MODELING RISKY CHOICES WHEN PROBABILITIES OF OUTCOMES ARE VERY LOW AND VERY HIGH: CHOICES REGARDING PRENATAL DIAGNOSIS OF DOWN SYNDROME.

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Objectives

1) Utilities of outcomes according to the Expected Utility Model

- Relevance of the Expected Utility Model ?

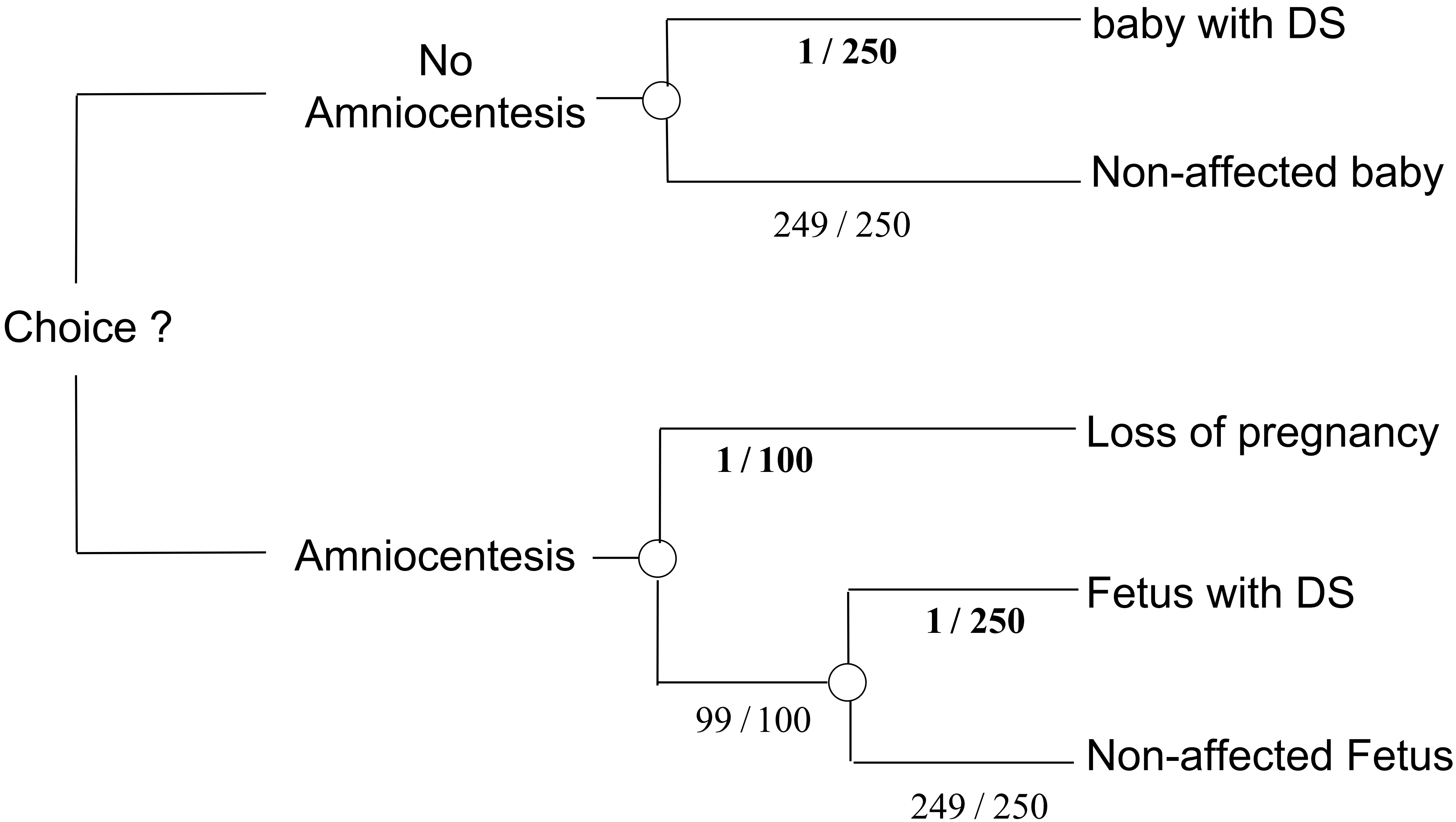
2) Analysis of observed choices according to :

- Utility values
- Probabilities of outcomes

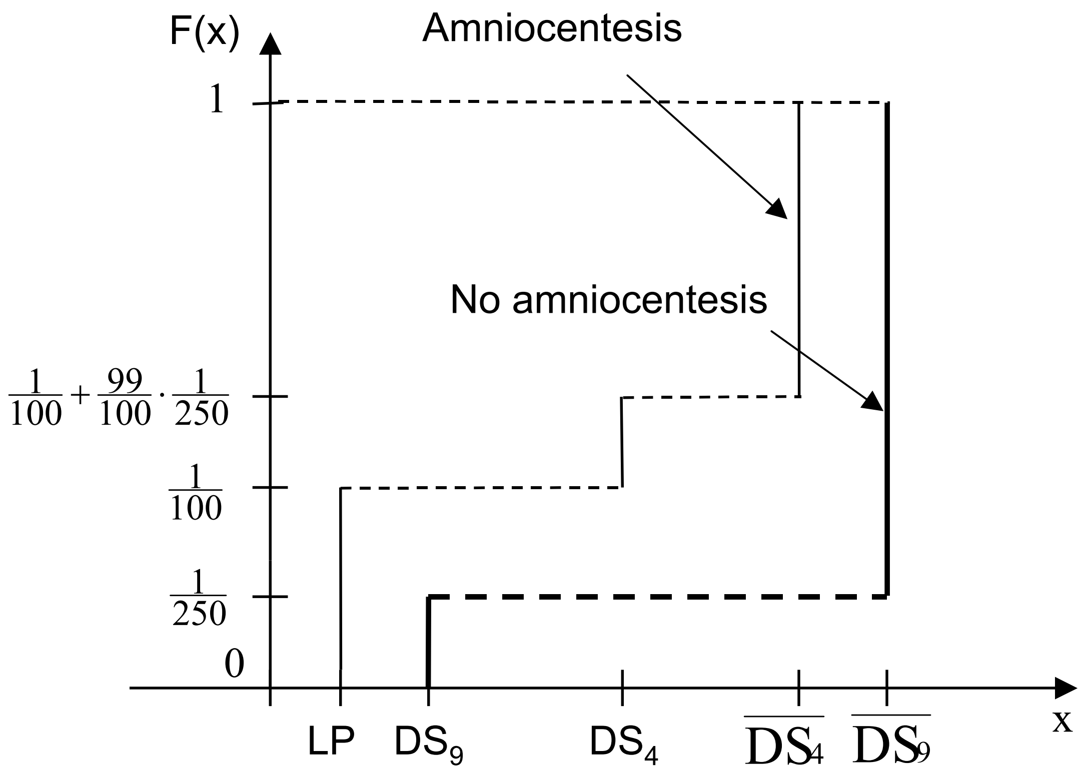
3) Elicitation of the probability weighting function

- Rank Dependent Utility Theory

Choice between « no amniocentesis » and « amniocentesis »



Case # 1.
Worst outcome: loss of pregnancy due to amniocentesis (LP)



<u>Notation</u>

LP: loss of pregnancy

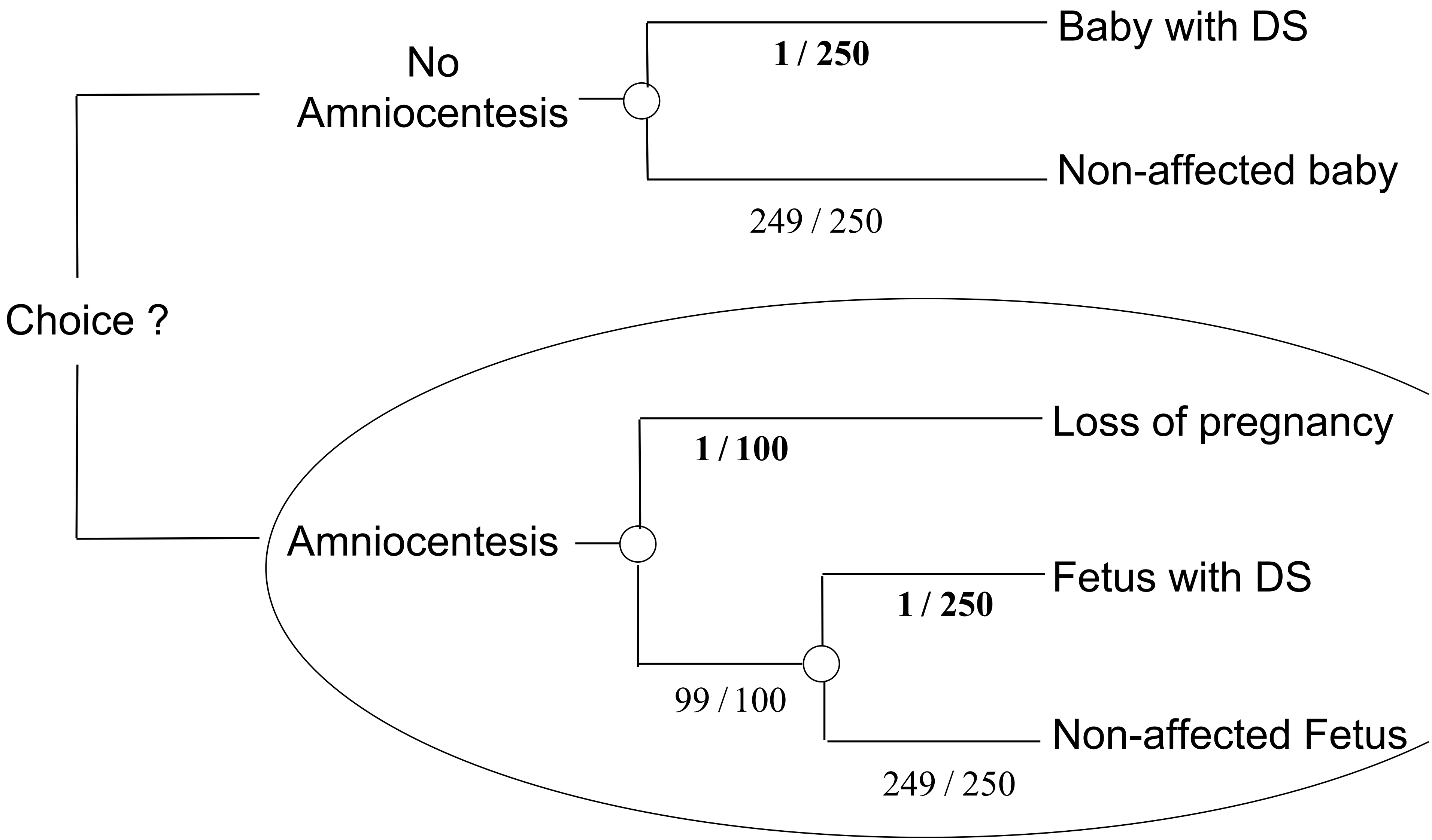
DS_9: birth of a baby with DS

DS_4: fetus with DS at 4 months

$\overline{DS_4}$: non-affected fetus at 4 months

$\overline{DS_9}$: birth of a non-affected baby

Choice between « no amniocentesis » and « amniocentesis »



Case #2. Worst outcome: birth of a baby with DS (DS_9)

1) Risk of DS = 1:250

- $u(DS_9) = 0$ and $u(\overline{DS_9}) = 1$

- Expected utility of « amniocentesis »

$$U(A) = \frac{1}{100} \cdot u(LP) + \frac{99}{100} \cdot \left[\frac{1}{250} \cdot u(DS_4) + \frac{249}{250} \cdot u(\overline{DS_4}) \right]$$

- Expected utility of « no amniocentesis »

$$U(\overline{A}) = \frac{1}{250} \cdot u(DS_9) + \frac{249}{250} \cdot u(\overline{DS_9}) = \frac{249}{250}$$

- $\mathbf{A} \succ \overline{\mathbf{A}}$ **if:**

  (i) $\mathbf{u(\overline{DS_4}) \in \,]0.996\,;1[}$

  (ii) $\mathbf{u(LP) \in \,]0.6\,;1[}$

Case #2. Worst outcome: birth of a baby with DS (DS_9)

2) Risk of DS = 1:700

- $\mathbf{A} \succ \overline{\mathbf{A}}$ if:

  (i) $u(\overline{DS_4}) \in \,]0.999\,;1[$

  (ii) $u(LP) \in \,]0.857\,;1[$

3) Risk of DS = 1:100

- $\mathbf{A} \succ \overline{\mathbf{A}}$ if:

  (i) $u(\overline{DS_4}) \in \,]0.989\,;1[$

  (ii) $u(LP) \in \,]0\,;1[$

The sample (n = 78)

1) Selection criteria

- Not pregnant
- Age: 25-35
- At least one child

2) Face-to-face interview

- Elicitation of utility values
  - → What are the most and the worst outcomes ?
  - → Standard Gamble method
- Elicitation of choice (Decision Board)
  - → 3 values of risk of DS: 1:700, 1:250, and 1:100

Data analysis (n = 64)

1) **14 women excluded** from the sample (n = 78)

- $u(x_i) = 0$ **or** $u(x_i) < 0$ **or** $u(x_i) > 1$

2) **Two groups** according to the worst outcome

- Group 1 (n = 46): birth of a baby with DS
- Group 2 (n = 18): loss of pregnancy

1) Worst outcome: birth of a baby with DS (n = 46)

- $A_{obs} \succ \overline{A}_{obs}$

Risk of DS	**A**	$\overline{A}$	$A \sim \overline{A}$
1:700	**37**	9	-
1:250	**40**	5	1
1:100	**41**	5	-

- **Risk of DS = 1:250**

	A	$\overline{A}$	
$u(LP)_{med}$	0.925	0.045	($p<0.003$)
$u(DS_4)_{med}$	0.985	0.64	($p<0.003$)
$u(\overline{DS_4})_{med}$	0.985	0.805	($p<0.004$)

→ Discrepancy between observed and theoretical choices (n=22)

20 chose A **although** $u(\overline{DS_4}) \notin]0.996 ; 1[$ <u>and</u> $u(LP) \notin]0.6 ; 1[$

→ Possible consistency with EUT (n=20)

$u(\overline{DS_4}) > 0.97$ **but** $u(\overline{DS_4}) > 0.996$?

2) Worst outcome: loss of pregnancy (n = 18)

- $\overline{\mathbf{A}}_{\mathbf{obs}} \succ \mathbf{A}_{\mathbf{obs}}$

Risk of DS	A	$\overline{\mathbf{A}}$
1:700	5	**13**
1:250 / 1:100	8	**10**

- **Risk of DS: 1:250 or 1:100**

	A	$\overline{\mathrm{A}}$	
$u(DS_9)_{med}$	0.413	0.448	($p<0.88$)
$u(DS_4)_{med}$	0.413	0.465	($p<0.88$)
$u(\overline{DS_4})_{med}$	0.985	0.985	($p<0.69$)

Rank Dependent Utility Theory

- $x_1 \prec x_2 \prec x_3$ avec $l_p = (x_1, x_2, x_3 ; p_1, p_2, p_3)$

Decision weight : $h_i(p) = g(\sum_{j=i}^{n} p_j) - g(\sum_{j=i+1}^{n} p_j)$

$$RDU(l_p) = h_1(p).u(x_1) + h_2(p).u(x_2) + h_3(p).u(x_3)$$

Elicitation of the probability weighting function

1) Estimation of $g(p) = \dfrac{p^{\gamma}}{(p^{\gamma} + (1-p)^{\gamma})^{1/\gamma}}$ (Tversky et Kahneman, 1992)

2) Calculation of RDU ($\overline{A}$) and RDU (A)

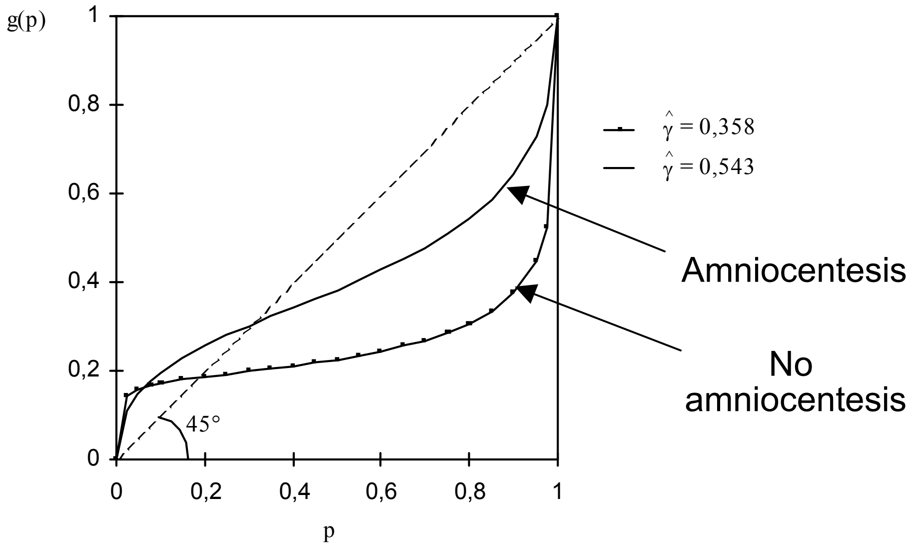
- $\gamma_j \in \left]0\,;2\right[$
- For each γ_j, comparison of observed choices to theoretical choices

When $A_{obs} \succ \overline{A}_{obs}$ or $\overline{A}_{obs} \succ A_{obs}$

$$\Leftrightarrow \underbrace{RDU(A) > RDU(\overline{A})}_{\gamma = \gamma_k} \qquad \Leftrightarrow \underbrace{RDU(\overline{A}) > RDU(A)}_{\gamma = \gamma_m}$$

Results - estimation of probability weighting function

1) Inverse S-shaped



2) Median values of γ according to choices

Risk of DS	A	$\overline{A}$	$A \sim \overline{A}$
1:700	0.543	0.219	-
1:250	0.663	0.176	0.322
1:100	0.808	0.358	-

Conclusion

1) Expected Utility model

- Very low and high probabilities: Relevance of the EU model?

2) Utility values are biased

- Standard gamble method $\Rightarrow$ Over-estimated utilities

3) Limitations of our parametric method

- **γ is related to the probability distribution**
- **Bias** on utilities $\Rightarrow$ **Biased** values of γ

$\Rightarrow$ Magnitude of the probability transformation ?