguity attitude is a-insensitivity. According to Li (2017), a-insensitivity is an important but sometimes neglected component of ambiguity attitude. It is important to measure both components of ambiguity attitudes because subject's attitudes can differ for both components. A-insensitivity reflects a lack of understanding of uncertainty (Baillon, Cabantous & Wakker, 2012). A-insensitivity takes different likelihoods into account and measures subjects' understanding of these likelihoods. As stated by Dimmock et al. (2016), most individuals cannot distinguish well between different levels of ambiguity. Individuals tend to transform their subjective probability of a high or low likelihood to a likelihood of 50-50 (moderate likelihood). The result of this is that individuals are ambiguity seeking for low likelihoods and ambiguity averse for high likelihoods (Dimmock et al., 2016). Graphically, a-insensitivity is an inverse-S shaped probability weighting function, see figure 1.

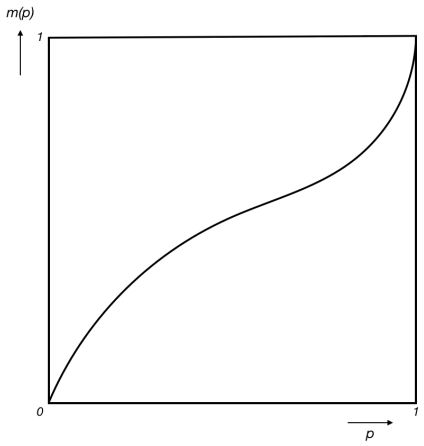

Figure 1. Feasible graphic representation of a-insensitivity

When it comes to proving decision-making, a-insensitivity could lead to new insights. If decision-making for others (compared to individual decision-making) influences a-insensitivity, this would create new opportunities for the development of theories to increase rational decision-making. A-insensitivity is more likely to be influenced by intervention than individuals' intrinsic aversion towards ambiguity (Li, 2017). Hence, decision-making could be improved through policy interventions that influence a-insensitivity. This makes a-insensitivity a relevant component of ambiguity attitude and therefore an interesting addition to this thesis.

Ambiguity is too comprehensive to only distinguish between ambiguity and risk. There are many different decision-situations under ambiguity. In the Ellsberg urn tasks there is a decision to be made between ambiguity and risk. However, this does not always have to be the case. There can also be ambiguity in multiple options. In such situations, home bias might occur. Home bias is a familiar problem in finance. Investors prefer to bet on domestic stocks than on foreign stocks although this is not necessarily the better option. The probabilities of betting on domestic versus foreign stocks are both unknown but investors feel like they are more knowledgeable about domestic stocks. For example, US investors hold 92.2% of their equity portfolio in domestic stock, UK investors 92%, German investors 79%, and French investors 89.4% (Castro & Chateauneuf, 2011).

2.3 Hypotheses

In order to answer the research question and to conduct relevant research related to the research question, I have formulated seven hypotheses.

Due to the similarities of ambiguity and risk, it seems plausible that people are less ambiguity averse in decision making for others just as people tend to be less risk-averse when deciding for an anonymous stranger (Chakravarty et al., 2011). Therefore, it is expected that ambiguity aversion changes in decision making for another. This results in the first hypothesis:

H1: Ambiguity aversion changes in making a decision for another as compared with deciding for oneself

As aforementioned, a-insensitivity means that individuals cannot distinguish well between different levels of ambiguity. It seems logical that individuals still have the same problem with different levels

of ambiguity in decision making for others. Therefore, it is not expected that there is a significant difference in a-insensitivity for decision making for others. More formally, the second hypothesis is stated as follows:

H2: A-insensitivity remains the same for individual decision-making and deciding for another

It is possible that ambiguity aversion in decision making for others is influenced by whom to decide for. As mentioned before, Sutter et al. (2013) mentioned that ambiguity attitude is influenced by socioeconomic characteristics. Since socioeconomic characteristics and emotional relationships could be related to each other, I expect an influence of emotional relationships on ambiguity aversion. Therefore, the third hypothesis is:

H3: The type of relationship a subject has with the person the subject decides for influences ambiguity aversion

It is not possible to measure the effect a relationship a decision-maker has with the person they decide for on a-insensitivity since for measuring a-insensitivity subjective probabilities for low and moderate likelihood are taken into account. Subjects have been randomly assigned a relationship per case, so the relationship assigned to subjects may differ for low and moderate likelihood. Therefore, the index for a-insensitivity is based on two different relationships. Thus, measuring the effect of a relationship on a-insensitivity would not be valid for this data.

Trautmann, Vieider, and Wakker (2008) mentioned the number of siblings as one of the socioeconomic characteristics. To gain more insight into which socioeconomic characteristics play a role and to what extent. I will examine the effect of socioeconomic characteristics on ambiguity attitudes. I will include the following socioeconomic characteristics: age, household size (in which a subject grew up), political preference, income, religion, gender, and education. The fourth and fifth hypothesis is stated as follows:

H4: Socioeconomic characteristics have an influence on ambiguity aversion
H5: Socioeconomic characteristics have an influence on a-insensitivity

Finally, I will look at the effects of socioeconomic characteristics on self-other decision-making differences for ambiguity aversion and a-insensitivity. Due to the known relationship between ambiguity and socioeconomic characteristics and the fact that it is known in the literature that risk

aversion is influenced by self-other decision-situations, the sixth and seventh hypothesis are stated as follows:

H6: Socioeconomic characteristics have an influence on self-other differences of ambiguity aversion

H7: Socioeconomic characteristics have an influence on self-other differences of a-insensitivity

3 Methods

This section presents how ambiguity attitudes in individual decision-making and decision-making for another are tested. The research questions are answered with the use of empirical research. A dataset has been constructed using the survey software Qualtrics. Ambiguity attitudes are constructed by obtaining matching probabilities. First, the experimental design is explained. Second, eliciting matching probabilities is explained in detail. Following, it is made clear how indexes can be derived from the elicited matching probabilities. Thereafter, concrete details concerning the sample are presented. Finally, the use of materials is clarified.

3.1 Experimental design

The experimental design is an empirical design that is done through an online survey. By exposing subjects to Ellsberg Urn tasks, ambiguity attitudes can be defined. The variables Ambiguity aversion and A-insensitivity are dependent variables. Education, Gender, Age, Political preference, Size of household (in which subjects grew up), Income, and Religion are independent or control variables. Decision making for yourself versus for others are the within-subjects variables and are referred to as "Self" and "Other". Further, participants are asked to decide for someone to whom they are emotionally attached. Therefore, it will also be tested whether the relationship people have with the person they make a choice for has an impact on ambiguity attitudes in decision making. Relationship is indicated with the variables Stranger, Colleague, Boss, Family, and Friend.

In this study, ambiguity attitudes are measured by adopting the matching probabilities method of Dimmock et al. (2016). This method is preferred for several reasons. Firstly, the method makes it possible to use subjective probabilities. Subjective probability denotes the estimate of the probability of an event, which is given by a subject, or inferred from his behaviour (Kahneman & Tversky, 1972, p. 431). According to Machina and Siniscalchi (2014) ambiguity aversion violates the hypothesis that individuals' uncertain beliefs can be represented by subjective probabilities. However, with the insight of Chew and Sagi (2006, 2008) that is processed in this method, it became clear that subjective probabilities can still be used by relaxing the implicit assumption of assuming identical weightings of both options in the Ellsberg Urn tasks (illustrated in the next paragraph). Second, this method is efficient if a large sample needs to be reached. The method takes a relatively short time to acquire subjects' subjective probabilities, therefore more respondents can be reached. Another advantage of this method is the use of a bisection technique. This technique makes the process of acquiring one's

subjective probability easier and improves the reliability of the obtained subjective probabilities (Dimmock et al., 2013). It is easier for respondents to decide between two options instead of directly formulating the subjective probability where they are indifferent between ambiguous and risky events. It is very difficult for respondents to estimate their subjective probability directly. By giving successive choices, a realistic subjective probability can be determined. The bisection method makes the survey not only more convenient but also more accessible to less educated people. Because of the symmetry of the coloured balls in the Ellsberg Urn tasks, this experimental design controls for beliefs that subjects have about the likelihoods of unknown urns. In the experimental design of this thesis, there is an absence of accountability: subjects do not have to justify themselves in the experiment.

In the survey, the Ellsberg Urn tasks were interspersed with questions related to socioeconomic characteristics in a subject's life. These are the variables related to socioeconomic characteristics:

- Education
- Gender
- Age
- Political preference
- Size of household (in which they grew up)
- Income
- Religion

Note, politic preference is reflected in a left or right politic preference. In the Netherlands, a left politic preference implies among other things supporting social equality and environmental movements. A right politic preference implies individual freedom; limiting the role of the government. Also is the right politic preference often associated with the conservative. In American terms, the leftist and democratic preferences are the most similar, just like right and republican preferences are most similar. Individuals may not necessarily have a left or a right preference, these individuals can indicate this in the survey.

Also note, altruism and grudging are not part of this thesis. Altruism is the behaviour where a subject benefits another individual at a cost to oneself. Altruism is not included in this experimental design because the subjects do not lose anything by winning 15 euros for another. Also, the survey contains a description for each "other" -block, explaining that the subject should grant 15 euros to the person they decide for, therefore it is not possible to begrudge. Leaving altruism and grudging out of this research makes it possible to purely measure the differences of ambiguity attitudes in Self – Other decision-making, without being affected by altruism or grudging.

I decided to alternate cases with general questions to avoid anchoring. Furthermore, the questions and cases were randomly presented to avoid anchoring and other biases.

3.2 Eliciting matching probabilities

Ellsberg Urn tasks are used to elicit subjects' matching probabilities. Similar to Dimmock et al. (2016), in this study is also deviated from the standard Ellsberg Urn colours red and black. This was done because colour-blind people often have trouble distinguishing the colour red from other colours.

A bisection method is used to elicit subjects matching probability. For example, a subject faces the decision situation in figure 2. The next decision situation is adapted to the decision of the subject. If a subject chooses urn K in figure 2, then urn K is made less attractive, as can be seen in figure 3. If the subject still chooses urn K, urn K is made even less attractive, this continues until indifferent is chosen. This also works the other way around, if urn U is chosen, then urn K is made more attractive. Urn U is fixed: the proportions of balls of a colour are adjusted in urn K. The bisection method continues until a subject is indifferent between urn K and urn U (then the subjective probability is elicited) or a subject reaches a maximum of 5 iterations. If a subject does not choose indifferent, then the average of the remaining upper and lower bound of a subject is taken as subjective probability. The combination of decision situations before a matching probability is determined will be referred to as a *block*. A path graph for both blocks can be found in figure 6 and 7 in the Appendix.

Figure 2. *Ellsberg Urn task in survey for individual decision-making round 1 (moderate likelihood)*

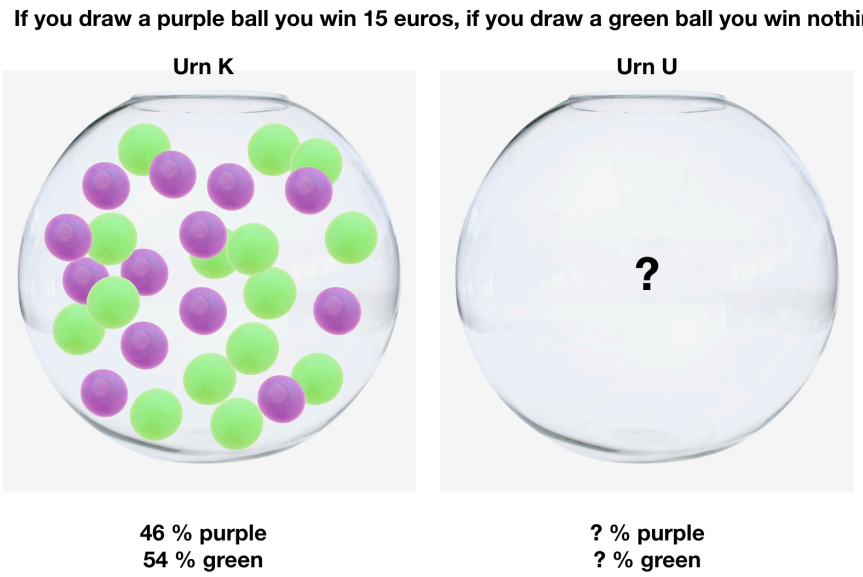

Figure 3. *Ellsberg Urn task in survey for individual decision-making round 2 (moderate likelihood)*

X is the amount of (purple) balls urn K contains that makes a subject indifferent between urn K and urn U. If the urns consist of 100 balls: 50 green and 50 purple, we speak of a moderate likelihood. In this case, the matching probability of a subject is m(0.5) = X/100. A subject is ambiguity averse if m(0.5) < 0.5, ambiguity neutral if m(0.5) = 0.5 and ambiguity seeking if m(0.5) < 0.5.

In this thesis, there are two different levels of ambiguous situations specified: *low likelihood* and *moderate likelihood*. *Low likelihood* is a situation where an event is unlikely to happen. Subjects are given multiple cases; these cases consist of Ellsberg-Urn tasks in low and moderate likelihoods. Moderate likelihood cases consist of Ellsberg-Urn tasks where two colours are used: purple and green. Moderate cases are cases with an ambiguity neutral probability of 0.5, which is elaborately explained in the previous paragraph. Low likelihood is represented by urns containing 10 different colours. Urn K is containing 10 balls of each colour. As a matter of course, the proportions of urn U are unknown. In low and moderate likelihood cases, 15 euros are won if a purple ball is drawn. There is chosen for 15 euros since it is easy for respondents to imagine the feeling that winning 15 euros gives. In low and likelihood, the matching probabilities are calculated for m(0.1). An example of a low likelihood situation could be the following: m(0.1) = 0.18. This means that the subject is indifferent between betting on one colour from urn K with 18 of the 100 balls in the urn versus betting on one colour from the 10-colour urn U. In this situation is m(0.1) > 0.10 (a-neutral probability), thus the subject is ambiguity seeking.

Matching probabilities of subjects in decision making for themselves are obtained for two likelihoods: low likelihood and moderate likelihood. Because of this, the measurement of the matching probability in deciding for themselves contains 2 blocks.

As previously introduced, ambiguity attitudes in decision making for others are also put to the test. To accomplish this, subjects are assigned to 2 blocks of the two likelihoods: low and moderate. The subject is asked to decide for another. This type of other person is randomly assigned per likelihood. It is not feasible to include all types of relationships in one survey for every subject. If the survey would include all types, it would take much more time, respondents would get bored and therefore would not provide reliable answers anymore. The other person for whom a subject decide for can be one of the following persons:

- Stranger
- Colleague
- Boss
- Family member
- Friend

Succinctly, every respondent faces 2 “decision-making for themselves” and 2 “decision-making for other” -blocks. For every subject, the blocks are presented in random order to minimize biases.

In this study, I have opted for a different design in presenting the Ellsberg Urn task to subjects than Dimmock et al. (2016) used. I have attempted to make the case look as realistic as possible. Subjects find it difficult to apply an abstract case like the Ellsberg Urn tasks to real-life decision making, by making the case as real as possible subjects can place themselves better in the situation. This way, the decisions of subjects resemble their real-life decisions better. Figure 2 is an example of an Ellsberg Urn task in moderate likelihood, round 1.

3.3 Indexes

Once the matching probabilities have been obtained, indexes for ambiguity attitudes can be derived. In this thesis, I will use among other indexes, the indexes by Jaffray (1989, equation (10)) and Kahn and Sarin (1988). These are the following indexes:

$$AA_{0.1;\, self/other} = 0.1 - m(0.1) \qquad \textit{Eq. 5}$$

$$AA_{0.5;\,self/other} = 0.5 - m(0.5) \qquad \textit{Eq. 6}$$

For a-neutral probability *p,* AA_p reflects subjects' ambiguity aversion. Every positive value of AA_p implies ambiguity aversion: m(*p*) < *p*. A negative value of AA_p suggests ambiguity seeking behaviour: m(*p*) > *p*. An individual is ambiguity neutral if m(p) = p, then AA_p is zero. A-insensitivity can also be deduced from the indices.

Dimmock et al. (2016) have constructed overall indices by applying matching probabilities to the ambiguity attitude indices of Abdellaoui, Baillon, Placido, and Wakker (2011). To get to the indexes you must first find the best fitting line between m(*p*) and *p* over the interval (0,1). Ordinary least squares (OLS) will be used to estimate the best fitting line:

$$\alpha + \beta p \qquad \textit{Eq. 7}$$

In this linear regression is α the intercept, β is the slope and *p* is the a-neutral probability: 0.1 or 0.5. The indices used in this thesis are not exactly the same as the indices of Dimmock et al. (2016) instead, they are simplified. What should also be noted is that the subjective likelihood where the chance of winning is 90% is not taken into account (m(0.9). The first index, $a_{self/other}$ measures a-insensitivity. The second index, $b_{self/other}$ is the measurement of ambiguity aversion. The ambiguity attitude indexes are defined as follows:

$$a_{self/other} = 1 - \left(\frac{\mathrm{m}(0.5) - \mathrm{m}(0.1)}{4}\right) \qquad \textit{Eq. 8}$$

$$b_{self/other} = 1 - 2 \cdot \mathrm{m}(0.5) \qquad \textit{Eq. 9}$$

If m(0.5) = m(0.1), then $a_{self/other}$ is 1. A value of 1 for index $a_{self/other}$ implies that a subject is perfectly insensitive. This subject is not able to see the difference of an ambiguous event under the likelihood of 50% or 10% chance. Subjects' subjective probabilities m(0.5) and m(0.1) are the same because this subject cannot discriminate between different likelihoods.

See figure 4 for a clear representation of the ambiguity attitudes. The x-axis is *p*, the objective probabilities and in other words the actual probabilities of drawing the wanted ball. The y-axis reflects

m(*p)*, the subjective probabilities. Figure 4.a shows ambiguity neutrality. Figure 4.b reflects a situation where there is ambiguity aversion ($b_{so} = 0.22$) but no a-insensitivity. Index b_{so} shows ambiguity aversion since it is inversely related to the average height of the curve (Dimmock et al., 2016). The next figure (figure 4.c), only shows a-insensitivity. The tendency to transform all a-neutral probabilities toward 50-50 (a-insensitivity) is captured by a_{so} because it is an index of the flatness of the curve (Dimmock et al., 2016). Figure 4.d shows both ambiguity aversion and a-insensitivity.

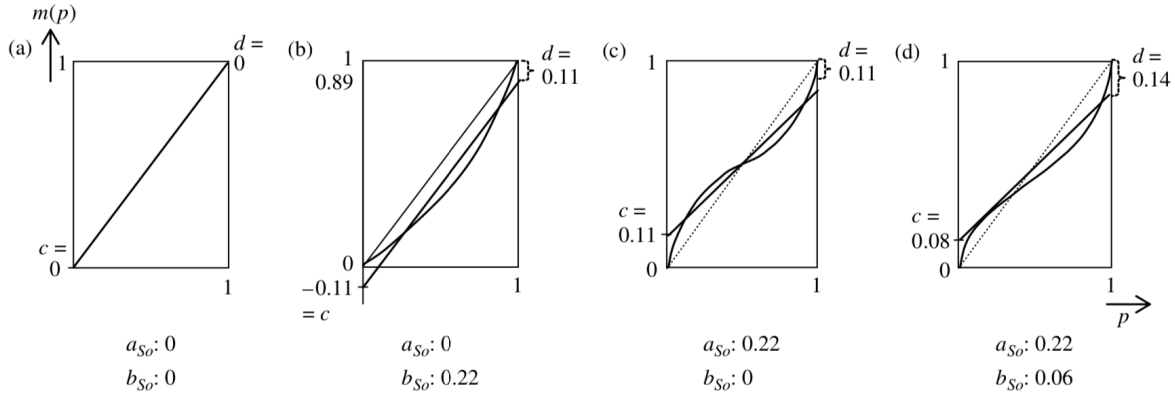

Figure 4. Possible graphs of indices a and b. Reprinted from: "Ambiguity attitudes in a large representative sample," by Dimmock et al., 2016, Management Science.

Two assumptions must be met when using the subjective probabilities method. The first assumption is the exchangeability condition of Chew and Sagi (2008). This condition holds because of the plausible assumption of symmetry of colours in the unknown urns. This assumption is applied for example in the following way: the subjective probability of an ambiguity neutral person of each colour in the 10-colour urn is 0.1 (low likelihood). Dimmock et al., (2016) further assume that the unknown 2-colour and 10-colour urns have the same source with the same function. In practice, this means that betting on 1 colour from the 2-colour unknown urn is the same as betting on 5 colours of the 10-colour unknown urn. Given that a similar mechanism lies under the two unknown urns, this assumption is reasonable (Dimmock et al., 2016, p.1366).

3.4 Sample

The correct sample size was determined using Smith's (2013) formula. This formula can be found in the appendix under equation 12. A confidence level of 95%, a 5% margin of error, and a standard deviation suggestion of 0.05 is taken for determining the sample size. This results in a (rounded up)

sample size of 385 participants. Due to feasibility reasons, especially a shortage of time, money, and resources, it was not possible to achieve this sample size.

The survey has been distributed through the following social media channels: Facebook, WhatsApp, and LinkedIn. In addition, a QR-code of the survey was posted on notice boards at several supermarkets in order to reach a wider audience. There where 290 responses to the survey. The data is cleaned based on incomplete answers and respondents that have not taken the survey seriously. Unserious subjects are subjects who chose urn K when they needed to draw a purple ball to win 15 euros even when urn K contained 0 purple balls. In total, the responses of 203 subjects are used in the analysis of this thesis. Outliers are not deleted because subjects could in fact make other decisions than most of the subjects do. Therefore, removing these outliers would be a manipulation of the data. Furthermore, the value of index a (a-insensitivity) is sometimes higher than 1. In this situation is a subjects m(0.1) higher than their m(0.5). This seems unlikely, but I do not find this a valid reason to remove these outliers. The distributions of ambiguity aversion and a-insensitivity for self and other are presented with the use of boxplots (Figure 5).

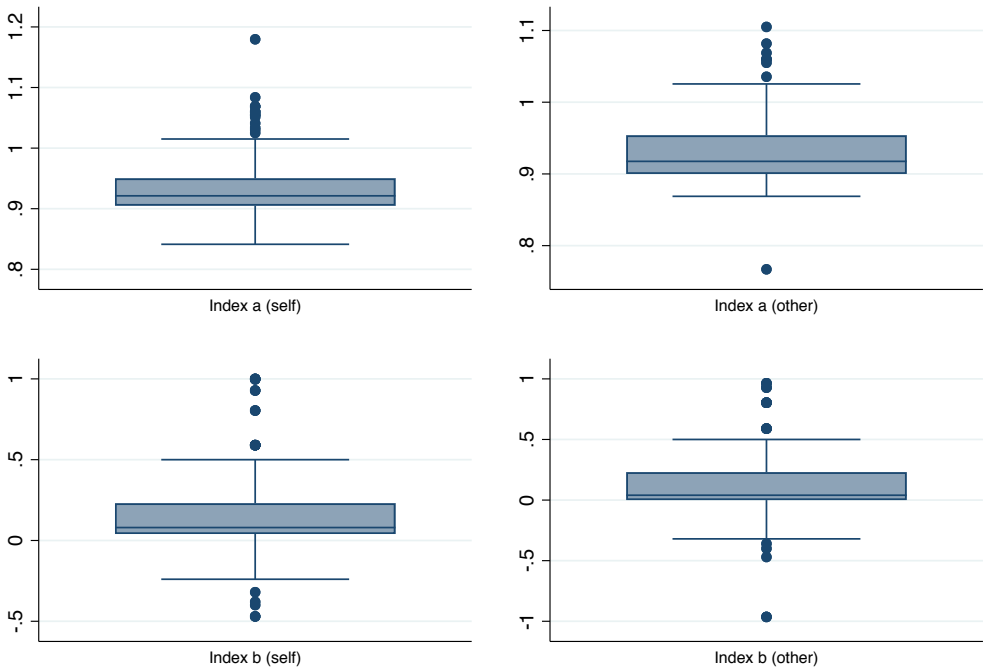

Figure 5. *Boxplots for indexes a and b for self - other*

As mentioned before, Dimmock et al. (2016) measured not only m(0.1) and m(0.5) but also m(0.9). Due to a mistake in the survey I could not use the subjective probabilities obtained for m(0.9). Nevertheless, it is still possible to measure a-insensitivity (equation 8).

All respondents are Dutch speaking. Most respondents are female; 73% (147 participants) of the sample. The average age is 35.4 years, the minimum age is 11 and the maximum age is 88 years. I have chosen not to remove subjects under 18 or elderly subjects because ambiguity is a phenomenon that occurs at all ages. About 34% of the participants who have indicated a political preference have a right-wing political preference (55/163 participants). The other 108 (66%) have a preference for leftist politics. One out of five respondents (40/203) respondents indicated that they had no political preference. The average size of a household in which a subject grew up is 3.7 people. The average income of the respondents is in the category €70.000 – €79.000. The majority of the subjects is not religious, 66% of the participants indicated being atheist. 32% of the participants are Christians. The median level of education is higher professional education (HBO). 50 percent of the subjects have a university degree or is attaining education at a university level (table 8, appendix). Further details of all the descriptive statistics can be found in the appendix (Table 7).

3.5 Materials

Survey completion took participants on average 11.32 minutes, with a minimum of 2.60 minutes and a maximum of 141.50 minutes. As an incentive an amount of 15 euros is raffled among 'serious' participants. 'Serious' participants are participants that did *not* choose urn K if urn K contained 0 purple balls (drawing a purple ball means winning 15 euros). The idea is that by informing participants about the incentive they will take more serious effort in completing the questionnaire. The raffle is also an attempt to make subjects more engaged with the Ellsberg Urn tasks, the idea of winning 15 euros might make the experience of Ellsberg Urn tasks feel more like a real-life experience.

4 Results

To obtain the indices a_{so} (a-insensitivity) and b_{so} (ambiguity aversion) ordinary least squares method (OLS) was performed for every subject in the dataset. OLS estimates a fitted line for every subject on the open interval (0,1). The coefficient and slope derived from this linear regression are the coefficients used in calculating indices a_{so} and $b_{so.}$. Table 1 shows the summary statistics of the indices used in this thesis, $AA_{0.1;\ self/other}$, $AA_{0.5;\ self/other}$, $a_{self/other}$ and $b_{self/other}$. The first part of the table shows the values for individual decision making, the bottom part of the table shows the indices in decision making for others (italic). This table shows that there are no exceptionally large differences in the mean values between self and other for the indices.

Variable	Obs	Mean	Std.Dev.	Min	Max
$AA_{0.1;\ self}$	203	-.066	.151	-.62	.08
$AA_{0.5;\ self}$	203	.076	.121	-.235	.5
a_{self}	203	.936	.046	.841	1
b_{self}	203	.153	.242	-.47	1
$AA_{0.1;\ other}$	*203*	-.062	.14	-.62	.08
$AA_{0.5;\ other}$	*203*	.067	.131	-.482	.482
a_{other}	*203*	.932	.045	.767	1.105
b_{other}	*203*	.134	.261	-.964	.964

Table 1. Descriptive statistics of the indexes

First, it is put to the test whether ambiguity attitudes changes in deciding for another (hypotheses 1 and 2). In order to test this, the differences in the means of the indices between self and other have been studied. Both indices a_{so} and b_{so} are not normally distributed, therefore a Wilcoxon Signed Rank Test is conducted for both hypotheses. First, ambiguity aversion for individual decision making (self) is compared to ambiguity aversion in decision making for others (other). The outcomes of the Wilcoxon Signed Rank Test for ambiguity aversion can be seen in table 2. In this paper a significance level of 5% is taken. For the Wilcoxon Signed Rank Tests, there is a significant difference if the p-value is below 0.05. The p-value of this test is 0.2012 and thus, above the 5% significance level. Therefore, it cannot be concluded that that individual's ambiguity aversion changes in decision making for others compared to individual decision making. This is not in line with the stated hypothesis.

The same test is executed to compare subjects 'a-insensitivity in individual decision-making versus decision-making for others. Index a_{so} is compared in "Self" and "Other" situations (table 3). Again, no significant result is found since the p-value is 0.2774. 0.2776 is above the 5% significance level. As predicted, there is no evidence found that individuals a-insensitivity does change in decision making for others.

Sign	**Obs**	**Sum ranks**	**Expected**
positive	68	9556	8525.500
negative	50	7495	8525.500
zero	85	3655	3655
all	203	20706	20706
unadjusted variance	702278.50		
adjustment for ties	-53.12		
adjustment for zeros	-52083.75		
adjusted variance	650141.62		
Ho: $b_{self} = b_{other}$			
z = 1.278			
Prob >	z	=	0.2012

Table 2. Differences in ambiguity aversion between self and other (Wilcoxon Signed Rank Test)

Sign	**Obs**	**Sum ranks**	**Expected**
positive	92	10908	9901.5
negative	69	8895	9901.5
zero	42	903	903
all	203	20706	20706
unadjusted variance	702278.50		
adjustment for ties	-78.88		
adjustment for zeros	-6396.25		
adjusted variance	695803.38		
Ho: $a_{self} = a_{other}$			
z = 1.207			
Prob >	z	=	0.2276

Table 3. Differences in a-insensitivity between self and other (Wilcoxon Signed Rank Test)

To measure the effect of a relationship that a decision-maker has with the person they decide for on ambiguity aversion (hypothesis 3) a regression is performed. Index b_{other} is the dependent variable and *Family*, *Friend*, *Colleague,* and *Stranger* are the independent variables (equation 10). Decision-making for a "Stranger" is the comparison group or in other words, the base level. The regression is controlled for Education, Household size (in which respondents grew up), Gender, Age, and, Income.

$$b_{\text{other}} = \beta_0 + \beta_1 * Friend + \beta_2 * Colleague + \beta_3 * Family + \beta_4 * Boss + controls + \varepsilon \qquad \textit{Eq. 10}$$

The results of the regression can be found in table 4. A coefficient is significant if the p-value is below the 5% significance level. The results show only one significant coefficient, this coefficient is *Boss*. The coefficient for *Boss* can be interpreted as follows: if an individual decides for their boss, their value for index b tend to be -0.128 lower, ceteris paribus. What can be concluded from these results is that individuals tend to be less ambiguity averse in deciding for their boss.

Variables	**Index b_{other} (ambiguity aversion)**
Friend	0.0279
	(0.0568)
Colleague	0.00926
	(0.0485)
Family	-0.0615
	(0.0589)
Boss	-0.128**
	(0.0612)
Education	-0.0129
	(0.0216)
Household size	-0.0161
	(0.0134)
Gender	-0.0513
	(0.0422)
Income	0.00300
	(0.00458)
Age	0.00126
	(0.00121)
Constant	0.231**
	(0.101)

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4. Regression of relationship on ambiguity aversion

Table 5 displays the results of the regressions of socioeconomic characteristics on the two ambiguity attitudes in individual decision making: a-insensitivity and ambiguity aversion (hypotheses 4 and 5).

Firstly, the regression of socioeconomic characteristics on index b_{self} is conducted. This regression results in a low F-value of 1.16, because of the low F-value it is known that the group means are close together and thus there is low variability relative to the variability within each group. Therefore, there are no significant results found for the effect of socioeconomic characteristics on ambiguity aversion. However, a marginally significant result is found for the characteristic *Religion*, the p-value of this coefficient is marginally significant since $0.05 < p < 0.1$.

Secondly, the regression of socioeconomic characteristics on index a_{self} is performed (table 5). Again, a low F-value of 1.51 is found. The results show a significant coefficient for *Age* since the p-value for this coefficient is below the 5% significance level. This can be interpreted as follows: every year a person gets older, their index a_{self} tend to increase with a number of 0.000458, ceteris paribus. Thus, older people tend to have a higher a-insensitivity and therefore their understanding of ambiguous situations is lower.

Variables	**Index b_{self} (ambiguity aversion)**	**Index a_{self} (a-insensitivity)**
Age	0.000912	0.000458**
	(0.00122)	(0.000227)
Household size	-0.00468	0.00214
	(0.0144)	(0.00408)
Political preference	-0.0607	-0.00314
	(0.0437)	(0.00915)
Income	0.00578	0.00117
	(0.00486)	(0.000929)
Religion	0.0247*	0.000507
	(0.0147)	(0.00280)
Gender	0.00475	-9.19e-07
	(0.0429)	(0.00848)
Education	-0.0318	-0.00777
	(0.0271)	(0.00546)
Constant	0.211*	0.929***
	(0.124)	(0.0311)
Observations	162	162
R-squared	0.061	0.075

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 5. Regression on social background factors for index $b_{self\ and}$ a_{self}

The last regression analysis is for socioeconomic characteristics on self-other differences for ambiguity aversion and a-insensitivity (Table 6). Self-other differences for *b* are constructed by taking the absolute difference between index b_{self} and index b_{other}. The same way, I constructed self-other differences of *a,* the absolute difference between a_{self} and a_{other} was taken. No significant results of socioeconomic characteristics on self-other differences have been found.

Variables	**Self-other differences of *b***	**Self-other differences of *a***
Age	0.000884	0.000157
	(0.00106)	(0.000187)
Household size	0.00397	0.00265
	(0.0120)	(0.00250)
Political preference	-0.00657	0.000290
	(0.0468)	(0.00748)
Income	0.00506	0.00109
	(0.00422)	(0.000756)
Religion	-0.00412	-0.000952
	(0.0117)	(0.00236)
Gender	0.0104	-0.00725
	(0.0399)	(0.00848)
Education	-0.0503	-0.00825
	(0.0316)	(0.00527)
Constant	0.205	0.0359
	(0.150)	(0.0217)
Observations	162	162
R-squared	0.050	0.071

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 6. Effect of social background factors on self-other differences

5 Discussion

In this paper, I focused on ambiguity attitudes in decision-making for others compared to individual decision-making. I expected a difference in self - other decision-making under ambiguity for ambiguity aversion. I did not expect a difference in self – other decision-making for a-insensitivity (hypotheses 1 and 2). No significant result was found from analysing the existence of a difference between self-other decision making under both ambiguity aversion and a-insensitivity. This is not in line with the first hypothesis that no significant difference is found for ambiguity aversion in self-other decision-making. However, this is in line with the results of König-Kersting and Trautmann (2016). Köning-Kersting and Trautmann (2016) compared across treatments (self-other) but did not observe significant differences for ambiguity aversion. It seems that because of the similarities of risk and ambiguity that it is likely that subject's ambiguity aversion changes in decision-making for others compared to individual decision-making. Despite the insignificant results, this hypothesis (H1) should be re-examined on a larger scale to actually make the statement that ambiguity aversion does not change in self versus other decision-making. After all, it is still meaningful to know whether ambiguity aversion changes when one makes a choice for another in order to optimize decision-making.

There is no significant difference found for a-insensitivity in self-other (H2). This in line with the hypothesis that a-insensitivity remains the same in deciding for another and deciding for one's self. There is no literature on a-insensitivity differences in decision making for self-other, so there is no existing literature to support this finding.

The third hypothesis which expects that the type of relationship a subject has with the person he/she decides for influences ambiguity aversion is marginally correct. I found evidence that the relationship *Boss* influences ambiguity aversion. Individuals tend to be less ambiguity averse in deciding for their boss compared to deciding for a stranger. For the other relationships, there is no significant influence. Again, there is no existing literature to support this finding.

Contrary to previous research and hypothesis 4, the results show no significant effect of socioeconomic characteristics on ambiguity aversion. The sample may be focused on a particular group of people or the sample might be too small to obtain significant results for the effect of socioeconomic characteristics on ambiguity aversion.

The fifth hypothesis describes an expectation of an influence of socioeconomic characteristics on a-insensitivity. There is evidence that socioeconomic characteristic *Age* tend to influence a-insensitivity. I found that older people tend to have a higher a-insensitivity and therefore a lower understanding of ambiguous situations. According to the literature and hypothesis 5 more socioeconomic characteristics were expected to be significant.

Lastly, no evidence for the influence of socioeconomic characteristics on self-other differences for both indices has been found (H6 & H7). For these hypotheses too, there is no previous literature to compare the results with.

There are several limitations of the research done in this thesis. First, the Ellsberg Urn tasks are very abstract. It is difficult for subjects to perceive an Ellberg Urn task the same as a choice in real life between ambiguity and risk. In the experimental design I conducted Ellberg Urn tasks that where even more abstract because subjects did not actually receive 15 euros if they drew a purple ball. This incentive was absent because a of a limitation of resources (money and time). Furthermore, the decisions that subjects made for another had no real effect on this other person. In short, the effect of the decisions that respondents made for themselves and for others where imaginary. Therefore, decisions made in the Ellberg Urn tasks may not reflect decisions subjects would make in real-life decision situations.

Moreover, respondents were forced to make a decision in the survey. In the Ellberg Urn tasks there was no option to not make a decision. Respondents could opt for being indifferent, but the absence of a preference does not necessarily mean that people are indifferent.

Furthermore, the bisection method was aimed to be more precise than the bisection method of Dimmock et al. (2016). This was designed in the way that subjects could opt urn K, then urn U, and could then, even face another decision-situation instead of being finished after opting two different urns. This was a bit too complex and probably superfluous since I assume that most subjects cannot distinguish well between little differences of probabilities. This had led to a less logical pathway of the bisection method (Figure 6 & 7, Appendix).

My suggestion for further research would be to conduct a lab experiment with bigger sample size. In this experiment, the Ellsberg Urn tasks must be perfectly executed and thus subjects should actually win 15 euros if they draw a purple ball. To examine the effect of deciding for another and to measure the effect of a relationship on ambiguity attitudes, every subject must bring a person where he/she has a specific relationship with. This to bind not only a hypothetical consequence to the Ellsberg Urn tasks but a real consequence. This will lead to decision-making of subjects that correspond more to real-life decision-making.

Furthermore, I do think that it would be valuable to create real-life computer simulations consisting decision-making under ambiguity. Then, the choice does not only have to be between risk and ambiguity (in contrast to Ellsberg urn tasks), but situations can be simulated under only ambiguous

options. Also, this type of software could be made so realistic that the obtained subjective probabilities correspondent perfectly to the subjective probabilities in real-life decision-making.

6 Conclusion

In this thesis, I conducted an experimental design in order to examine whether 'self versus other' decision-making influences ambiguity attitudes. For both ambiguity attitudes, ambiguity aversion, and a-insensitivity no significant difference has been found. However, there is evidence that decision-making for a boss influences an individual's ambiguity aversion. Individuals tend to be less ambiguity averse when they decide for their boss compared to deciding for a stranger. This may be related with hierarchy. There is no evidence that the other relationships influence ambiguity aversion. Furthermore, I did not find significant effects of socioeconomic characteristics on ambiguity aversion. However, according to my results, a-insensitivity tends to increase as a person gets older. Besides Age, there is no significant effect found for the other socioeconomic characteristics variables on a-insensitivity.

With this thesis I hope to have emphasized the importance of ambiguity attitudes in decision-making for others and to have contributed to the limited number of studies that have been done on this topic. More knowledge could lead to significantly better decision-making under ambiguous situations. Studying ambiguity attitudes is especially important in improving crucial decision-making that is found in dealing with topical problems such as climate change and the Covid-19 pandemic crisis.

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8 Appendix

Variable	Obs	Mean	Std.Dev.	Min	Max
Gender	202	.728	.446	0	1
Age	203	35.429	17.579	11	88
Political preference	163	.663	.474	0	1
Household size	203	3.7	1.287	1	10
Income	203	8.488	3.779	1	12
Religion	203	.798	1.264	0	6
Education	203	3.7209	0.906	1	4

Table 7. Descriptive Statistics

Categories	Freq.	Percent	Cum.
High school diploma	17	8.37	8.37
Secondary vocational education	12	5.91	14.29
Higher professional education	73	35.96	50.25
University education	101	49.75	100.00

Table 8. Tabulation of Education

Categories	Freq.	Percent	Cum.
Stranger	42	20.69	20.69
Friend	39	19.21	39.90
Colleague	39	19.21	59.11
Family	42	20.20	79.31
Boss	42	20.69	100.00

Table 9. Tabulation of Relationship

$$Necessary\ Sample\ Size = (Z - Value)^2 * standard\ deviation * \frac{(1 - standard\ deviation)^2}{(margin\ of\ error)} \qquad Eq.\ 11$$

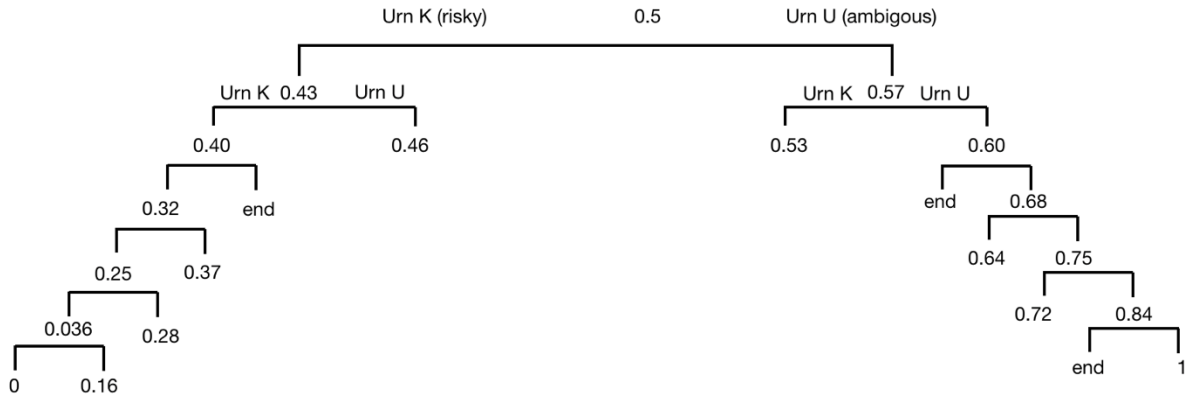


Figure 6. *Bisection method for moderate likelihood (note: the steps taken are not proportional, this can be seen as a misktake made in the design of the survey)*

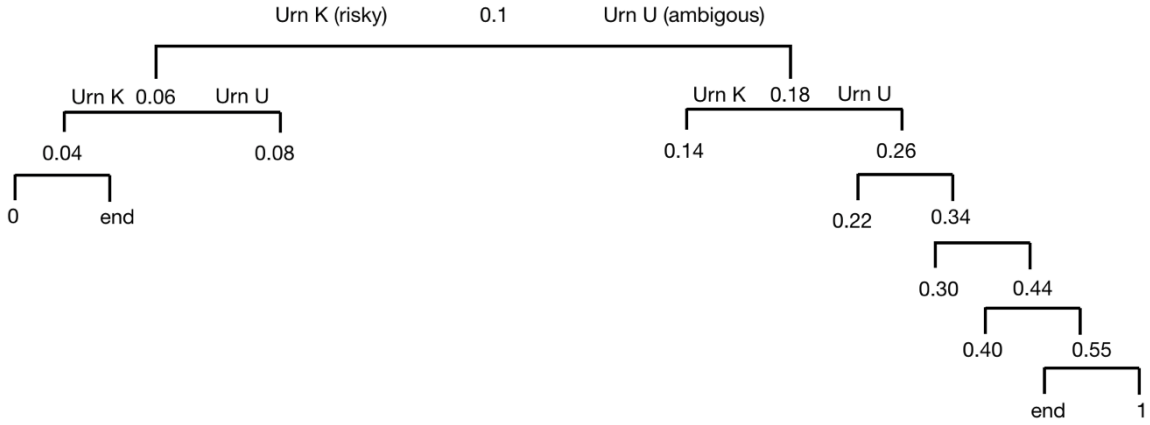


Figure 7. *Bisection method for low likelihood (note: the steps taken are not proportional , this can be seen as a misktake made in the design of the survey)*

Survey

The survey was distributed in Dutch but translated for this appendix

Questions related to social background factors:

- What is your gender?
    - Female
    - Male
    - Other
- What is your age?
- What is your religious preference?
    - Jewish

    - Christian
    - Islam
    - Hinduism
    - Buddhism
    - I do not have a religious preference
    - Something else (please specify)
- What is the highest level of education you have completed/attained?
    - High School
    - MBO
    - HBO
    - WO
    - Something else (please specify)
- Do you lean more towards left-wing or right-wing political preference?
    - Left
    - Right
    - I have no preference
- What is the size of the household you grew up in?
- What was the total aggregate income of all members of your household in 2019?
    - € 0 – € 9999
    - € 10.000 – € 19.999
    - € 20.000 – € 29.999
    - € 30.000 – € 39.999
    - € 40.000 – € 49.999
    - € 50.000 – € 59.999
    - € 60.000 – € 69.999
    - € 70.000 – € 79.999
    - € 80.000 – € 89.999
    - € 90.000 – € 99.999
    - € 100.000 or more
    - I don't know / I'd rather not tell

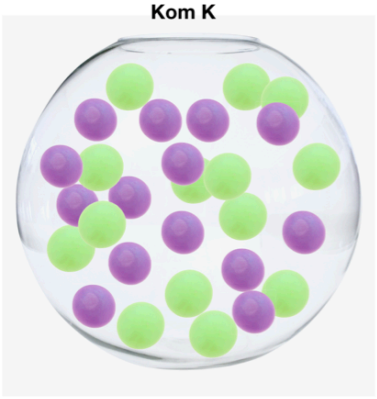
There are four blocks containing Ellsberg-Urn tasks in low and moderate likelihood, two for individual decision-making and two for decision making for another (relationship type is specified). I attached two examples of Ellsberg-Urn tasks (in first round) to show what was presented to respondents.

Example question of an Ellsberg-Urn task for individual decision-making in moderate likelihood, first round.

Stel: je kunt 15 euro winnen als je een paarse bal grabbelt uit een kom. In allebei de kommen zitten alleen paarse en groene ballen. Bij kom K is de verdeling van deze ballen bekend, dit is niet het geval bij kom U. Uit welke kom zou jij willen grabbelen?

Je wint 15 euro als je de paarse bal pakt, 0 euro als je de groene bal pakt

Kom K



50 % paars
50 % groen

Kom U

? % paars
? % groen

Kom K

Ik vind beide kommen even aantrekkelijk (het maakt mij niet uit)

Kom U

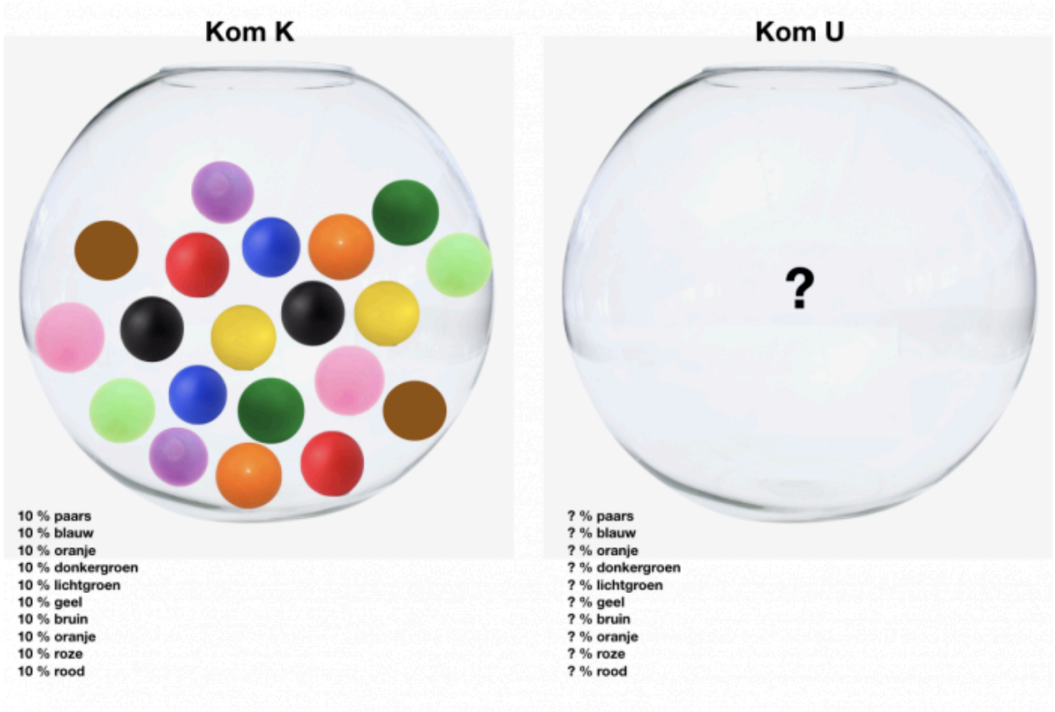
Translation:

Suppose you win 15 euros if you draw a purple ball from one of the urns. Both urns contain only purple and green balls. The distribution of these balls is known for bowl K, this is not the case at bowl U. From which bowl would you like to draw?

- Urn K
- Indifferent
- Urn U

Example question of an Ellsberg-Urn task for a stranger in low likelihood, first round.

Stel: een vreemde krijgt 15 euro als jij een paarse bal uit een de kom grabbelt. In allebei de kommen zitten 10 verschillende kleuren ballen: paars, bruin, rood, blauw, oranje, geel, zwart, donkergroen, lichtgroen en roze. Bij kom K is de verdeling van deze ballen bekend, dit is niet het geval bij kom U. Uit welke kom zou jij willen grabbelen? Beeld je in dat je deze vreemde de 15 euro gunt.



Kom K

Ik vind beide kommen even aantrekkelijk (het maakt mij niet uit)

Kom U

Translation:

Suppose a stranger wins 15 euros if you draw a purple ball from one of the urns. Both urns contain 10 different coloured balls: purple, brown, red, blue, orange, yellow, black, dark green, light green and pink. The distribution of these balls is known for bowl K: 10% for every colour. The distribution is not known for urn U. From which bowl would you like to draw?

- Urn K
- Indifferent
- Urn U