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Comprehending non-literal language: effects of aging and bilingualism

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Abstract

A pressing issue that the 21st century is facing in many parts of the developed world is a rapidly aging population. Whilst several studies have looked at aging older adults and their language use in terms of vocabulary, syntax and sentence comprehension, few have focused on the comprehension of non-literal language (i.e. pragmatic inference-making) by aging older adults, and even fewer, if any, have explored the effects of bilingualism on pragmatic inferences of non-literal language by aging older bilinguals. Thus, the present study examined the effects of age(ing) and the effects of bilingualism on aging older adults' ability to infer non-literal meaning. Four groups of participants made up of monolingual English-speaking and bilingual English-Tamil speaking young (17–23 years) and older (60–83 years) adults were tested with pragmatic tasks that included non-conventional indirect requests, conversational implicatures, conventional metaphors and novel metaphors for both accuracy and efficiency in terms of response times. While the study did not find any significant difference between monolinguals and bilinguals on pragmatic inferences, there was a significant effect of age on one type of non-literal language tested: conventional metaphors. The effect of age was present only for the monolinguals with aging older monolinguals performing less well than the young monolinguals. Aging older bilingual adults were not affected by age whilst processing conventional metaphors. This suggests a bilingual advantage in pragmatic inferences of conventional metaphors.

1. Introduction

38 Everyday communication involves not only literal language, but also the use of non-literal
39 language, such as idioms, proverbs, metaphors, indirect requests, and conversational
40 implicatures. To comprehend non-literal language, pragmatic inferences have to be made: the
41 listener has to go beyond the literal meaning of the utterance and draw upon the situational
42 context of the utterance as well as the listener's and speaker's knowledge of the world to
43 arrive at the implied (non-literal) meaning. Pragmatic inferences are also thought to be
44 cognitively more demanding because the listener has to both access their theory of mind to
45 realize the speaker's communicative intentions (Champagne-Lavau and Joannette 2009) and
46 inhibit the literal meaning (Glucksberg, Newsome, and Goldvarg 2001) which becomes
47 activated together with the implied meaning (Stewart and Heredia 2002) during the
48 processing of the non-literal language. Given that a great part of our daily conversations
49 includes non-literal utterances, it is remarkable that listeners are able to comprehend them
50 effortlessly and in great speed in spite of the high cognitive demands. This is true of healthy
51 young adults who are in the peak of their cognitive abilities. However, it is unclear whether
52 this is the case also for aging older adults, whose cognitive abilities are on the decline.
53 Moreover, it is unclear whether the aging process affects the comprehension of non-literal
54 language in monolingual and bilingual aging older adults in the same way given recent
55 findings that show bilinguals having a cognitive reserve (Craik, Bialystok, and Freedman
56 2010; Bialystok, Craik, Fergus, and Luk 2013). The present paper fills these gaps by
57 addressing how monolingual and bilingual healthy young and aging older adults comprehend
58 non-literal language.

59

60 The general perception has been that the language abilities of aging older adults regress with
61 each decade. However, research has revealed that regression is not in all language areas.
62 Healthy aging older adults may face difficulty in understanding spoken discourse, experience
63 problems retrieving words from the mental lexicon while speaking or increasingly suffer
64 from tip-of-the-tongue state (Burke and Shafto 2008; Gollan and Brown 2006; Thornton and
65 Light 2006). On the other hand, they have been found to have a larger vocabulary size
66 (Bialystok and Luk 2012; Burke and Shafto 2008; Kavé and Halamish 2015), and to create
67 more complex narratives than younger adults (Burke and Shafto 2008; Thornton and Light
68 2006). Healthy aging older adults have also been reported to use "high-level vocabulary and
69 complex syntax" (Ulatowska, Chapman, Highley and Prince, 1998, p. 628). In addition,
70 sentence comprehension has been reported to be intact in old age (Tyler et al. 2009).

71

72 While much research has been aimed at aging older adults' understanding and production of
73 vocabulary and grammatical structures at the sentential level and at times, discourse level
74 (see Thornton and Light 2006 for a comprehensive review), research into the pragmatic
75 language abilities of aging older adults is comparatively rather scattered, if not impoverished.
76 Thus, it is unclear whether or not aging older adults' pragmatic inferential abilities, which
77 lead to correct meaning formation of non-literal languages, regresses much like some other
78 aspects of the aging older adults' language.

79

80 Of the few studies that have investigated the comprehension of non-literal language by aging
81 older adults, the focus has been on idioms (Westbury and Titone 2011), proverbs
82 (Uekermann, Thoma, and Daum 2008; Ulatowska et al. 1998; Nippold, Uhden, and Schwarz
83 1997) and metaphors (Newsome and Glucksberg 2002; Mashal, Gavrieli, and Kavé 2011;
84 Qualls and Harris 2003). These studies, discussed below, have revealed contradictory or
85 questionable findings in terms of the aging older adults' pragmatic inferential abilities.

86

87 A few of the aforementioned studies point to regression in aging older adults' pragmatic
88 inferential abilities. (Nippold, Uhden, and Schwarz (1997) investigated the proverb
89 comprehension abilities of 353 people in Oregon aged between 13 and 79 years using a
90 Proverb Explanation Task. This task consisted of 24 proverbs which had received low
91 familiarity ratings in Nippold and Haq 1996 (Nippold et al. 1997). The adolescents and adults
92 read short stories with the proverbs appearing at the end and wrote down the meanings of the
93 proverbs. While the study found proverb comprehension ability to decline in adults in their
94 60s (Nippold, Uhden, and Schwarz 1997), the stories, based on one out of the two examples
95 provided by the authors, required connective inferences. A failure to make the connective
96 inference could potentially impede understanding of the proverbs under study. Uekermann,
97 Thoma, and Daum' (2008) study of 105 healthy adults, 35 of whom were aging older adults
98 between the ages of 60 and 79, led to a similar conclusion that aging older adults were
99 impaired in proverb comprehension. The participants in this study had to, firstly, rate the
100 familiarity of 32 German proverbs on a five-point Likert scale, and secondly, had to
101 determine the non-literal meaning of these proverbs from four options which varied along
102 "degree of abstraction" and "meaningfulness" (p. 35). On the other hand, other studies did
103 not find any regression in aging older adults' non-literal language comprehension. Ulatowska
104 and colleagues (1998), who had looked at 16 normally aging older monolingual speakers of
105 American English in their 80s and 90s over a period of three years, found that there was no
106 decline in proverb understanding and interpretation; instead there was an improvement for
107 familiar proverbs and no significant changes for unfamiliar proverbs on the second testing
108 after three years.

109

110 Metaphor comprehension too does not seem to regress with age. Aging older adults have
111 been found to have access to metaphorical meaning (Morrone et al. 2010). Morrone and
112 colleagues (2010) found their aging older participants aged 65 to 75 years making more
113 errors and taking a longer time to reject the non-literal meaning of metaphors than the
114 younger participants aged 21 to 30 years. This was believed to indicate that the aging older
115 adults had access to the non-literal meanings of the metaphors. They posit that the non-literal
116 meanings of the metaphors were likely activated and arrived at immediately, and thus needed
117 to be inhibited; a decline in the inhibitory abilities of the aging older adults was deemed to
118 lead to longer rejection times and more errors. Similarly, Newsome and Glucksberg (2002)
119 found that the metaphor comprehension processes of aging older adults between the ages of
120 70 to 79 were not only seemingly intact, but also that the aging older adults were "as efficient
121 as the younger adults (aged 17-21) in filtering out metaphor-irrelevant information" (p. 262).
122 Newsome and Glucksberg presented the non-reversible metaphors and literal phrases in
123 sentences as primes which were followed by metaphor-relevant and metaphor-irrelevant
124 sentence probes with the last word of each prime beginning each sentence probe; participants
125 had to judge whether the sentences made sense. Both young adults and aging older adults
126 were better able to appreciate metaphor-relevant material after being primed by the
127 metaphors and metaphor-irrelevant materials after being primed by the literal sentence
128 primes.

129

130 In some instances, older adults have been found to possess superior pragmatic inferential
131 abilities to young adults. Qualls and Harris (2003) investigated both younger (17-31 years)

132 and older (54-73 years) African American adults' comprehension of non-literal language.
133 This study revealed that the older adults have better comprehension of idioms and metonyms
134 than the younger adults. However, Qualls and Harris (2003) had a number of important
135 confounds in their study: the answer options for metonyms included metaphors, which
136 themselves require pragmatic inferring. In addition, the metaphor items included both
137 conventional and novel metaphors, both under the umbrella term of metaphors. This is
138 problematic because processing of conventional and novel metaphors employ different
139 cognitive mechanisms and appreciation of novel metaphors has been shown to be affected by
140 age (Mashal, Gavrieli and Kavé, 2011). Lastly, the authors had included adults who were
141 between 50 to 59 in their group of older adults. Whilst this definition of older adults is
142 applicable to most African countries (WHO 2002), it should not apply to African Americans
143 who experience a longer life expectancy than and differ socially from the people in Africa;
144 adults between 50 and 59 years of age would have better cognitive abilities than older adults,
145 thus confounding the results.

146

147 Another important study on metaphors and aging older adults is the study by Mashal,
148 Gavrieli and Kavé (2011). Mashal, Gavrieli, and Kavé (2011) compared young and aging
149 older adults in their appreciation of conventional and novel metaphoric expressions. Their
150 first experiment, which was aimed at rating the plausibility of metaphors and literal
151 expressions, revealed that the young adults regarded more metaphoric expressions as
152 plausible than the aging older adults, with both groups not showing any significant difference
153 for the plausibility rating of the literal and unrelated expressions. However, it is unclear
154 whether the aging older adults found more of the novel metaphoric expressions as less (or
155 more) plausible than the conventional ones; this they address in their second experiment that
156 used different groups of young and aging older adults to examine if there was any age effect
157 in terms of appreciating conventional versus novel metaphors. In this second experiment, the
158 young and aging older adults had to rate the familiarity level of the 79 metaphoric
159 expressions that were appreciated as plausible in the first experiment. Interestingly, the aging
160 older adults rated more of the metaphoric expressions as being more familiar, appreciating
161 them as being conventional. This was unlike the young adults who regarded the metaphoric
162 expressions as being more novel. Expressions that were deemed as being highly novel by the
163 young adults, were rated as being highly meaningless by the aging older adults. The study by
164 Mashal, Gavrieli, and Kavé (2011) alludes to novel metaphor processing, unlike conventional
165 metaphor processing, to be problematic in aging older adults.

166

167 The aforementioned studies, besides highlighting the contradictory findings with regard to
168 aging older adults' non-literal language comprehension, also point to the possibility that
169 different pragmatic inference-making strategies are employed depending upon the type of
170 non-literal language encountered (Garcia 2004). In addition, these studies either did not
171 present the non-literal utterances within a situational context or presented them in texts that
172 require connective inferences to be made. In our everyday social interactions, literal and non-
173 literal utterances do not occur in isolation. These utterances are produced within specific
174 contexts, and we unpack the meaning of these utterances based on these contexts. Thus, the
175 failure to comprehend non-literal language in some of the studies looked at earlier could be
176 due to the lack of context. To address these shortcomings, the present study focused on the
177 comprehension of a range of non-literal language in the same groups of participants and

178 included a situational context for each target utterance to increase the ecological validity of
179 the task.

180

181 All the studies mentioned above have focused on monolingual aging older adults. Although
182 an estimated 50 percent or more of the world's population is either bilingual or multilingual
183 (Grosjean 2010), there is a lack of studies investigating bilingual aging older adults'
184 comprehension of non-literal language. Given the current debate about whether or not
185 bilinguals have better cognitive abilities than monolinguals and, as established earlier, the
186 cognitive demands of pragmatic inferring during non-literal language comprehension, it is
187 important to investigate the comprehension of non-literal language by bilingual aging older
188 adults. In the present study, 'bilinguals' are defined based on Grosjean (2010, p. 4), according
189 to whom bilinguals are people "who use two or more languages (or dialects) in their everyday
190 lives".

191

192 A number of studies have found that bilinguals have better cognitive abilities than
193 monolinguals in terms of better executive control functions across the lifespan (Bialystok and
194 Craik 2010; Luk et al. 2011; Bialystok, Craik, and Ryan 2006) and working memory
195 (Bialystok et al. 2004). Moreover, aging adults who might otherwise succumb to dementia or
196 neurodegenerative disease(s) earlier are now being diagnosed later due to their bilingualism
197 (Craik, Bialystok, and Freedman 2010). This has led to the hypothesis that the accrued
198 neurocognitive differences arising from bilingual language processing over the lifespan lead
199 to neuroplastic changes in the bilingual brain which attenuate age-related cognitive decline
200 (Bak, Nissan, Allerhand, & Deary, 2014; Baum & Titone, 2014, p. 859). In addition, studies
201 have also found that the frontal and temporal lobes, where language functions take place, are
202 of greater volume in bilinguals than monolinguals (Olsen et al. 2015).

203

204 However, several other studies were not able to find a bilingual cognitive advantage
205 (Bogulski et al. 2015; Paap and Greenberg 2013; Zahodne et al. 2014). For example, in
206 contrast to researchers who found bilinguals to be in possession of superior inhibitory
207 abilities, Kousaie and Phillips (2012), using the Colour Stroop task, did not find a bilingual
208 advantage for inhibitory control for either their young bilinguals or their old bilinguals in
209 comparison to their monolingual counterparts. Likewise, Colzato and colleagues (2008) did
210 not find any difference between the young monolinguals and young bilinguals in the Stop
211 Signal inhibition task, although they did find the bilinguals to be better able to maintain
212 action goals and use them to differentiate goal-related information leading to "more
213 pronounced reactive inhibition of irrelevant information" (p. 302). Similarly, de Bruin, Bak,
214 and Della Sala (2015), who had controlled for a number of variables such as education,
215 socioeconomic status, intelligence, age of acquisition and immigration status, did not find a
216 bilingual cognitive advantage for inhibitory control in their aging older adults regardless of
217 whether they were active or inactive bilinguals. Yet other studies have found the age of
218 acquisition of the second language to influence the bilingual cognitive advantage; Vega-
219 Mendoza and colleagues' (2015) study found late acquisition of second language having a

220 positive effect on inhibition. Given that the comprehension of non-literal language is
 221 cognitively more demanding, examining monolingual and bilingual aging older adults'
 222 comprehension of non-literal language can shed light on the debate surrounding the cognitive
 223 advantage in bilinguals.

224

225 The present study addresses the issues highlighted earlier by investigating the comprehension
 226 of non-literal utterances by monolingual and bilingual young and aging older adults. It aims
 227 to answer two research questions: 1) Is there an age effect on pragmatic inference-making?,
 228 and 2) Is there a bilingual advantage in pragmatic inference-making?.

229

230 This study focuses on three types of frequently occurring non-literal language: non-
 231 conventional indirect requests, conversational implicatures, and metaphors which are further
 232 divided into conventional and novel metaphors. The inclusion of different types of non-literal
 233 language will allow for greater insight to the pragmatic inferential abilities of healthy aging
 234 older adults. It is predicted that aging older adults will have pragmatic inferential abilities on
 235 par with young adults for some, but not all, non-literal language types.

236

237 Given that a number of studies have argued that L1 and L2 proficiency, age of L2 acquisition,
 238 language dominance, and L1 or L2 dominant linguistic environment that the bilinguals live in
 239 ought to be taken into account when studying bilinguals (Dong & Li, 2015; Hell & Poarch,
 240 2014; Mishra, 2015; Titone et al., 2015), the present study controls for age of acquisition,
 241 vocabulary knowledge, verbal fluency (see Perani et al. 2003), education, socioeconomic
 242 status, inhibition, intelligence, and processing speed, which is known to slow down with age
 243 (Salthouse 1996), as well as verbal short-term memory and working memory, which are
 244 believed to play vital roles in discourse processing and comprehension (Hasher and Zacks
 245 1988).

246 **2. Materials and Methods**

247 **2.1. Participants**

248

249 Seventy-three healthy adults participated in this study: 19 monolingual English-speaking
 250 young adults (mean age = 19.47, *SD* = 0.7) and 20 monolingual English-speaking aging older
 251 adults (mean age = 69.9, *SD* = 6.8) from the United Kingdom as well as 19 bilingual English-
 252 Tamil-speaking young adults (mean age = 21.02, *SD* = 1.58) and 15 bilingual English-Tamil-
 253 speaking aging older adults (mean age = 67.01, *SD* = 4.39) from Singapore. Table 1 shows
 254 the demographic information of all four groups. All aging older adults were screened with the
 255 Mini Mental State Examination (MMSE) to rule out the onset of dementia or mild cognitive
 256 impairment; the cut-off of 27 was used based on a study conducted by O'Bryant and
 257 colleagues (2008) on the sensitivity of the MMSE. Table 1 shows the groups' mean scores on
 258 the MMSE. None of the aging older adults had a score of less than 27 on the MMSE.

259

=====

260 insert Table 1 around here

261 =====

262
 263 All participants completed the Language History and Use Questionnaire (LHUQ), an
 264 adaptation of the Language History Questionnaire of the Brain, Language, and Computation
 265 Lab, Penn State University (Li, Sepanski, and Zhao 2006). The LHUQ consisted of 22 items
 266 which gather information such as the age of language acquisition, self-assessed language
 267 proficiency, and L1 and L2 frequency of use and code switching among other questions that
 268 elicit the participants' age, sex and socioeconomic status (SES) (years of formal education as
 269 an indication of SES). Table 2 provides the results of the LHUQ pertaining to age of
 270 language acquisition and language usage.

271 =====

272 Insert Table 2 around here

273 =====

274
 275 All monolingual participants were native speakers of British English. Some of the
 276 monolingual participants indicated on the LHUQ that they were aware of one or more foreign
 277 languages; these were learnt in a classroom setting around the age of 11 and later at school or
 278 after the age of 19 for work. Only two young monolinguals reported using their additional
 279 language. The use was only for half an hour out of 24 per day and not on a daily basis and
 280 therefore they were included in the monolingual group based on Grosjean's (2010) definition
 281 of bilinguals. All bilingual participants were speakers of Standard Singapore English and
 282 Standard Spoken Tamil; both English and Tamil were used in the homes of all bilingual
 283 participants. All, but four, of the young bilinguals reported that English was acquired from
 284 birth; two of the young bilinguals acquired English at the age of five, while the other two
 285 began acquiring English once in school at ages six and seven when they started school. Most
 286 of the older bilinguals began acquiring English from around the age of six, except for three
 287 older bilinguals who began learning English at the age of 12 in a formal school setting before
 288 migrating to Singapore as young adults. Given that English is widely used in public life in
 289 Singapore, all learners were exposed to English in a naturalistic environment, including these
 290 three older bilinguals. To address the potential role of age of acquisition acting as a
 291 confounding factor, it was included as a covariate in the analyses of the pragmatic tasks.

292 The Complex Ideational Materials Subtest (CIMS) of the Boston Diagnostic Aphasia
 293 Evaluation (BDAE) (short version) was used to test participants' auditory English sentence
 294 comprehension. The task includes a total of six pairs of yes-no questions. Each question
 295 answered correctly was awarded 1 point giving rise to a total possible score of 12. Only the
 296 aging older adults were tested in the CIMS because of the significant difference between the
 297 aging older monolinguals' and bilinguals' age of acquisition of English.

298
 299 The monolingual young adults were undergraduates from the Department of Psychology,
 300 University of Reading, and received course credits for their participation. The monolingual
 301 aging older adults were recruited via the University of Reading's Aging Research Panel and

302 were reimbursed £10 towards their transport. The bilingual young adults were recruited from
 303 the National University of Singapore, the Nanyang Technological University and Ngee Ann
 304 Polytechnic in Singapore. The bilingual aging older adults were recruited through visits at
 305 temples in Singapore and through personal contacts and were given gifts of fruits and biscuits
 306 for cultural reasons.

307 **2.2. Materials**

308 **2.2.1. Background tests**

309

310 To be able to control for potential confounding factors resulting from differences between the
 311 groups on verbal and non-verbal abilities, as well as processing speed, a large battery of
 312 background tests was carefully selected to record the participants' lexical and semantic
 313 knowledge, and cognitive abilities, including fluid intelligence, verbal short-term memory
 314 and working memory, as well as processing speed. In terms of verbal abilities, the battery
 315 focused on lexical and semantic rather than grammatical abilities because the experimental
 316 pragmatic tasks relied heavily on lexical and semantic information and did not have any
 317 grammatical manipulations. Of course, grammatical abilities are relevant for all tasks
 318 involving the sentence and discourse level, but the battery was already very long.

319 **2.2.1.1 Lexical and semantic measures**

320

321 The **Raven's Short Vocabulary Scale (RVS)**, consisting of 17 words increasing in difficulty
 322 in an ascending order, was used to measure lexical knowledge. All participants had to give
 323 the meanings of the words on the list; their answers were audio recorded, and later scored
 324 with a 0 if outright wrong, 1 if partially correct and 2 when totally correct. Because
 325 vocabulary acquisition is positively related to socioeconomic status (SES) (Fernald,
 326 Marchman, and Weisleder 2013; Hoff 2003), the RVS was used as a covariate together with
 327 education to control for the SES of the participants.

328

329 A **Tamil vocabulary list (TVL)** was created with the help of a native Singapore Tamil
 330 speaker. The TVL, like the RVS, had 17 vocabulary words and increased in its level of
 331 difficulty as the bilingual participants progressed down the list. The TVL was scored in a
 332 similar manner to the RVS.

333

334 The **English Verbal Fluency (EVF)** test comprised of the English Letter Fluency (ELF) task
 335 and the English Semantic Category Fluency (ESCF) task. The ELF task measures vocabulary
 336 retrieval, and together with the SCF task, also detects neuropsychological impairments and
 337 frontal disorders (Gladsjo et al. 1999). In the ELF task, all participants were instructed to
 338 provide as many words as possible that began with the letters F, A and S in one minute each.
 339 They were also instructed to exclude proper nouns, such as names of people and places. In
 340 the ESCF task, the participants were instructed to state as many animals as they could in one
 341 minute; they were specifically instructed to leave out breeds of the same animal (e.g.
 342 Alsatian, German Shepard, and Pomeranian all being breeds of the animal 'dog').

343

344 The **Tamil Verbal Fluency (TVF)** test comprised of a Tamil Letter Fluency (TLF) task and
 345 a Tamil Semantic Category Fluency (TSCF) task. In the Tamil LF task, the bilingual
 346 participants were given the Tamil letters ஶ ([pʌ]), ஶ ([ʌ]) and ஶ ([sʌ]) and were similarly
 347 instructed as the English LF task, to provide as many words as possible that began with these
 348 letters in one minute each. They were also instructed to exclude proper nouns, such as names
 349 of people and places, and were provided with additional instructions where they were allowed
 350 to substitute the vowel sound [ʌ] in the syllabic consonants, ஶ ([pʌ]) and ஶ ([sʌ]), with any
 351 of the other 11 vowels found in the Tamil alphabet.

352

353 The bilingual participants were required to complete both the EVF and the TVF. However,
 354 owing to the fact that Tamil speakers in Singapore seldom distinguish most animals by their
 355 breeds whilst speaking in Tamil, they were not instructed in the Tamil SCF to refrain from
 356 naming animals of the same breed.

357 **2.2.1.2. Measures of cognitive abilities**

358

359 The **Stroop Arrow task** (Blumenfeld and Marian 2011) was used to measure participants'
 360 inhibitory abilities. The Stroop Arrow task has two stimulus dimensions: arrow direction and
 361 arrow location. These are either congruent, with right-facing arrow (or left-facing arrow)
 362 appearing on the right (or left) of the screen, or incongruent, with right-facing arrow (or left-
 363 facing arrow) appearing on the left (or right) of the screen. Participants had to respond to the
 364 direction of the arrow and ignore the location. For instance, for a right-facing arrow on the
 365 left screen, participants had to inhibit the reflex to press the key on the left for two accounts,
 366 one being the location of the arrow on screen and the other being the direction of the arrow.
 367 The Stroop Arrow task consisted of 40 congruent trials and 40 incongruent trials which were
 368 preceded by 12 practice trials. Each trial began with a black fixation cross which remained on
 369 the white screen for 800 milliseconds and was followed by a blank white screen for 250
 370 milliseconds, before the stimulus appeared either on the left or the right of the white screen.
 371 The stimulus remained on screen for 1000 milliseconds or until a response key was hit. The
 372 trial ended with a blank screen that lasted for 500 milliseconds, before a new trial began. The
 373 response keys were a 'left-facing arrow' and a 'right-facing arrow' which were overlaid on
 374 the 'A' and 'L' keys of a standard US keyboard, respectively. The Stroop Effect was obtained
 375 by subtracting the congruent reaction time from the incongruent reaction time for correct
 376 trials; a smaller Stroop effect implies greater inhibitory control.

377

378 The **Wechsler Adult Intelligence Scale (WAIS-III) Block Design** was used to measure
 379 fluid intelligence and to control for between group differences on non-verbal IQ (de Oliveira
 380 et al. 2014). The WAIS-III Block Design required the participants to physically manipulate
 381 blocks to resemble the image shown to them. There was a total of nine images to reproduce
 382 using the blocks with five images being a two-by-two with a maximum time limit of 60
 383 seconds and the remaining being a three-by-three with a maximum time limit of 120 seconds.
 384 Participants were scored according to the scoring system found in the WAIS-III Block
 385 Design where scores range between 4 and 7 for reproducing each image correctly within the
 386 time limit; for each image, the score obtained was inversely proportional to the time taken.

387

388 The **forward and backward Digit Span (DS)** tasks from the Wechsler Memory Scale
 389 (Revised) were used to test verbal short-term memory and working memory (Woods et al.
 390 2011) because according to Hasher and Zacks (1988) they play vital role in discourse
 391 processing. In the forward digit span, participants were required to recall the digits in the
 392 order they were presented. In the backward digit span, participants were required to recall the
 393 sequence in the reverse order. Participants were given a score of one for each correct set of
 394 numbers recalled with a possible total score of 24.

395

396 The **Number Comparison (NC)** task (Salthouse and Babcock 1991) was used to measure
 397 processing speed because the pragmatic task involved testing the response time. Participants
 398 had to decide if pairs of numbers were the same or different. There were 3 sets of 12 pairs of
 399 three, six and nine digits making a total of 36 items. All participants were timed separately
 400 for each set of pairs beginning with the three-digit pairs followed by the six-digit pairs and
 401 then the nine-digit pairs. Processing speed was calculated by first dividing the time taken to
 402 complete each set by the total number of items in the set (i.e. 12), and then multiplying that
 403 by the number of items that were correctly identified as being either same or different. The
 404 total number of correct items for the entire task was then divided by the total time taken for
 405 correct identification to give the processing speed (number of correct items per second).

406 **2.2.2. Experimental pragmatic tasks**

407

408 Two pragmatic tasks were created to measure a range of non-literal language as well as literal
 409 language: an English (EPrag) and a Tamil (TPrag) task. Each task was made up of five sets of
 410 10 short stories to cover non-conventional indirect requests, conversational implicatures,
 411 conventional metaphors, novel metaphors, and literal utterances. Standard Singapore English
 412 is based on Standard British English; while there is no variation in the grammar, lexical
 413 differences do exist (Gupta 2010; Gupta 2012; Leimgruber 2011). Vocabulary that may have
 414 different meanings in the two varieties of English were avoided in the stories. Similarly, all
 415 stories were created to be culturally neutral, that is, the situational contexts were applicable to
 416 both Singapore and the United Kingdom. The English conventional metaphors were selected
 417 from a familiarity rating list administered to nine healthy aging monolingual English speakers
 418 aged 60 years and above in the United Kingdom and six healthy aging bilingual English-
 419 Tamil speakers aged 60 years and above in Singapore. Similarly, the Tamil conventional
 420 metaphors were selected from a familiarity rating list administered to the same group of aging
 421 bilingual English-Tamil speakers. Participants completed three practice trials before starting
 422 on the actual task.

423

424 Each trial consisted of a short dialog by or between a male and a female character that were
 425 accompanied by a line drawing to create a story. Participants heard the target utterances at the
 426 end of these short dialogs. Each story started with the narrator providing the setting (e.g. "At
 427 a party") and background (e.g. "Jill is at a party.") and ended with a multiple-choice
 428 comprehension question in the format of "What will <story character's name or gender> say
 429 or do next?". Participants heard the narrator reading out the questions and the four options as
 430 well as seeing the questions and options displayed on the screen below the line drawings. The
 431 questions and options for EPrag were typed onto the slide as text, whereas the questions and
 432 their answer options for Tamil had to be handwritten and uploaded as images because the

433 experiment software did not support the Tamil script. The complete story board for the EPrag
434 task can be found in the supplementary material.

435

436 Each option can be categorized under one of four types: a) inferred meaning, b) literal
437 meaning, c) possible, but wrong reaction and d) wrong answer. There were two ‘wrong
438 answers’ for the literal category as there are no inferred meanings for the literal target
439 utterances. Participants pressed the corresponding key on the keyboard to record their
440 answers, after which a new slide with the words “Next story?” appeared on the screen.
441 Pressing the space bar then brought the participants to the next slide which had a fixation
442 cross for 250 ms before a new story begun.

443

444 The dependent variables—accuracy scores and time taken to respond (in seconds)—were
445 recorded for each of the non-literal language types (i.e. non-conventional indirect requests,
446 conversational implicatures, conventional metaphors, and novel metaphors) and literal
447 utterances. The Time Taken to Respond (TTR) measure was calculated only for correct
448 responses for each non-literal and literal language type tested.

449 **2.3. Procedure**

450

451 The Pragmatic tasks were run using E-prime 2.0 Professional on an Acer Aspire 4820T
452 laptop with an Intel® Core™ i5 processor 4.30M and a 14.0-inch HD LED LCD screen.
453 Participants were tested individually in separate sessions. The bilingual participants
454 completed the English and Tamil tasks in separate sessions. The bilinguals’ testing sessions
455 were counterbalanced by language; the English and Tamil sessions were spaced apart by two
456 to three weeks.

457 **2.4. Data analyses**

458

459 The study has set out to answer two research questions: 1) ‘Is there an age effect on
460 pragmatic inference-making?’, and 2) ‘Is there a bilingual advantage in pragmatic inference-
461 making?’. Language Group (monolingual, bilingual) and Age (young, old) were the
462 independent variables for this study.

463

464 The age of acquisition of English and Tamil and CIMS scores were analysed with a Mann-
465 Whitney test. Age, education and the variables arising from the background tests were
466 analysed with a two-way univariate analysis of variance (ANOVA) with Age and Language
467 Group as factors. The MMSE was analyzed with a one-way ANOVA with Language Group
468 as the independent variable. Variables arising from the Tamil background tests were analyzed
469 with a one-way ANOVA with Age as the independent variable.

470

471 Each of the pragmatic tasks (the EPrag and TPrag tasks) had five dependent variables for the
472 accuracy and five for the TTRs, corresponding to the five pragmatic conditions (non-

473 conventional indirect requests, conversational implicatures, conventional metaphors, novel
474 metaphors and literal utterances).

475 For the EPrag task, a two-way multivariate analysis of covariance (MANCOVA) was used to
476 test the effects of Age and Language Group on the EPrag accuracy scores (i.e. arising from
477 the non-conventional indirect requests, conversational implicatures, conventional metaphors,
478 novel metaphors and literal utterances) whilst controlling for potential effects of
479 socioeconomic status, verbal IQ, education, inhibition, verbal short-term memory and
480 working memory as well as age of acquisition of English that may affect the participants'
481 inferential abilities. A similar analysis was conducted on the EPrag TTRs with Number
482 Comparison as an additional covariate to control for the differing processing speed of the
483 groups. Planned pairwise comparisons were conducted to compare differences between
484 young and aging older adults, and monolinguals and bilinguals for each pragmatic condition
485 separately.

486

487 For the TPrag task, a one-way MANCOVA was run to test for effects of Age on the TPrag
488 accuracy scores (arising from the non-conventional indirect requests, conversational
489 implicatures, conventional metaphors, novel metaphors and literal utterances) with
490 Education, Tamil Vocabulary List, Stroop Arrow, Block Design, Tamil Verbal Fluency, Age
491 of Acquisition of Tamil' and Digit Span as covariates. The covariates were included to
492 control for socioeconomic status, verbal IQ, differing educational levels between groups,
493 inhibition, verbal short-term memory and working memory that can potentially affect
494 inferential abilities, and to reduce error variances. Similarly, a one-way MANCOVA was
495 conducted on the TPrag TTRs with Number Comparison as an additional covariate to control
496 for differing processing speed of the groups. Finally, planned pairwise comparisons were
497 conducted to compare differences between young and aging older bilingual adults for each
498 pragmatic condition.

499 3. Results

500 3.1. Demographics

501 There was no significant difference between the monolinguals and bilinguals for Age in
502 Years ($F(1, 68) = .523, p = .472, d = .2, 1 - \beta = .12$)¹ and for Years of Education ($F(1, 68) =$
503 $.037, p = .849, d = .06, 1 - \beta = .06$). As expected, there was a significant difference in Age in
504 Years between the young and older adults ($F(1, 68) = 2353.2, p < .001, d = 11.8, 1 - \beta = 1.0$)
505 with a significant interaction between Age and Language Group ($F(1, 68) = 4.776, p = .032,$
506 $d = .5, 1 - \beta = .6$): Age in Years was different between young and aging older monolinguals
507 ($F(1, 37) = 1036.4, p < .001, d = 10.7, 1 - \beta = 1.0$) and between young and aging older
508 bilinguals ($F(1, 31) = 1724.3, p < .001, d = 14.8, 1 - \beta = 1.0$). However, there was also a
509 significant difference between young and older adults in Years of Education ($F(1, 68) =$
510 $6.14, p = .016, d = .6, 1 - \beta = .71$). There was no significant interaction between Age and
511 Language Group for Years of Education ($F(1, 68) = 2.443, p = .123, d = .4, 1 - \beta = .36$). The
512 difference in education between young and older adults is due to differences in years of

¹ Effect size and power for all analyses were calculated using G*Power (Version 3.1.9.2) and Lenhard & Lenhard (2016) (https://www.psychometrica.de/effect_size).

513 education across generations, especially in Singapore, and was impossible to control for due
 514 to changes in the society. Hence, Years of Education was used as a covariate to address this
 515 confounding factor.

516

517 There was no significant difference on the MMSE between the monolingual and bilingual
 518 aging older adults ($F(1, 33) = .113, p = .739, d = .1, 1 - \beta = .06$).

519

520 Mann-Whitney tests comparing the age of acquisition for English and Tamil between the
 521 groups showed a significant difference in the age of acquisition of English between the aging
 522 older monolinguals and bilinguals ($U = .000, p < .001, r = .9, 1 - \beta = 1.0$), and the young and
 523 aging older bilinguals ($U = 19, p < .001, r = .8, 1 - \beta = 1.0$). There was no significant
 524 difference between the young monolinguals and bilinguals ($U = 123.5, p = .15, r = .4, 1 - \beta =$
 525 $.89$). As for the age of acquisition of Tamil, there was no significance difference between the
 526 young and aging older bilinguals ($U = 141, p = .973, r = .02, 1 - \beta = .05$).

527

528 The Mann-Whitney test comparing the Complex Ideational Materials Subtest (CIMS) scores
 529 did not show any significant difference between the aging older monolinguals and bilinguals
 530 ($U = 125, p = .354, r = .17, 1 - \beta = .23$).

531

532 **3.2. Background tests**

533

534 Table 3 shows the results from the background tests

535

=====

536

Insert Table 3 around here

537

=====

538

539 **3.2.1. Lexical and semantic measures**

540

541 In terms of vocabulary knowledge in English (RVS), there was a significant main effect of
 542 Language Group ($F(1, 68) = 4.188, p < .05, d = .5, 1 - \beta = .55$), but no significant main
 543 effect of Age ($F(1, 68) = 1.847, p > .05, d = .3, 1 - \beta = .28$). There was a significant
 544 interaction effect between Language Group and Age ($F(1, 68) = 4.141, p < .05, d = .5, 1 - \beta =$
 545 $.54$). Follow-up simple effects showed that aging older monolinguals had better vocabulary
 546 knowledge than young monolinguals ($F(1, 68) = 6.309, p < .05, d = .6, 1 - \beta = .72$) and
 547 aging older bilinguals ($F(1, 68) = 8.026, p < .01, d = .7, 1 - \beta = .82$). There were no

548 significant differences in the vocabulary knowledge of the young monolinguals and
 549 bilinguals ($F(1, 68) = .000, p > .05, d = .00, 1 - \beta = .05$), and between young bilinguals and
 550 aging older bilinguals ($F(1, 68) = .210, p > .05, d = .1, 1 - \beta = .074$). In terms of vocabulary
 551 knowledge in Tamil (TVL) the young bilinguals and aging older bilinguals did not differ (F
 552 $(1, 32) = .696, p > .05, d = .3, 1 - \beta = .13$).

553

554 The two-way ANOVA on the English Verbal Fluency test (EVF) showed a significant main
 555 effect of Language Group ($F(1, 68) = 5.266, p < .05, d = .6, 1 - \beta = .64$), but no significant
 556 main effect of Age ($F(1, 68) = 1.852, p > .05, d = .3, 1 - \beta = .29$). There was a significant
 557 interaction effect between Language Group and Age ($F(1, 68) = 9.208, p < .01, d = .7, 1 - \beta$
 558 $= .87$). Both aging older monolinguals ($F(1, 68) = 13.685, p < .001, d = .9, 1 - \beta = .96$) and
 559 young bilinguals ($F(1, 68) = 8.886, p < .01, d = .7, 1 - \beta = .86$) had better verbal fluency than
 560 aging older bilinguals. There were no significant differences between the young
 561 monolinguals and aging older monolinguals ($F(1, 68) = 1.534, p > .05, d = .3, 1 - \beta = .24$),
 562 and between the young monolinguals and young bilinguals ($F(1, 68) = .284, p > .05, d = .1,$
 563 $1 - \beta = .083$). The young bilinguals and aging older bilinguals did not differ in the Tamil
 564 Verbal Fluency test (TVF) ($F(1, 32) = .055, p > .05, d = .09, 1 - \beta = .057$).

565

566 3.2.2. Measures of cognitive abilities

567

568 A two-way ANOVA showed no significant main effect of Language Group on the Stroop
 569 Effect ($F(1, 68) = .116, p > .05, d = .09, 1 - \beta = .07$) and no significant interaction of
 570 Language Group and Age ($F(1, 68) = 2.243, p > .05, d = .36, 1 - \beta = .33$). However, there
 571 was a highly significant main effect of Age on the Stroop Effect ($F(1, 68) = 24.15, p < .001,$
 572 $d = 1.2, 1 - \beta = .999$) indicating that young adults had better inhibitory abilities than aging
 573 older adults.

574

575 The Kruskal-Wallis test showed a highly significant effect of Age on the Block Design ($H(1)$
 576 $= 17.985, p < .001$). There was no significant effect of Language Group ($H(1) = 1.968, p >$
 577 $.05$). Follow-up Mann-Whitney tests indicated that the young bilinguals had higher scores on
 578 the BD than the aging older bilinguals ($U = 2.0, p < .001, d = 2.1$). There was no difference
 579 between the young and aging older monolinguals ($U = 148.5, p > .025, d = .38$). (A
 580 Bonferroni correction was applied, and all effects are reported at a 0.025 level of
 581 significance.)

582

583 There was a significant main effect of Language Group on the Digit Span ($F(1, 68) = 9.731,$
 584 $p < .01, d = .76, 1 - \beta = .89$), but no significant main effect of Age ($F(1, 68) = 3.598, p > .05,$
 585 $d = .49, 1 - \beta = .48$). There was a significant interaction effect between Language Group and
 586 Age ($F(1, 68) = 14.001, p < .001, d = .91, 1 - \beta = .97$). Follow-up simple effects analyses
 587 showed the young bilinguals had a significantly better verbal short-term memory and
 588 working memory than young monolinguals ($F(1, 68) = 24.461, p < .001, d = 1.2, 1 - \beta =$
 589 $.999$), and aging older bilinguals ($F(1, 68) = 14.623, p < .001, d = .93, 1 - \beta = .97$). There

590 were no differences between young monolinguals and aging older monolinguals ($F(1, 68) =$
 591 $1.864, p > .05, d = .33, 1 - \beta = .29$), and between aging older monolinguals and bilinguals (F
 592 $(1, 68) = .187, p > .05, d = .11, 1 - \beta = .08$).

593 There was no significant main effect of Language Group ($F(1, 68) = 2.173, p > .05, d = .36,$
 594 $1 - \beta = .32$) on the Number Comparison and no significant interaction effect between
 595 Language Group and Age ($F(1, 68) = .878, p > .05, d = .23, 1 - \beta = .16$). However, there was
 596 a highly significant main effect of Age ($F(1, 68) = 25.206, p < .001, d = 1.2, 1 - \beta = .999$),
 597 indicating that the young adults had better processing speed than the older adults.

598

599 **3.3. Pragmatic tasks**

600 **3.3.1. EPrag accuracy scores and TTRs**

601

602 Figure 1 shows the participants' accuracy scores for the English Pragmatic (EPrag) task.

603 =====

604 Insert Figure 1 around here

605 =====

606

607 The MANCOVA on the accuracy scores showed a significant effect of Age on the combined
 608 dependent variables (non-conventional indirect requests, conversational implicatures,
 609 conventional metaphors, novel metaphors and literal utterances) ($\lambda = .779, F(5, 57) = 3.225,$
 610 $p < .05, d = 1.1$), indicating differences between young and aging older participants. There
 611 was no significant effect of Language Group on the combined dependent variables ($\lambda = .948,$
 612 $F(5, 57) = .626, p > .05, d = .5$), indicating that monolinguals and bilinguals performed alike,
 613 and no significant interaction effect between Language Group and Age ($\lambda = .935, F(5, 57) =$
 614 $.793, p > .05, d = .5$), indicating that monolinguals and bilinguals show the same pattern of
 615 performance. The planned comparisons for each non-literal condition separately showed that
 616 young monolinguals were significantly better than aging older monolinguals at conventional
 617 metaphors ($F(1, 31) = 9.06, p = .005, d = 1.1, 1 - \beta = .9$). There was no significant
 618 difference between young bilinguals and aging older bilinguals for conventional metaphors
 619 ($F(1, 24) = 2.072, p > .05, d = .6, 1 - \beta = .37$).

620 Figure 2 shows the participants' TTRs for the English Pragmatic (EPrag) task.

621 =====

622 Insert Figure 2 around here

623 =====

624

625 The MANCOVA on the TTRs showed a significant main effect of Age on the combined
 626 TTRs for the non-conventional indirect requests, conversational implicatures, conventional
 627 metaphors, novel metaphors and literal utterances ($\lambda = 0.746, F(5, 56) = 3.818, p < .01, d =$
 628 1.2), indicating differences between young and aging older participants. There was no
 629 significant main effect of Language Group on the combined TTRs ($\lambda = .911, F(5, 56) =$
 630 $1.096, p > .05, d = .6$), indicating that monolinguals and bilinguals performed alike. There
 631 was no significant interaction effect between Language Group and Age ($\lambda = .963, F(5, 56) =$
 632 $.435, p > .05, d = .4$), indicating that monolinguals and bilinguals showed the same pattern of
 633 performance. The planned comparisons for each non-literal condition separately showed that
 634 young monolinguals were significantly faster than aging older monolinguals in inferring
 635 conventional metaphors ($F(1, 30) = 7.074, p = .012, d = 1.0, 1 - \beta = .84$). whilst there was
 636 no significant difference between the young and aging older bilinguals ($F(1, 23) = 2.034, p >$
 637 $.05, d = .6, 1 - \beta = .37$). (A Bonferroni correction was applied, and the effects are reported at
 638 a .0125 level of significance.) There were no significant differences between the young
 639 monolinguals and aging older monolinguals for the literal utterances TTR ($F(1, 30) = 1.401,$
 640 $p > .05, d = .4, 1 - \beta = .26$), conversational implicatures TTR ($F(1, 30) = 5.112, p > .05, d =$
 641 $.8, 1 - \beta = .7$) and novel metaphors TTR ($F(1, 30) = 6.195, p > .01, d = .9, 1 - \beta = .78$).
 642 Likewise, there were no significant differences between the young bilinguals and aging older
 643 bilinguals for literal utterances TTR ($F(1, 23) = 2.873, p > .05, d = .7, 1 - \beta = .49$),
 644 conversational implicatures TTR ($F(1, 23) = .716, p > .05, d = .4, 1 - \beta = .16$), and novel
 645 metaphors TTR ($F(1, 23) = 3.634, p > .05, d = .8, 1 - \beta = .59$). (Planned comparison was not
 646 done for non-conventional indirect requests TTR because the independent one-way
 647 ANCOVA did not show a significant main effect of Age ($F(1, 60) = 4.755, p > .01, d = .6, 1$
 648 $- \beta = .65$.)

649

650 **3.3.2. TPrag task accuracy scores and TTRs**

651 Figures 3 and 4 show the accuracy scores and TTRs for the TPrag task.

652 =====

653 Insert Figure 3 around here

654 =====

655 =====

656 Insert Figure 4 around here

657 =====

658 The MANCOVA on the accuracy scores showed no significant main effect of Age on the
 659 combined accuracy scores ($\lambda = 0.873, F(5, 21) = .609, p > .05, d = .8$). Likewise, the
 660 MANCOVA on the TTRs did not show a significant main effect of Age on the combined
 661 TTRs ($\lambda = 0.635, F(5, 20) = 2.3, p > .05, d = 1.5$).

662

663 **4. Discussion**

664

665 Everyday communication comprises of an extensive use of non-literal language, such as
 666 idioms, proverbs, metaphors, indirect requests, and conversational implicatures. Although the
 667 developed world is facing a rapidly aging population, research on the comprehension of non-
 668 literal language in aging older adults is limited and is based mainly on monolingual speakers.
 669 Whilst some studies found that aging older adults are able to access the non-literal meanings
 670 of metaphors (Morrone et al. 2010; Newsome and Glucksberg 2002; Ulatowska et al. 1998;
 671 Qualls and Harris 2003) and suggested that aging older adults are “as efficient” as younger
 672 adults when processing metaphors (Newsome and Glucksberg 2002), some other studies
 673 demonstrated an age-related decline in non-literal language comprehension (Nippold, Uhden,
 674 and Schwarz 1997; Uekermann, Thoma, and Daum 2008). The differences in the findings of
 675 these studies could be related to the differences in the methodologies used, the variability in
 676 the participant populations, and the designs of the studies. Importantly, although context
 677 plays a key role in the comprehension of non-literal language, previous studies reviewed
 678 either did not present non-literal utterances within a situational context or presented them in
 679 texts that required connective inferences.

680

681 The current study aimed to fill the gap in the literature of aging older adults’ pragmatic
 682 inferential abilities using non-literal utterances embedded in situational contexts. It also
 683 sought to investigate if there was a bilingual advantage in pragmatic inference-making.
 684 Young and older monolinguals and bilinguals underwent a battery of background tests to
 685 measure their vocabulary knowledge, non-verbal IQ, verbal fluency, inhibition, verbal short-
 686 term memory and working memory, and processing speed as well as completed a language
 687 use and history questionnaire to provide information such as education, age of acquisition of
 688 English and language usage. To address their pragmatic inferential abilities, participants
 689 completed an English pragmatic task that had the target literal and non-literal utterances
 690 presented in context-based vignettes that were culturally neutral. The bilinguals were, in
 691 addition, tested with a Tamil pragmatic task. Participants were tested for both accuracy and
 692 response time. After controlling for education, vocabulary knowledge, non-verbal IQ, verbal
 693 fluency, inhibition, verbal short-term memory and working memory, age of acquisition of
 694 English and processing speed, a clear effect of age on the comprehension of English
 695 conventional metaphors emerged. Planned comparisons showed that aging older
 696 monolinguals were less accurate and slower than young monolinguals on the comprehension
 697 of English conventional metaphors. Aging older bilinguals, on the other hand, were as
 698 accurate and efficient as young bilinguals on the comprehension of English conventional
 699 metaphors. Moreover, although there was no effect of Language Group (i.e. bilingualism) for
 700 any of the non-literal language types tested, this effect of age found for the monolinguals was
 701 not found for the bilinguals for any of the non-literal language types tested in the study, be it
 702 in English or Tamil.

703

704 **4.1. Understanding non-literal language as we age**

705

706 In the present study, we found an age-related decline in conventional metaphor
 707 comprehension, but only for the monolinguals. Not only were the aging older monolinguals
 708 less accurate than the young monolinguals in comprehending conventional metaphors, they

709 were also much slower when processing conventional metaphors. Past literature supports the
 710 present findings that monolingual aging older adults experience an age-related decline in non-
 711 literal language comprehension (Nippold, Uhden, and Schwarz 1997; Uekermann, Thoma,
 712 and Daum 2008). It is worth noting here that the conventional metaphors were selected based
 713 on the metaphor familiarity rating list completed by a sample of both monolingual and
 714 bilingual aging older adults, but not by the younger groups. Hence, older participants would
 715 have been guaranteed familiar with the conventional metaphors, more so than the young
 716 participants. In spite of this advantage, the aging older monolinguals were significantly less
 717 accurate and slower in inferring the metaphorical meaning of the utterances.

718

719 On the other hand, the aging older bilinguals were as accurate as the young bilinguals in
 720 terms of understanding English and Tamil metaphors (as well as the other non-literal
 721 language types tested); this is in line with studies showing that aging older adults are able to
 722 access the non-literal meanings of metaphors (Morrone et al. 2010; Newsome and
 723 Glucksberg 2002; Ulatowska et al. 1998; Qualls and Harris 2003). In addition, the aging
 724 older bilinguals were not significantly slower than the young bilinguals at arriving at the
 725 correct meaning of the English and Tamil metaphors. These findings suggest that aging older
 726 adults are “as efficient” as young adults when processing metaphors (Newsome and
 727 Glucksberg 2002).

728

729 We now know that pragmatic inference-making does slow down with aging, even with
 730 processing speed attrition as well as cognition and other factors having been taken into
 731 account, but not for all non-literal language types and not for bilinguals.

732

733 **4.2. Bilinguals and pragmatic inference-making**

734

735 The present study did not find any significant differences between the monolinguals and
 736 bilinguals in terms of pragmatic inference-making. Of the very few studies that investigated
 737 the pragmatic inference-making abilities of bilinguals, one found no bilingualism effect on
 738 conversational implicatures for L2 learners and native speakers of English (Manowong
 739 2011), while another found a slightly higher correlation between linguistic comprehension
 740 and pragmatic comprehension of both indirect requests and conversational implicatures for
 741 L2 learners of English with higher English language proficiency than L2 learners with lower
 742 English language proficiency (Garcia 2004).

743

744 In the present study, the bilinguals used the English language on a daily basis and had self-
 745 assessed their English language proficiency in speaking and listening as being between
 746 ‘Good’ to ‘Native-like’. The bilinguals in the present study were not disadvantaged by their
 747 ‘non-native speaker’ status unlike the L2 learners of English in Garcia’s (2004) study and did
 748 not display a significant disadvantage in discourse processing as seen by their performance in
 749 both the literal and non-literal language types tested in the pragmatic tasks.

750 Although there was no overall significant effect of bilingualism on pragmatic inference-
 751 making, the findings of the present study point to a bilingual advantage when it comes to
 752 comprehending English conventional metaphors; aging older bilinguals' conventional
 753 metaphor processing was not affected by age unlike the aging older monolinguals'. As
 754 established earlier, pragmatic inferences require higher order cognitive skills (Champagne-
 755 Lavau and Joannette 2009), and a number of studies have shown bilingualism attenuating
 756 cognitive decline associated with aging (Luk et al. 2011) and bilinguals possessing superior
 757 cognitive abilities than monolinguals even as they get older (Bialystok, Craik, and Ryan
 758 2006). Thus, it should come as no surprise that aging older bilinguals were not affected by
 759 age whilst processing conventional metaphors unlike their monolingual counterparts.

760 The sample size of the present study was small, which is one of the limitations of the study. A
 761 second limitation is that the study focused only on comprehension and did not measure the
 762 participants' production of non-literal language. Future research can compare the
 763 comprehension with the production of non-literal language by a larger sample of aging older
 764 adults and examine the effects of Language Group. This would provide a complete picture of
 765 both comprehension and production of non-literal language.

766

767 **5. Conclusion**

768 The present study examined the effects of age(ing) and the effects of bilingualism on
 769 pragmatic inferences by monolingual and bilingual young and older adults. The present study
 770 has controlled for a large number of variables that can affect pragmatic inference-making.
 771 These variables include the participants' vocabulary knowledge, non-verbal IQ, education,
 772 socioeconomic status, age of acquisition of English, inhibition, verbal short-term memory and
 773 working memory, verbal fluency and processing speed. On top of this, the young and aging
 774 older bilinguals were tested in both their languages, English and Tamil. Regardless of
 775 language, aging older bilinguals were not affected by age whilst processing literal and non-
 776 literal language. This is in direct contrast to aging older monolinguals who displayed an age-
 777 related disadvantage when confronted with conventional metaphors. This suggests a bilingual
 778 advantage in pragmatic inferences of conventional metaphors.

779

780 **6. Ethics Statement**

781 This study was reviewed by the School of Psychology and Clinical Language Sciences'
 782 Ethics Committee and the University Research Ethics Committee (University of Reading)
 783 and was given a favourable ethical opinion for conduct.

784 **7. Author Contributions**

785 SS conceived and designed the study together with TM and AB. SS created the pragmatic
 786 tasks, collected, analysed and interpreted the data. SS together with TM and AB wrote the
 787 paper.

788 **8. Acknowledgements**

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792 SS would like to thank her supervisors for their guidance throughout the research.

793 **9.** Datasets are available on request:

794 The raw data supporting the conclusions of this manuscript will be made available by the
795 authors, without undue reservation, to any qualified researcher.

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Table 1 Demographic statistics of all participants

Demographic characteristics		Monolinguals		Bilinguals	
		Young (n = 19)	Old (n = 20)	Young [#] (n = 18)	Old (n = 15)
Gender (M, F)		3, 16	10, 10	7, 11 [7, 12]	6, 9
Age	Mean (SD)	19.47 (0.7)	69.9 (6.8)	20.93 (1.57) [21.02 (1.58)]	67.01 (4.39)
	Min-Max	18-21	60-83	17-23	60-78
Education	Mean (SD)	14.97 (0.63)	14.4 (3.58)	15.83 (1.54) [15.89 (1.52)]	13.3 (3.63)
	Min-Max	14-16	10-20	14-19	7-18
MMSE	Mean (SD)	NA	28.8 (1.24)	NA	28.67 (1.05)
	Min-Max	NA	27-30	NA	27-30
CIMS	Mean (SD)	NA	11.65 (0.67)	NA	11.33 (0.98)
	Min-Max		10-12		9-12

MMSE = Mini Mental State Examination; CIMS = **Complex Ideational Materials Subtest**; YM

= Young monolinguals; YB = Young bilinguals; OM = Old monolinguals; OB = Old bilinguals

[#] One bilingual young adult was excluded from the final analysis of the English pragmatic task because of equipment failure during this task. [] indicates data for n = 19 for young bilinguals.

Table 2 Linguistic characteristics of participants derived from the LHUQ according to groups

Linguistic characteristics		YM (N = 19)	OM (N =20)	YB (N =19)	OB (N = 15)
Age of Acquisition of English (in years)	0 – 5	19	20	17	2
	6 – 10	0	0	2	10
	11 – 19	0	0	0	3
Age of Acquisition of Tamil or other language (in years)	0 – 5	0	0	18	15
	6 – 10	0	0	1	0
	11-19	2	5	0	0
	20 >	0	3	0	0
Conversing in English ^ (hours/day)	Mean (SD)	13.95 (4.2)	10.73 (3.45)	10.08 (4.19)	5.2 (3.9)
	Min-Max	2.5-16	1.5-14	3-17	0.3-12
Conversing in Tamil or other language (hours/day)	Mean (SD)	0.5 (0.0)	0 (0)	4.4 (3.52)	6.12 (5.48)
	Min-Max	0.5-0.5	0	0-11	0.3-16

^ Monolingual young and older participants, who chose to state ‘English only’ or ‘English All Day’ when asked on the LHUQ to state the number of hours (out of 24 hours per day) that they communicate with various groups of people in the languages they know, were assigned 16 hours and 12 hours respectively to match the total hours stated by their age cohorts.