Women's attractiveness is linked to expected age at menopause

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2   WOMEN'S ATTRACTIVENESS IS LINKED TO EXPECTED AGE AT

3   MENOPAUSE

4   (WOMEN'S ATTRACTIVENESS AND AGE AT MENOPAUSE)

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23   Abstract

24   A great number of studies have shown that features linked to immediate fertility explain a

25   large part of the variance in female attractiveness. This is consistent with an evolutionary

26   perspective, as men are expected to prefer females at the age at which fertility peaks (at least

27   for short-term relationships) in order to increase their reproductive success. However, for

28   long-term relationships, a high residual reproductive value (the expected future reproductive

29   output, linked to age at menopause) becomes relevant as well. In that case, young age AND

30   late menopause are expected to be preferred by men. However, the extent to which facial

31   features provide cues to the likely age at menopause has never been investigated so far. Here,

32   we show that expected age at menopause is linked to facial attractiveness of young women.

33   As age at menopause is heritable, we used the mother's age at menopause as a proxy for her

34   daughter's expected age of menopause. We found that men judged faces of women with a

35   later expected age at menopause as more attractive than those of women with an earlier

36   expected age at menopause. This result holds when age, cues of immediate fertility and facial

37   ageing were controlled for. Additionally, we found that the expected age at menopause was

38   not correlated with any of the other variables considered (including immediate fertility cues

39   and facial ageing). Our results show the existence of a new correlate of women's facial

40   attractiveness, expected age at menopause, which is independent from immediate fertility cues

41   and facial ageing.

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46   Key words: humans, sexual selection, mate choice, female attractiveness, face, menopause,

47   residual reproductive value, fertility

1. Introduction

49 Why some women are more attractive than others has been the focus of many studies, and it

50 has been repeatedly shown that features linked to immediate fertility (i.e. fertility at a given

51 time) explain a large part of the variance in attractiveness (see Rhodes 2006 for a review).

52 Cues of immediate fertility can be found in body shape, voice pitch, or facial features; in fact,

53 all traits linked to sexual maturity, age and parity or substantially influenced by sex hormones

54 (which are factors influencing immediate fertility) have the potential to influence physical

55 attractiveness (see, for example, Symons 1995; Henss 2000; Singh 2002; Jasienska et al.

56 2004; Feinberg et al. 2005; Law Smith et al. 2006; Pipitone and Gallup 2008; Singh et al.

57 2010; Little et al. 2011; Puts et al. 2012, 2013; Pfluger et al. 2012; Jones 2014; Mondragón-

58 Ceballos et al. 2015; Sugiyama 2015; Butovskaya et al. 2017 but see Marcinkowska et al.

59 2014, 2015 for some modulations of these preferences). To increase their reproductive

60 success, males should prefer females of the age at which age-specific fertility peaks, at least

61 for short-term mates (Maestripieri et al. 2014). For long-term relationships such as marriage,

62 however, residual reproductive value - the expected future reproductive output - becomes

63 pertinent too. In humans, this trend is strengthened by the existence of reproductive

64 senescence or menopause (i.e., the permanent cessation of menstruation), associated with the

65 ultimate cessation of child-bearing potential, long before the somatic senescence.

66 Consequently, for long-term relationships, the number of offspring produced by the couple

67 will depend in part on the number of years before the woman reach menopause, particularly in

68 natural fertility populations where reproduction could theoretically extend until menopause.

69   Thus, men can increase their reproductive success by choosing a long-term mate with

70 a longer reproductive window (i.e. higher residual reproductive value). The first criterion of a

71 long reproductive window is of course age. And indeed, youth is one of the most important

72 factor of women's attractiveness (Buunk et al. 2001). Then, for a given age, the temporal

73 reproductive window will vary according to the age at menopause, which is highly variable

74 both across and within populations (Avis et al. 2001; Thomas et al. 2001; Velde et al. 2002;

75   Dratva et al. 2009; Morris et al. 2011; Stepaniak et al. 2013). If the future age at menopause is

76   somehow detectable in young adults, it could contribute substantially to mate choice and thus

77   influence female attractiveness. It is possible that previously identified components of

78   immediate fertility are also informative of female residual reproductive value: reproductive

79   value at a young age and later in life could be positively correlated due to some common

80   underlying factors, or negatively correlated as a result of a biological trade-off (Hamilton

81   1966; Wood et al. 2001; Carter and Nguyen 2011). Alternatively, future age at menopause

82   could be independent of immediate fertility cues, and thus a correlate of attractiveness that has

83   not yet been identified.

84   In this study, we investigated whether expected age at menopause is related to the

85   attractiveness of young women's faces. As age at menopause is heritable (heritability between

86   0.42 and 0.72 depending on the study: Snieder et al. 1998; de Bruin et al. 2001; van Asselt et

87   al. 2004; Murabito et al. 2005; Morris et al. 2011), mother's age at menopause was used as a

88   proxy for the daughter's expected age of menopause. To better understand how the residual

89   reproductive value could be facially detectable, immediate fertility cues were included in the

90   model as possible explanatory variables. It could also be speculated that women who reach

91   menopause later have an overall slower life history trajectory, with a slower general physical

92   ageing, and may look younger, at the same age, than women who will experience menopause

93   at an earlier age (in line with this idea, a later age at menopause is associated with a longer

94   life expectancy, for a review see Gold 2011). To see if general physical ageing could mediate

95   the relationship between facial attractiveness and expected age at menopause, we included

96   facial ageing (measured as the difference between actual age and perceived age) as another

97   explanatory variable.

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99   2. Materials and Methods

100   **2.1 Ethics Statement.** The protocol used to recruit participants and collect data was approved

101   (#1226659) by the French National Committee of Information and Liberty (CNIL). For each

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102 participant, the general purpose of the study was explained ("a study on the determinants of

103 mate choice") and a written voluntary agreement was requested for a statistical use of data

104 (private information and photographs). Data were analysed anonymously.

105 **2.2 Stimuli.** A total of 97 women between 25 and 35 years of age were recruited by social

106 networks and advertising in Montpellier, France. Sixty-eight Caucasian women whose mother

107 had a natural and known age at menopause constituted our final stimuli sample (mean age =

108 28.4, age range: 25-35, see table S4). Volunteers were instructed to come to the lab after

109 collecting information about their mother's and (when possible) grandmothers' menopause

110 (menopause was defined as the first full year without any menstruation) and without wearing

111 any make-up. For each woman, the following information was collected: date and place of

112 birth for themselves, their parents and grandparents; monthly income (divided into ten classes

113 from less than 760€ to more than 4705€) for themselves and their parents; education level;

114 and age at menopause for their mother and grandmothers. A facial photograph was taken with

115 the same digital still camera (Canon EOS 20D) at a distance of 1 m using the same general

116 settings. Each woman was asked to have a neutral facial expression, to remove any glasses or

117 earrings, and to wear a hairband (to make sure that all the face was visible). All photographs

118 were electronically processed using Adobe Photoshop CS3 to normalise size (photographs

119 were aligned on eyes position, with a fixed distance between eyes and chin), colour balance,

120 contrast and luminosity (using the Photoshop auto-corrections tools). Hairstyle was cropped,

121 and the background was replaced by a uniform grey colour (see figure 1). A compensation of

122 20€ was provided for the subjects' participation.

123 **2.3 Procedure.** A Delphi-based computer program was generated to present randomly drawn

124 pairs of photographs of the 68 women (see figure 1). For each pair, the rater was instructed to

125 click on the photograph depicting the woman he found the most attractive (the outcome

126 measure of our study). The position of the photograph on the screen (left or right) was

127 randomly ascribed. Each rater had 30 distinct pairs of photographs to assess, corresponding to

128 60 different women. If the rater knew one of the women he had to judge, the trial was

129   removed. Also, the first pair seen by each participant was not used for the analyses, because

130   the task could require some habituation. Three pairs, randomly chosen from among those

131   previously viewed, were presented again at the end to estimate judgement reliability.

132   **2.4 Raters.** A total of 156 male raters assessed the relative attractiveness of these women.

133   Volunteer raters were recruited in public places in Montpellier (France) and were unaware of

134   the purpose of the study when assessing the pairs of pictures. For each rater, the following

135   information was collected: date and place of birth, grandparents' origins, monthly income,

136   occupation, house ownership, taxability, education level, and sexual orientation. Only data

137   from Caucasian and heterosexual raters were used for the analyses. Assessments of unreliable

138   raters (i.e., with more than one incorrect answer during the test of judgement reliability) were

139   removed. A total of 119 raters were retained in the final sample, with a mean age of 36.2 (age

140   range: 17-72, see table S4). Each woman was observed, on average, by 101.1 raters (range:

141   93-108).

142   **2.5 Immediate fertility cues.** We collected 3 physical features hypothesised to be linked to

143   women's immediate fertility: the waist-to-hip ratio (the ratio between body circumference at

144   the waist and the hips or WHR, Singh 1993; Jasienska et al. 2004; Singh and Randall 2007;

145   Lassek and Gaulin 2007; Mondragón-Ceballos et al. 2015; Butovskaya et al. 2017; but see

146   Nenko and Jasienska 2009), the fundamental frequency of the voice (F0, Harries et al. 1998;

147   Abitbol et al. 1999; Feinberg 2008; Evans et al. 2008; Abend et al. 2014) and the facial

148   femininity (Farkas 1987; Johnston and Franklin 1993; Perrett et al. 1998; Fink and Neave

149   2005; Law Smith et al. 2006; Little et al. 2011; Pfluger et al. 2012; Jones 2014). The WHR

150   was measured in the lab by the investigator. To measure the F0, women were recorded reading

151   the French version of a standard text ("La bise et le soleil") using a Tascam DR-07 MKII

152   digital recorder. Across each recording, the fundamental frequency (F0, the acoustic correlate

153   of pitch) was measured using Praat software (Boersma and Weenink 2013). To generate

154   morphological facial femininity scores, a geometric morphometric analysis of the faces was

155　used following methods described in Scott et al. 2010; Lee et al. 2014; Dixson et al. 2017:

156　First, the coordinates of 142 landmarks (anatomical points present in all individuals, e.g. the

157　corners of the lips) and semi-landmarks (sliding points positioned along some anatomical

158　curves, such as the bow of the eyebrow) were delineated for each female face, as well as for

159　26 male facial photographs retrieved from another database. These 26 additional men were

160　recruited according to the same criteria as for the women's recruitment: heterosexuality,

161　Caucasian origin, 25-35 years old. The delineation of the landmarks and semi-landmarks were

162　done using Psychomorph (Tiddeman et al. 2005). The R package Geomorph (version 3.0.3)

163　was used to carry out a Procrustes superimposition of the landmark and semi-landmark data,

164　which removes non-shape information such as translation, size, and rotational effects

165　(Zelditch et al. 2012, 2013). A Principal Component Analysis (PCA) was conducted on the

166　Procrustes-registered landmarks and semi-landmarks data of the 26 male faces and 26 female

167　faces randomly drawn from this study dataset, matching the age distribution of the 26 men.

168　This PCA produced shape variables which are a decomposition of the landmark coordinates of

169　the male and female faces (see figure S1). The values on the factors of the PCA were

170　computed for the remaining 42 female faces (not used to create the PCA). Then, a linear

171　discriminant analysis (LDA) incorporating the two first components of the PCA was used to

172　discriminate between male and female faces. The resulting analysis provided correct sex

173　classification for 92.6% of faces. Discriminant function scores were therefore used as an

174　index of facial femininity, with high scores indicating a more feminine facial morphology

175　scores (Scott et al. 2010; Lee et al. 2014; Dixson et al. 2017). All analyses were performed

176　using R software, version 3.4.2.

177　**2.6 Estimation of facial ageing.** It could be speculated that women who reach menopause

178　later have an overall slower life history trajectory, with a slower general physical ageing, and

179　may look younger, at the same age, than women who will experience menopause at an earlier

180　age. To control for this possibility, a second Delphi-based computer program was generated to

181　present the facial photographs of the 68 women to 136 raters. For each photograph, the rater

182   was instructed to estimate the age of the woman (see figure S2). Each rater had 20 distinct

183   photographs to assess, randomly drawn among the 68 pictures. Three photographs, randomly

184   chosen among those previously viewed, were presented again at the end to estimate

185   judgement reliability. For each rater, information about sex and age was collected. The

186   reliability of raters was assessed by computing the sum of absolute differences between the 3

187   first estimations and the corresponding repetitions. Raters with values higher than 15 years

188   were removed (a more stringent threshold of 9 years, or no threshold, did not change

189   qualitatively the results). A total of 107 facial ageing raters (including 61 women) were

190   retained in the final sample, with a mean age of 35.1 (age range: 16-65). Each woman was

191   observed, on average, by 31.2 raters (range: 24-43). For each woman, the difference between

192   their real age and the mean age given by the raters was calculated. This variable represents the

193   facial ageing of the women, a critical explanatory variable for the analysis of attractiveness.

194   **2.7 Statistical analyses.** Logistical regressions were used to analyse raters' attractiveness

195   preferences. The binary response variable corresponded to being chosen or not for the focal

196   woman (arbitrarily the woman presented at the left position) during the presentation of each

197   pair. Women and attractiveness raters were considered random samples from a larger

198   population of interest and were thus random-effect variables. Therefore, generalised linear

199   mixed models with a binomial error structure were used. For each choice made by a rater, the

200   difference between the ages at menopause of the focal and the non-focal woman's mothers

201   was calculated. The value of this difference was integrated into the model as the main variable

202   of interest. To control for potential confounding effects, the differences between the focal and

203   the non-focal woman's ages and socio-economic status (SES, a PCA combination of

204   education level and the woman's and her parents' monthly incomes) were introduced into the

205   model. Because the subjects displayed a perceptible smile in some photographs, a qualitative

206   variable describing this aspect was also introduced (this binary variable was coded by three

207   independent raters, blind to the other characteristics of the women). Variables concerning the

208   raters' characteristics were also included in the model as potential confounding effects. These

209   variables were the rater's age and SES (a PCA combination of the variables "monthly

210   income", "occupation", "house ownership", "taxability", and "education level"). All variables

211   were standardized for the analysis. In a second model, the difference between the two women

212   for cues of immediate fertility (facial femininity, WHR and F0), and facial ageing were

213   included as explanatory variables. Indeed, these variables, which may be linked to expected

214   age at menopause, could potentially mediate the relationship between expected age at

215   menopause and facial attractiveness.

216   Linear regression was used to analyse the mother's age at menopause according to the

217   maternal grandmother's age at menopause. The "one-parent - one child" regression coefficient

218   represents half the heritability (h^2) of the trait (Lynch and Walsh 1998). Pearson correlations

219   were used to analyse relationships between each woman's measured traits: expected age at

220   menopause, immediate fertility cues, facial ageing, age, and SES. All statistical analyses were

221   performed using R software, version 3.4.2.

222

223   3. Results

224   **3.1 Attractiveness, age at menopause and immediate fertility.** The variable expected age at

225   menopause (estimated by mother's age at menopause) had a significant positive effect on the

226   probability of a woman being chosen as the most attractive: Men tend to prefer women who

227   are likely to reach menopause later ($\beta = 0.22$, SE $= 0.053$, $P < 0.001$ see model 1 in table 2).

228   This result holds when immediate fertility cues and facial ageing are controlled for ($\beta = 0.24$,

229   SE $= 0.053$, $P < 0.001$, see model 2 in table 1 and figure 2), showing that the effect of

230   expected age at menopause on attractiveness is not due to know cues of immediate fertility

231   cues or facial ageing. Additionally, the 3 cues of immediate fertility had a significant effect on

232   the probability of being chosen: men tend to prefer more feminine faces ($\beta = 0.4$, SE $= 0.057$,

233    $P < 0.001$, see model 2 in table 1), and the faces of women who have a higher (i.e. more

234   feminine) F0 ($\beta = 0.2$, SE $= 0.058$, $P = 0.001$). In contradiction with our prediction, men also

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235 tend to prefer the faces of women who had a higher (i.e. more masculine) WHR ($\beta = 0.13$, SE

236 $= 0.057$, $P = 0.02$). Facial ageing had a negative effect on the probability to be chosen ($\beta = $ -

237 0.56, SE $= 0.06$, $P < 0.001$): Independently of their actual age, women who look younger than

238 their actual age were preferred by men. Women's age and smile demonstrated a significant

239 effect on the probability of being chosen: men preferred women who were younger ($\beta < -0.2$,

240 $P < 0.001$, see models 1 and 2 in table 1) and smiled more ($\beta > 0.27$, $P < 0.001$, see models 1

241 and 2 in table 1). The socio-economic status of the woman had a negative effect on the

242 probability to be chosen as the more attractive, but this result was significant only in model 2

243 ($\beta = -0.17$, SE $= 0.057$, $P = 0.003$). The raters' age and socio-economic level had no

244 significant effect on their choices (all $P > 0.5$, see models 1 and 2 in table 1).

245 **3.2 Menopause and other women's features.** There was no significant correlation between

246 expected age at menopause and immediate fertility cues (facial femininity, F0 and WHR),

247 facial ageing, woman's age or socio-economic status (all $P > 0.1$, see table 2), showing that

248 expected age at menopause is capturing a distinct correlate of facial attractiveness. There was

249 no significant correlation between the other variables, except a negative correlation between

250 facial ageing and SES (r $= -0.29$, $P = 0.021$, see table 2).

251 **3.3 Heritability of age at menopause.** To help establish the validity of our sample, we

252 measured the heritability of age at menopause, for comparison with previous studies done

253 with various samples and methods (Snieder et al. 1998; de Bruin et al. 2001; van Asselt et al.

254 2004; Murabito et al. 2005; Morris et al. 2011). Here we used the regression between grand-

255 mother and mother, without controlling for possible shared environments (this is not crucial

256 for the present study, as the main purpose here is to establish the validity of the mothers' age

257 at menopause as a proxy for the daughters' expected age at menopause). Among the 97

258 women, 42 completed information about both their mother's and maternal grandmother's

259 menopause. The mean age at menopause was 51.0 (range: 42-58) for the mothers and 50.3

260 (range: 39-60) for the grandmothers. The maternal grandmother's age at menopause had a

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261   significant effect on the mother's age at menopause (β = 0.275, SE = 0.11, P = 0.016, see

262   figure 3). This implies a heritability of age at menopause from the maternal side of 27.5% and

263   thus an overall heritability h² ~ 55% (*SE* = 0.22).

264   <u>4. Discussion</u>

265   Here, we show that expected age at menopause is significantly related to the facial

266   attractiveness of young women. This result holds when variables potentially linked to

267   immediate fertility (age, facial femininity, voice pitch and WHR), facial ageing and socio-

268   economic status are controlled for. Additionally, immediate fertility cues and facial ageing

269   were not correlated with the expected age at menopause. Thus, the expected age at menopause

270   seems to be linked to independent facial information, which is not deducible from previously

271   documented components of facial attractiveness linked to immediate fertility or facial ageing.

272   Results classically found in the literature were replicated in this study, suggesting that

273   this sample of young females is not different from those described elsewhere. First, our

274   sample provided an heritability estimate for age at menopause of 0.55, consistent with

275   previous values ranging from 0.42 to 0.72 (Snieder et al. 1998; de Bruin et al. 2001; van

276   Asselt et al. 2004; Murabito et al. 2005; Morris et al. 2011). Moreover, immediate fertility

277   cues were positively correlated with facial attractiveness, as in previous studies: men in our

278   sample preferred more feminine faces as in Cunningham et al. 1995; Perrett et al. 1998;

279   Rhodes et al. 2003; Koehler et al. 2004; Little et al. 2011, and facial attractiveness was

280   positively correlated to pitch voice (F0), consistent with Collins and Missing 2003; Feinberg

281   et al. 2005; Wheatley et al. 2014; Smith et al. 2016. Also, attractive faces were rated younger

282   than their true age, as in the study of Kwart (2012). However, two variables had significant

283   effects on attractiveness, but in the opposite direction than expected. First, men in our sample

284   had a preference for faces of women who have a higher (i.e. more masculine) WHR, which is

285   in contradiction with the idea that face and body would signal one same quality. However, our

286   results go in the same direction than results of Thornhill and Grammer (1999), who found a

287 positive but insignificant correlation between facial attractiveness and WHR. Further studies

288 are needed to investigate if face and WHR are signaling different aspects of female mate

289 quality. Secondly, we found that socio-economic status of the women had a negative effect on

290 facial attractiveness. We were expecting a positive correlation, as a higher socio-economic

291 status is related to less stress during development, better nutrition, less unhealthy behavior,

292 etc. (Adler et al. 1994; Kalick et al. 1998). But here again, even if counterintuitive, our results

293 are in the same direction than a previous study showing a negative correlation between facial

294 attractiveness and SES for female (Hume and Montgomerie 2001). We cannot speculate on

295 this result, as the variance of SES in our female sample is very narrow (women were all

296 students at the university). However, we can suggest that it deserves more study (a lot of

297 research focused on the effect of attractiveness on SES, but less on the reverse relationship).

298   Spurious significant results may sometimes arise following model simplification

299 (Whittingham et al. 2006). This statistical bias is unlikely in this study, as all terms were kept

300 and no model simplification was performed. However, it is still possible that a confounding

301 variable, which remains to be identified, explains the link between expected age at menopause

302 and facial attractiveness. Moreover, further study is needed to specify the facial cues used by

303 men to detect residual reproductive value in young women (in this respect, figure S3 shows

304 the differences in face shape between women of high and low expected age at menopause).

305 Here, we investigated the mediating role of immediate fertility cues and facial ageing, as

306 residual reproductive value could potentially be linked to these two traits (Wood et al. 2001;

307 Gold 2011). The next step would be to consider a large range of facial features such as facial

308 symmetry, averageness, adiposity, skin colour, skin homogeneity, hair, etc., in an exploratory

309 attempt to detect the facial cues linked to expected age at menopause. Also, age at menopause

310 could additionally be assessed with more objective methods then self-report, for example by

311 using the serum antimüllerian hormone concentration (Disseldorp et al. 2008), or through

312 genetic analysis (He et al. 2009, 2010). Assuming that preferences reflect actual mate choice

313 (which remains to be established for this trait), men's preference for women signalling a late

314 age at menopause - and thus a longer temporal reproductive window - could suggests a

315 current selection towards a later menopause, at least in Western societies. Interestingly, a

316 secular trend of increased menopausal age has recently been observed (vanNoord et al. 1997;

317 Rodstrom et al. 2003; Dratva et al. 2009). This suggests that the social, familial and cultural

318 conditions found today in Western societies are promoting current selection towards a later

319 menopause in women. As a consequence, studies carried out in these societies are probably

320 not adequate to empirically test evolutionary hypotheses on the ancestral selection on the

321 emergence or maintenance of an extensive post-reproductive life-span in the human lineage

322 (Thouzeau and Raymond 2017). Our results also suggest that sexual selection should be

323 included in studies investigating the evolution of menopause in humans.

324   Somatic senescence, or ageing, is readily detectable in a face through wrinkles, skin

325 texture and colouration, etc. (for a review, see Rhodes 2009). Those traits are specifically

326 targeted by cosmetic changes when a younger appearance is desirable. Facial traits correlated

327 with reproductive senescence have yet to be identified, and it remains to be determined

328 whether they can be, or are already, manipulated to increase attractiveness by signalling a

329 later menopause.

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509

Tables and figures captions

511 ***Table 1.*** *Effects of the different variables on the probability to be chosen during the test of*

512 *attractiveness (male raters had to choose the woman found to be the most attractive between*

513 *two facial photographs). N = 3439 observations (119 male raters and 68 female faces). Model*

514 *1 only includes the variable of interest (mother's age at menopause), and the control*

515 *variables. Model 2 also includes cues of immediate fertility and facial ageing as explanatory*

516 *variables. Significance codes: *** p < 0.001; ** p < 0.01; * p< 0.05.*

	Model 1					Model 2				
	Estimate	Std. Error	z value	Pr(>|z|)		Estimate	Std. Error	z value	Pr(>|z|)	
(Intercept)	0.092	0.121	0.762	0.446		0.096	0.112	0.861	0.389	
Mother's age at menopause[†]	0.217	0.053	4.129	< 0.001	***	0.240	0.053	4.516	< 0.001	***
WHR[†]	-	-	-	-		0.132	0.057	2.321	0.020	*
Facial femininity[†]	-	-	-	-		0.404	0.057	7.148	< 0.001	***
F0[†]	-	-	-	-		0.200	0.058	3.469	0.001	**
Age[†]	-0.204	0.053	-3.883	< 0.001	***	-0.271	0.058	-4.683	< 0.001	***
Facial ageing [†]	-	-	-	-		-0.563	0.060	-9.350	< 0.001	***
Smile[†]	0.335	0.053	6.364	< 0.001	***	0.271	0.058	4.662	< 0.001	***
Socio-economic status[†]	-0.067	0.052	-1.302	0.193		-0.170	0.057	-3.009	0.003	**
Raters' characteristics										
Age	-0.033	0.061	-0.548	0.584		-0.041	0.063	-0.642	0.521	
Socio-economic status	-0.015	0.061	-0.252	0.801		-0.012	0.063	-0.187	0.852	

517 [†]*For each of these variables, the difference between the two women presented was integrated*
518 *into the model.*

519 ***Table 2. Pearson's correlations between measures in the female sample (N=68 women).***

520 ***Significance codes: *** p < 0.001; ** p < 0.01; * p < 0.05.***

	Age	Mother's age at menopause	F0	WHR	Facial femininity	Facial ageing
Mother's age at menopause	0.07					
F0	-0.10	0.07				
WHR	0.22	-0.04	0.01			
Facial femininity	-0.20	-0.13	0.03	-0.01		
Facial ageing	-0.23	-0.08	-0.13	-0.03	0.24	
Socio-economic status	0.05	0.13	0.08	0.20	-0.18	-0.29*

521

522 **Figure 1.** Example of screenshot during the evaluation of women's facial attractiveness by the

523 raters. For each pair of women, which was randomly chosen, the rater was instructed to click

524 on the photograph of the woman that he found the most attractive. Photographs reproduced

525 with permission.

526 **Figure 2.** Predicted probability to be chosen during the test of attractiveness, according to the

527 difference in expected age at menopause (unstandardized values) between the focal and the

528 non-focal women, controlling for all the other variables of model 2. Circle areas are

529 proportional to the number of choices made by the raters: chosen (1) or not (0) as the most

530 attractive woman. 95% confidence interval is represented by the dotted lines.

531 **Figure 3.** Relationship between age at menopause of mothers and maternal grandmothers.

532 Plain line represents the linear regression with all points ($\beta = 0.275$, SE $= 0.11$, $P = 0.016$,

533 corresponding to a heritability of age at menopause $h^2 = 0.55$). 95% confidence interval in

534 grey.

535

536 <u>Supporting Information</u>

537 **Figure S1.** Results of the Principal Component Analysis (PCA) conducted on the Procrustes-

538 registered landmarks and semi-landmarks data. This PCA produced shape variables which are

539 a decomposition of the landmark coordinates of the female (black dots) and male (grey dots)

540 faces. Only the two first components (or shape variables) are represented here.

541 **Figure S2.** Example of screenshot during the evaluation of women's age by the raters. The

542 rater was instructed to estimate the women's age. The age appearing by default for each

543 picture was randomized. For each woman, the difference between their real age and the mean

544 age given by the raters was calculated. This variable represents the facial ageing of the

545 women. Photograph reproduced with permission.

546 **Figure S3**. *Top*: Shape differences of a low expected reproductive value face (average face of

547 the 7 women with the earlier expected age at menopause in our sample) relative to the average

548 face (average of all the women's face in our study), on a Thin-Plate Spline (TPS) grid.

549 *Bottom*: shape differences of a high expected reproductive value face (average face of the 7

550 women with the later expected age at menopause) relative to the average face. For both, the

551 shape deformation has been magnified by 2. Figure created using R package Geomorph 3.0.3.

552

553   **Table S4.** Descriptive statistics

| Variable	N	Mean	St. Dev.	Min	Max
Mother's age at menopause (year)	68	50.97	3.22	42	58
WHR (ratio)	68	0.73	0.04	0.62	0.83
Facial femininity (index)	68	0.78	0.98	-1.71	3.33
F0 (Hz)	68	203.28	19.94	142.50	243.70
Age (year)	68	28.43	3.00	25	35
Facial ageing (years)	68	1.34	3.90	-5.57	12.71
Smile (binary)	68	0.31	0.47	0	1
Socio-economic status (PCA coordinate)	68	0.07	0.75	-1.23	2.08
Raters' characteristics					
Age (year)	119	36.23	12.25	17	72
Socio-economic status (PCA coordinate)	119	0.02	0.72	-0.99	1.98

554

21
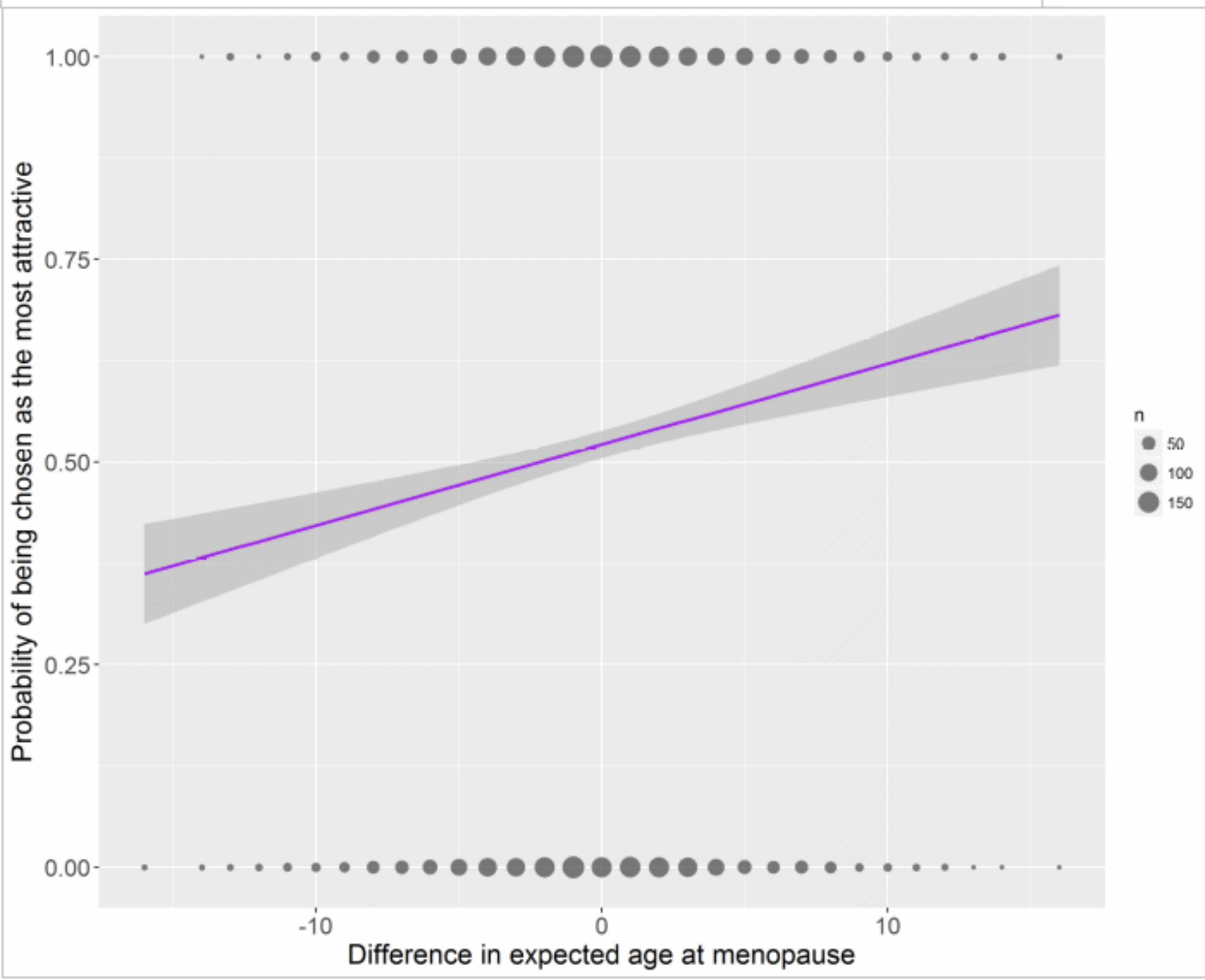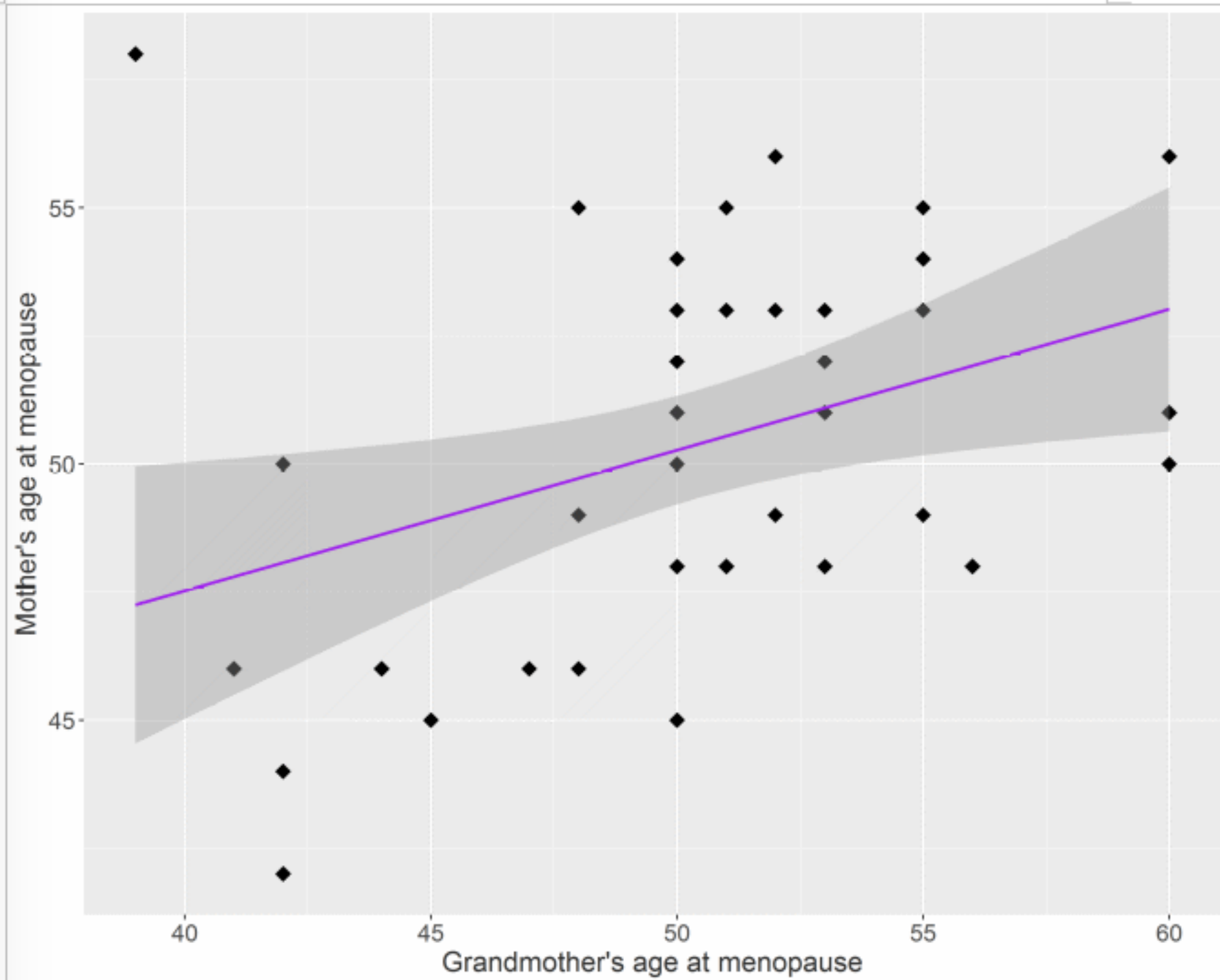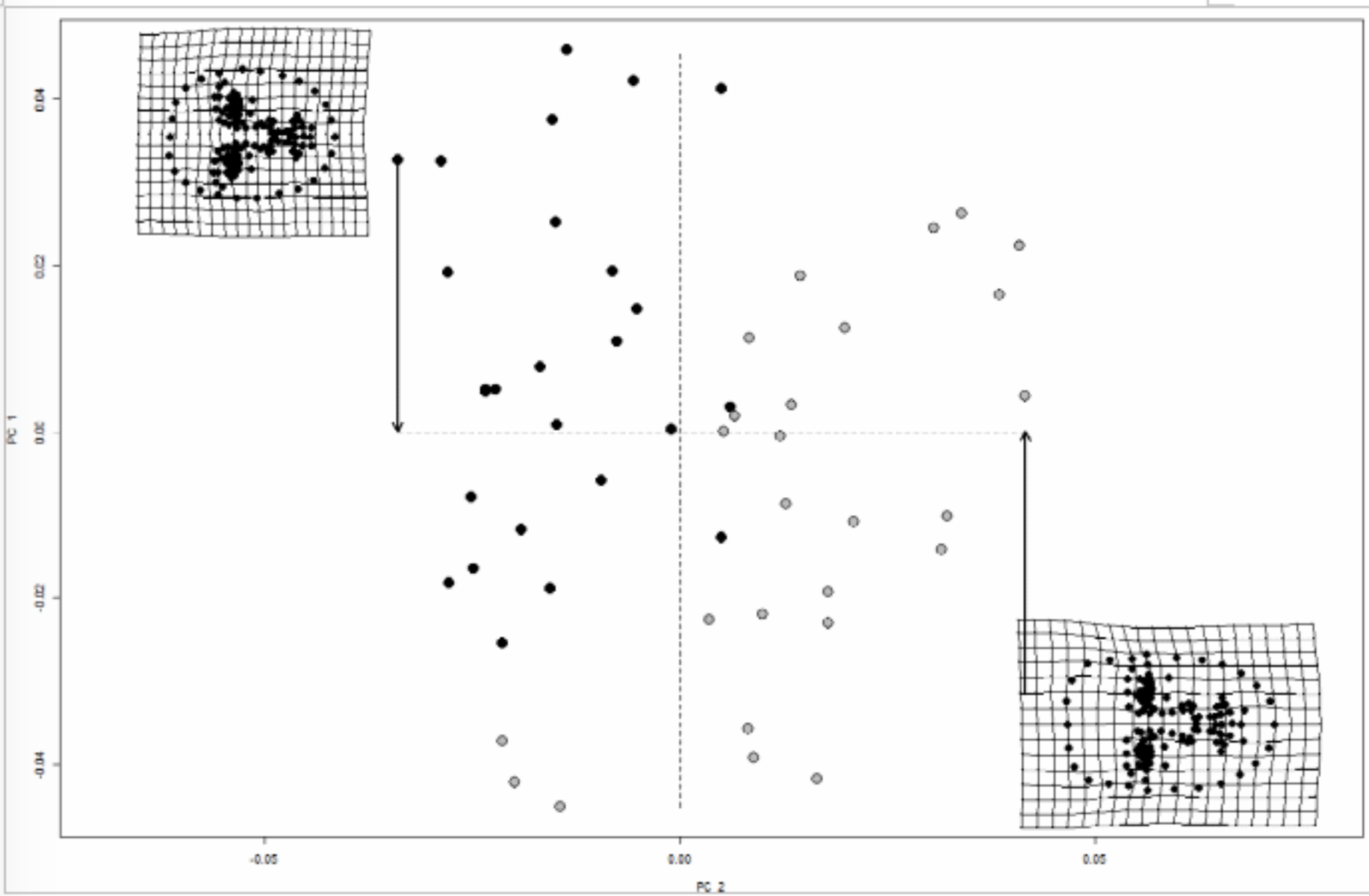
Age:

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Next

☐ I know this person

How old is she ?