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# Referential adjustment during discourse production in Alzheimer's disease

Mélanie Sandoz[a], Katia Iglesias[b], Amélie M Achim[c], Jean-François Démonet[d] and Marion Fossard[a]

[a]Institut des Sciences Logopédiques, Université de Neuchâtel, Neuchâtel, Switzerland; [b]Haute Ecole de Santé, HES-SO Haute Ecole Spécialisée de Suisse Occidentale, Fribourg, Switzerland; [c]Département de Psychiatrie et Neurosciences, Université Laval, Québec, Canada, Centre de Recherche CERVO, Québec, Canada; [d]Centre Leenaards de la Mémoire, Département des Neurosciences Cliniques, Centre Hospitalier Universitaire Vaudois, Lausanne, Switzerland

**ABSTRACT**

Several studies have shown that people with Alzheimer's disease (AD) tend to use more pronouns than healthy aged adults when referring to entities during discourse. This referential behavior has been associated with the decrease of cognitive abilities, such as lexical retrieval difficulties or reduced abilities in working memory. However, the influence of certain important discourse factors on the referential choices made by people with AD has yet to be established. This study examines referential choices made at three discourse stages during narrative discourse (the introduction of a referent, the maintaining of the referent in focus, and the shift from one referent in focus to another). These referential choices are examined in increasingly complex referential contexts. In addition, this study investigates the relationships between referential choices and various cognitive abilities. To do so, the narrative discourses of 21 people with AD and 21 healthy adults were elicited using a newly developed storytelling in sequence task. The analyses focused on the production of three major referential expressions (indefinite expressions, definite expressions and pronouns) which are expected to vary according to discourse stage and the referential complexity of the stories. The results show that AD participants produce significantly fewer of the referential expressions expected at the introduction and shift stages than healthy aged adults produce. Nevertheless, the variation in the categories of referential expressions produced by the AD participants between the discourse stages is similar to that produced by the healthy aged adults, suggesting a preserved sensitivity to the factors manipulated in the task (i.e., discourse stages and referential complexity). This study also highlights the fact that different cognitive competences, especially executive abilities, are greatly involved in referential choices. The results add further evidence that referential choices rely on a variety of cognitive skills, depending on the discourse context in which they are made.

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## 1. Introduction

Language impairments in Alzheimer's disease (AD) have been studied for several decades. While AD is principally characterized by a loss in anterograde episodic memory associated with deficits in executive functions and attention (McKhann et al., 2011), people with AD exhibit significant deficit in lexical retrieval, due to impaired access to – and representation of – concepts in the mental lexicon (Adlam et al., 2010; Garrard et al., 2005; Kavé & Goral, 2018). Several studies have also highlighted communicative difficulties, such that people with AD produce less informational content than healthy aged adults during discourse production (for a review, see Mueller et al., 2018). For instance, they produce fewer temporal or logical connections between propositions (Duong et al., 2005; Ska & Duong, 2005), demonstrate frequent off-topic intrusions (Murray, 2010) and/or manifest difficulties in maintaining discourse topics (Ash et al., 2007). Because communicative breakdowns have serious consequences for the quality of social interactions (Hays et al., 2004; Savundranayagam & Orange, 2014), identification of the most predominant impairments in AD has become a growing research area.

Among the variety of skills necessary for successful communication, the choice of referential expressions according to the targeted referent's accessibility level is important to the addressee's ability to identify who or what is mentioned during discourse (Ariel, 1990, 2001). It is now well documented that people with AD have difficulties with reference production. For instance, they tend to produce indefinite or vague terms to refer to objects, people or events (Chapman et al., 1995; Ehrlich et al., 1997). Crucially, several studies have shown that people with AD produce more pronouns without clearly identified antecedents than healthy aged adults do,

**CONTACT** Mélanie Sandoz melanie.sandoz@unine.ch Institut des Sciences Logopédiques, Université de Neuchâtel, Neuchâtel, Switzerland

resulting in discourse which is often difficult for the addressee to follow (Almor et al., 1999; Bucks et al., 2000; Drummond et al., 2015; Kavé & Dassa, 2018; Kavé & Goral, 2016; Laine et al., 1998; Ripich et al., 2000). Such problematic referential behavior has been observed across various discourse contexts (for example, using standardized picture description tasks or in autobiographical narratives), and is considered an important "marker" of communicative difficulties in AD (Kavé & Goral, 2018).

Overuse of underspecified expressions during discourse – such as pronouns – is indeed problematic, as it may create difficulties for the addressee when keeping track of referents, especially when the discourse involves several of these. According to most models of reference production (Ariel, 1990, 2001; Gundel et al., 1993), the speaker's choice of referential expressions is expected to be closely connected to the referent's accessibility level (low, intermediate and high accessibility) at a given moment in the addressee's discourse representation. Within this framework, pronouns – which convey little descriptive information – are principally used to indicate highly accessible referents (i.e., referents which the addressee can easily retrieve). When a referent's accessibility is low or intermediate, speakers generally produce expressions which include more informational content, such as full noun phrases (NPs). Thus, a new referent will ideally be indicated by a full NP with an indefinite determiner (as in "a man"), whereas a wide variety of expressions will be used for a referent with intermediate accessibility, including definite NPs ("the man"), demonstrative NPs ("this man"), possessive NPs ("his/her man") and accented pronouns. In accordance with the referent's accessibility level, as assumed by the speaker, this pattern of referential expressions has been observed in many different studies, using a variety of narrative tasks with both children and adults (Arnold, 2001; Contemori & Dussias, 2016: Experiment 1; Colle et al., 2008; Hendriks et al., 2008, 2014).

Different factors within the linguistic or situational context have been shown to influence the referent's accessibility and, consequently, referential choices. In particular, important factors for maintaining referents at a highly accessible level include the referent's frequency and recency of mention (Arnold, 2001; Arnold et al., 2009), its prominent syntactic and thematic position in the preceding clauses (Arnold, 2000), and the absence of other referents in the linguistic and/or visual environments (Arnold & Griffin, 2007; Contemori & Dussias, 2016; Fukumura et al., 2010: Experiment 1). The literature demonstrating the problematic management of referential expressions in AD provides very little information about the discourse context in which pronouns are overused. In these studies, pronouns are generally extracted regardless of the referent's accessibility level. It is therefore difficult to determine whether the overuse of pronouns in AD is due to an overall difficulty in the selection of an appropriate expression, or specific difficulties only occurring when discursive constraints vary (for instance, when a referent's accessibility level changes because a second referent is present). As such, whether or not people with AD use pronouns inappropriately in relation to the referent's accessibility level can only be determined by a task which takes into account the discourse context in which referential expressions are produced.

Recently, Fossard et al. (2018) developed a new type of storytelling task based on sequences of six cartoon images specifically designed to assess referential choices during discourse. The authors manipulated two important parameters. First, the manipulation of the number (one vs two) and gender (different vs same gender) of the characters displayed between the sequences allows three levels of referential complexity to be distinguished. Level 1 corresponds to sequences featuring one character, and is considered the simplest; level 2 corresponds to sequences featuring two characters of different genders; and level 3, the most complex, corresponds to sequences displaying two characters of the same gender (see Figure 1). Second, within each sequence, the manipulation of characters' visual salience and agentivity in the images creates different discourse stages: the introduction, maintaining and shift of the referent in focus (i.e., the character who is visually salient and active in a given image). Fossard et al. (2018) showed substantial variation in the referential expressions produced by healthy adults according to the three discourse stages, favoring use of indefinite expressions at the introduction stage, pronouns at the maintaining stage, and definite expressions at the shift stage. The authors also reported increased use of informative expressions (like full NPs) in line with the increasing referential complexity of the sequences. It should be emphasized that such adjustments according to level of referential complexity were made at specific discourse stages, demonstrating that the constraints implemented in the task (discourse stages and the referential complexity of the sequence) impact referential choices differently.

As such, the use of the storytelling task (Fossard et al., 2018) with people with AD could be useful in identifying the discourse factors which people with AD may fail to take into account, thus failing to adjust their referential choices. Moreover, distinguishing the referential choices made at different discourse stages could also improve our understanding of the cognitive deficits related to the overuse of pronouns associated with AD.

To date, different hypotheses have been proposed to account for these referential difficulties. For instance, because pronouns are high-frequency words and phonologically attenuated, their overuse in the discourse of AD people may be the result of a deficit in lexical retrieval (Drummond et al., 2015; Kavé & Goral, 2016). A further hypothesis is that the referential difficulties expressed by people with AD might instead reflect a difficulty in processing the discourse context due to the presence of executive and memory deficits. For instance, several studies have found significant negative correlations between the number of pronouns produced by people with AD and their working memory abilities (Almor et al., 1999; March et al., 2009), general cognitive functioning (Ehrlich et al., 1997; Harris et al., 2008) and memory abilities (Ehrlich et al., 1997; March et al., 2009); this indicates that the lower these competences are, the more the pronoun rate increases. However, these studies have related cognitive abilities to the overall proportion of pronouns used, possibly muddling the different mechanisms underlying the referential choices during specific discourse stages. One exception is Kuijper et al. study (Kuijper et al., 2015), which showed that different cognitive abilities were involved in the choice of appropriate referential expression at specific discourse stages (introduction of a referent, maintaining the referent in focus and reintroduction of a previously mentioned referent). Using a storytelling task with young speakers, their results showed that the production of full NPs to indicate a referent which has to be reintroduced in the discourse is linked to several abilities. The authors found a significant contribution of working memory, inhibition and Theory of Mind abilities, suggesting that this discourse stage might involve cognitive and socio-cognitive skills in particular, thus taking the addressee into account.

For the other stages, a significant contribution of working memory abilities to the production of pronouns at the maintaining stage was only observed for a subgroup of participants; no relationship to cognitive abilities has been established with the full NPs produced at the introduction stage. To our knowledge, Kuijper et al. study (Kuijper et al., 2015) is the first to report distinct contributions of cognitive abilities related to referential choices during a narrative task, highlighting the potential diversity of the mechanisms involved.

In summary, while it is clearly demonstrated that people with AD have problems with reference production, important discourse factors which may have an impact on their referential choices are yet to be clarified. The present study examines two major sources relating to referential choices in AD: the discourse factors manipulated in the storytelling task (the discourse stages and the levels of referential complexity; Fossard et al., 2018); and the contribution of different cognitive abilities which have been shown to relate to referential choices.

The first objective was to examine whether people with AD adjust the choice of referential expressions (indefinite expressions, definite expressions and pronouns) according to the three discourse stages in the storytelling task (introduction of the referent, maintaining of the referent in focus, and shift in the referent in focus) (Fossard et al., 2018). According to previous studies on reference production, we expected AD participants to produce more pronouns than control participants did at the introduction and shift stages; no difference between the two groups of participants was expected at the maintaining stage, where pronouns are the most appropriate expression. In line with our first objective, we also investigated whether finer variations in choice of referential expressions within a given discourse stage could be observed according to the stories' referential complexity. For instance, in Fossard et al. study (2018), an effect of referential complexity was observed at the maintaining stage, with sequences involving two characters (different and same gender) exhibiting more full NPs (like "the girl" instead of "she") than sequences with one character, suggesting that speakers choose to produce more explicit referential expressions when a competitor (i.e., another referent) is linguistically and visually present (see also Arnold & Griffin, 2007; Contemori & Dussias, 2016; Fukumura et al., 2010: Experiment 1). To our knowledge, no study has to date examined AD referential choices in contexts which increase in complexity. However, we expected AD participants to be less sensitive than control participants to the level of referential complexity, and to present fewer variations in referential choices than healthy aged participants.

The second objective was to investigate the cognitive abilities related to referential choices made by AD participants. Previous studies have found that the use of pronouns relates not only to poor lexical retrieval abilities (Kavé & Goral, 2016), but also to impoverished cognitive competences, such as a decrease in working memory abilities (Almor et al., 1999). However, these studies did not focus on referential choices which depended on specific discourse stages. According to Kuijper et al. (2015), we expected different cognitive competences to contribute to referential choices depending on the discourse stage. In particular, we expected referential expressions produced in the shift stage to involve more cognitive abilities than those in the other stages. In line with this second objective, we chose to assess the contribution of the various

competences typically impaired in AD (episodic memory, executive functions and lexical retrieval). We also chose to assess the contribution of Theory of Mind abilities, which have been shown to decrease in AD (Moreau et al., 2016; Sandoz et al., 2014).

As such, our objectives extend beyond those of existing studies on AD people's referential choices, as we examine pronoun use by way of discourse stages and explore the other cognitive competences which may relate to referential choices.

## 2. Method

### 2.1. Participants

Twenty-one patients with probable or possible Alzheimer's disease (AD) and twenty-one healthy elderly control participants (HC) took part in the study. The participants were strictly matched for age and educational level (see Table 1). The AD participants were recruited from the Center Hospitalier Universitaire Vaudois (CHUV) and the Réseau Hospitalier Neuchâtelois (RHNe). They received a probable or possible diagnosis of Alzheimer's disease according to the criteria proposed by McKhann et al. (2011). The diagnosis was made by a neurologist. All AD participants underwent a neurological and neuropsychological examination. They exhibited mild to moderate levels of AD, as assessed with the CDR scale (Morris, 1993) or with other information collected during the neurological examination, such as the degree of autonomy in activities of daily living.

The inclusion criteria for all participants (AD and HC) were that they were native or proficient French speakers, that they did not present with uncorrected visual or auditory deficits, and that they had no history of severe psychiatric disorders. Additional inclusion criteria for the HC included the absence of any history of cerebral or neurological disorder and a preserved general cognitive profile, assessed with the MoCA (score equal to or greater than 26; Nasreddine et al., 2005).

The study and participant recruitment were approved by the local ethics committee (Commission cantonale (VD) d'éthique de la recherche sur l'être humain; CER-VD). Both participant and their relatives received written information and were encouraged to discuss together to ensure informed consent.

### 2.2. Materials and procedure

#### 2.2.1. The storytelling in sequence task *(Fossard et al., 2018)*

The storytelling in sequence task (Fossard et al., 2018) was used to assess referential choices during discourse production. The task comprises nine narrative sequences, each composed of six colored images (10 x 11.5 cm), displaying one or two characters performing everyday activities (for instance, going shopping or going camping). The task was designed to assess the effects of two main parameters: the levels of referential complexity of the stories, and the discourse stages.

The levels of referential complexity correspond to the manipulation of the number (one or two) and gender (different or same) of the characters depicted in the sequences (see Figure 1). This manipulation made it possible to distinguish between three levels of increasing referential complexity, equally distributed across the

**Table 1.** Demographic and neuropsychological data of AD and HC groups.

| | | AD (n = 21) | | HC (n = 21) | | | |
|---|---|---|---|---|---|---|---|
| | | Mean (±SD) | Median [25%;75%] | Mean (±SD) | Median [25%;75%] | U | $\eta^2$ |
| Age (*Range*) | | 75.3 (6.4) *(58–87)* | 76 [8] | 75.4 (5.8) *(59–86)* | 77 [4] | 216 | 0.00 |
| Education | Level (1 to 3) | 2.2 (0.5) | 2 [0] | 2.1 (0.6) | 2 [1] | 219.5 | 0.00 |
| General cognitive functioning (*Range*) | MoCA | 18.5 (4.4) *(10–25)* | 20 [5.7] | 28.1 (1.6) *(26–30)* | 29 [4] | 420* | 0.74 |
| Episodic memory | FCSRT Delayed Free Recall | −4.1 (1.1) | −4.1 [1.4] | 0.3 (0.9) | 0.30 [1.24] | 399* | 0.73 |
| Short-term memory | Digits span forward | 5.5 (0.9) | 5 [1] | 5.9 (1.1) | 6 [2] | 172.5 | 0.04 |
| Working memory | Digits span backward | 3.6 (0.8) | 3 [1] | 4.1 (1.1) | 4 [1] | 151.5 | 0.05 |
| Flexibility | Category switching | 6.5 (3.7) | 7 [5] | 13 (2.8) | 13 [3] | 32.5* | 0.54 |
| | Phonemic fluency | 8.1 (4.6) | 6 [8] | 14.3 (3.6) | 14 [5] | 63.5* | 0.54 |
| | Semantic fluency | 10.5 (4.7) | 12 [7] | 18.7 (4.6) | 18 [5] | 39* | 0.73 |
| Inhibition | Stroop interference score (s) | 4.1 (2) | 3.5 [3.4] | 2.5 (1) | 2.20 [0.5] | 118.5* | 0.10 |
| Planning | Zoo map test score part A | 3.9 (2.4) | 3.5 [3.2] | 6.7 (1.9) | 8 [2] | 62.5* | 0.30 |
| Lexical retrieval | BNT | −5.00 (5.6) | 2 [1] | 1.14 (0.2) | 3 [0] | 22.5* | 0.70 |
| Perspective taking | Subscale from the IRI | 28.9 (4.9) | 23 [6] | 22.8 (3.9) | 23 [6] | 196 | 0.00 |
| Theory of Mind | Short version of the BICS | 13.8 (3.6) | 15 [5] | 19.4 (2.5) | 18 [2] | 36* | 0.48 |

*p-values <.0.5; AD = Alzheimer's disease; HC = Healthy controls; Mann Whitney U test; $\eta^2$ = eta squared; MoCA = Montreal Cognitive Assessment; FCSRT = Free and Cued Selective Reminding Test; BNT = Boston Naming test; IRI = Interpersonal Reactivity Index; BICS = Batterie Intégrée de Cognition Sociale.


**Figure 1.** Examples of the sequences used in the storytelling tasks. (a) Complexity level 1 (low referential complexity); (b) Complexity level 2 (intermediate referential complexity); (c) Complexity level 3 (high referential complexity).

task (three stories for each level of complexity). The first and lowest complexity level (level 1) corresponds to sequences displaying one character (Figure 1A); the intermediate level (level 2), to sequences displaying two characters of different genders (Figure 1B); and the third and most complex level (level 3), to sequences displaying two characters of the same gender (Fig. 1C).

The discourse stages refer to the manipulation of the relative visual salience of the characters, combined with their active/passive roles in the sequence of six images. Within each story, the task allows for the distinction between the introduction of a character (image 1 for all levels of referential complexity), the maintaining of the character in focus, which is the second consecutive time the character is active and in the foreground of the picture (images 2 to 6 for the first level of referential complexity and images 2, 4 and 6 for the second and third levels), and the shift of the character in focus, where the character moves to the foreground of the picture and becomes active (images 3 and 5 for the second and third levels of referential complexity).

Following Fossard et al. study (2018), we used a referential communication paradigm in order to reproduce a collaborative communication situation between two partners. The participants in the study (AD and HC) played the role of the speaker-narrator, whose task for each of the nine sequences was to tell a story to his or her addressee (the first author of the present study). The role of the addressee was to recreate the story told by the participant by placing each set of six images in the same predetermined order. The addressee could give positive feedback to signal understanding, and had to ask for clarification when she could not identify the correct image.

### 2.2.2. Neuropsychological assessment

All participants (AD and HC) underwent a neuropsychological assessment comprising several major cognitive abilities: episodic memory, working memory, executive functions and lexical retrieval abilities. The following tasks were used: 1) the French adaptation of the Free and Cued Selective Reminding Test (Van der Linden et al., 2004), with the free delayed recall scores as verbal episodic memory indexes; 2) the Digit Span task (Wechsler, 1987), with the span forward as short-term memory index and the span backward as working memory index; 3) the Stroop Victoria (Bayard et al., 2009), with interference scores as inhibition indexes; 4) the Zoo map task from the BADS (Behavioral Assessment of the Dysexecutive Syndrome; Wilson et al., 1996), with part 1 scores as planning index; 5) the Category Switching condition of the Verbal Fluency test from the D-KEFS (Delis-Kaplan Executive Function System; Delis et al., 2001) and the phonemic and semantic fluency tasks (GREFEX; Godefroy & le Groupe de Réflexion pour l'Evaluation des Fonctions Exécutives [GREFEX], 2008), with the number of words produced as flexibility scores; 6) the picture denomination task from the BNT (Boston Naming Test; Goodglass & Weintraub, 1983), to assess lexical retrieval abilities.

In addition, two socio-cognitive tasks were also administered to evaluate Theory of Mind (ToM) and perspective taking abilities. Perspective taking was assessed using the "perspective taking" subscale from the French adaptation

of the Interpersonal Reactivity Index (Gilet et al., 2013). ToM refers to the ability to infer the mental states of other people, which was assessed with a shortened version of the Combined Stories task (Achim et al., 2012), from which we retained a subset of 10 ToM stories.

The raw scores were used in most of the cognitive and socio-cognitive tasks. Five Alzheimer participants received an adapted version of a verbal episodic memory task and two received a longer version of the picture denomination task. To allow comparisons, standardized Z scores based on normative data were used for these two tasks.

### 2.3. Extraction and coding of referential expressions from the storytelling in sequence task

Following Fossard et al. study (2018), each story was recorded and then transcribed verbatim. All the stories were divided into six fragments, corresponding to the six images composing each sequence. Within each fragment, we focused on the clause that referred to the character in focus (the character visually in the foreground and active in the image), and the first referential expression produced to refer to the character was extracted. Then, the referential expression was coded according to whether it began with: (a) an indefinite expression (IN); (b) a definite expression (D+); or (c) an unaccented pronoun (PR) (clitic pronouns or zero pronouns). As in Fossard et al. (2018), the category of definite expressions was defined widely, so as to include definite and possessive expressions as well as a few demonstratives and accented pronouns which are expected to signal an intermediate level of accessibility (Ariel, 1990; Cornish, 1999; Fossard et al., 2012; Gundel et al., 1993).

Two verbatim transcriptions are reported below. The referential expressions extracted and coded for each fragment (separated by double slashes) are underlined (see Figure 1B for corresponding images). The English translation of the verbatim is presented in brackets.

Example from an AD participant:

"un jeune homme qui est très gai (a young man who is very happy)//qui se met à jongler avec des œufs (who starts juggling with eggs)//une dame allume des bougies (a lady lights candles)//et qui se met à jongler avec les bougies (and who starts juggling with candles)//ensuite il ramasse les bougies (then he collects the candles)//et il les éteint en soufflant dessus (and he blows them out)"

Example from an HC participant:

"un jeune homme a l'air très content et se présente tout simplement devant une amie (a young man seems very happy and simply shows up in front of a friend)//il jongle avec quatre boules (he juggles with four balls)//et laisse la place à sa partenaire qui allume des flambeaux (and gives way to his partner who lights torches)//et qui se met à jongler avec son ami avec ses flambeaux (and who starts juggling with her friend with torches)//et ensuite l'ami jongle tout seul sous le regard de son amie (and then the friend juggles alone in front of his friend)//puis ensuite il les éteint parce que c'est dangereux de conserver tout ça allumé (then he blows them out because it's dangerous to keep it all lighted) "

### 2.4. Statistical analyses

For the demographic and neuropsychological data, comparisons between the two groups (AD and HC) were performed using the Mann-Whitney U test, due to the distribution of the variables. Eta squared were used to estimate effect sizes.

For each of the study's two objectives, we conducted separate generalized linear mixed models for each category of referential expressions (IN, D+ and PR as dichotomic dependent variables; referential expression present "yes/no") with participants as random effect (Baayen et al., 2008), using R (R Development Core Team, 2013) with the "lme4" package (Bates, Maechler et al., 2015). While it might have been interesting to generalize for the items as well, the task did not contain enough items (i.e., sequences) to insert them as random intercepts. Likelihood ratio tests were systematically used to compare the different models performed (Pinheiro & Bates, 2000). Betas, standard errors and odds ratios (OR) are presented in the section on results. Effect size was computed using McFadden pseudo $R^2$ from deviance (McFadden, 1974) (1 minus the deviance of the model with the fixed effects divided by the model without the fixed effects).

For the first objective, two steps were performed to assess the effect of the discourse stages and the level of referential complexity on the choices of referential expressions. First, we performed one model which included the following independent variables: 1) the discourse stages (introduction, maintaining and shift); 2) the group (AD and HC); and 3) the interaction between the discourse stages and the group. Second, to assess the effect of the referential complexity on referential choices, we conducted two separate models: in the first, we compared the presence of one vs two characters (level 1 vs levels 2 and 3); in the second, the effect of the gender of the characters (level 2 vs 3). The following independent variables were included in the two models: 1) the discourse stages; 2) the group; 3) the level of referential complexity (level 1 vs 2–3 or level 2 vs 3); and 4) the interactions between the level of referential complexity, the discourse stage and the group. Note that only the introduction and maintaining stages were included in the model assessing the effect of the number of characters (level 1 vs 2–3), as there is no shift stage in the level 1 stories.

We decomposed the significant interaction by performing post hoc tests to assess the effect of one independent variable (for instance, the group) on the modalities of the other (for instance, introduction, maintaining and shift for the discourse stages). All post hoc tests were performed using Tukey correction for multiple comparisons with the "lsmeans" package (Lenth, 2016).

For each model performed, we also assessed random slopes for the discourse stages with likelihood ratio tests. As they did not change the effects of the independent variables and their interactions, only the simplest models were retained (Bates, Kliegl et al., 2015).

For the second objective, we performed separate models for each discourse stage, with the performance in each cognitive and socio-cognitive task as an independent variable. We performed likelihood ratio tests to assess the effect of the cognitive competences on the category of referential expressions expected at each discourse stage – indefinite expressions at the introduction stage, pronouns at the maintaining stage, and definite expressions at the shift stage. For each model, we added the interactions between cognitive or socio-cognitive performance and group, to assess whether differential effects would be observed according to the group (for instance, a stronger effect of working memory abilities in the AD group than in the HC group).

## 3. Results

### 3.1. Neuropsychological characteristics

The neuropsychological characteristics of AD and HC groups are presented in Table 1. The AD group showed lower scores on verbal episodic memory ($p$ <.001), flexibility (category switching: $p$ < .001; phonemic fluency: $p$ < .001; and semantic fluency: $p$ < .001), inhibition ($p$ < .05) and planning abilities ($p$ < .001). Their lexical retrieval abilities were also lower than the HC group ($p$ < .001). No significant difference between groups was found for short-term ($p$ = .14) and working memory ($p$ = .17). In terms of socio-cognitive task performance, lower scores in the Theory of Mind test were observed for the AD group ($p$ < .001), but no significant difference was found for the perspective taking scale ($p$ = .54).

### 3.2. Storytelling in sequence task

Figure 2 presents the proportion of each referential expression (indefinite expressions (IN), definite expressions (D+) and pronouns (PR)) produced at each discourse stage and at each level of referential complexity, according to group (AD and HC).

The results for each category of referential expression are presented in different subsections. In each subsection, we first report descriptive statistics of the proportion of each referential expression produced, over all expressions, according to groups, discourse stages and levels of referential complexity (Table 2 to 4). Second, inferential statistics for the effect of the group, the discourse stages, the level of referential complexity and the interaction between the variables are reported.

#### 3.2.1. Indefinite expressions (IN)

Table 2 presents the proportions of indefinite expressions by group (AD and HC) at each discourse stage, according to the three levels of referential complexity (see also Figure 2).

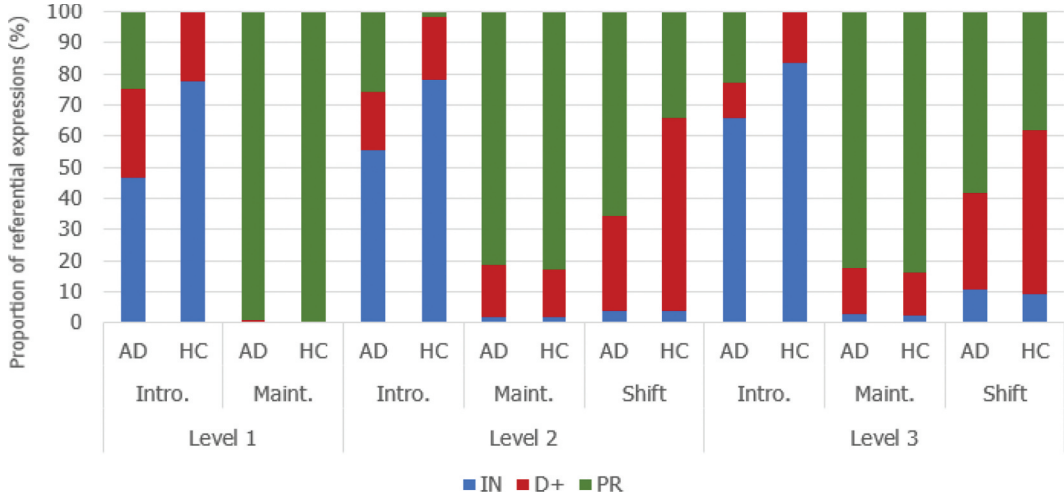


**Figure 2.** Proportion of referential expressions (%) at each discourse stage (introduction, maintaining and shift) and each level of referential complexity, according to the two groups (AD and HC).AD = Alzheimer's disease; HC = Healthy controls; Intro. = Introduction; Maint. = Maintaining; IN = Indefinite expressions; D+ = Definite expressions; PR = Pronouns.

**Table 2.** Proportions of indefinite expressions produced, over all expressions (IN, D+ and PR) by group (AD and HC) at each discourse stage and according to three levels of referential complexity.

| | | Levels of referential complexity | | | | | |
|---|---|---|---|---|---|---|---|
| | | Level 1 | | Level 2 | | Level 3 | |
| | | AD | HC | AD | HC | AD | HC |
| Discourse stages | Introduction | 46.43 | 77.8 | 55.56 | 78.18 | 66.04 | 83.33 |
| | Maintaining | 0 | 0 | 1.81 | 1.67 | 2.63 | 2.38 |
| | Shift | | - | 4.04 | 3.6 | 10.68 | 9.09 |

**Table 3.** Proportions of definite expressions, over all expressions (IN, D+ and PR), produced by group (AD and HC) at each discourse stage, according to three levels of referential complexity.

| | | Levels of referential complexity | | | | | |
|---|---|---|---|---|---|---|---|
| | | Level 1 | | Level 2 | | Level 3 | |
| | | AD | HC | AD | HC | AD | HC |
| Discourse stages | Introduction | 28.57 | 22.2 | 18.52 | 20 | 11.32 | 16.67 |
| | Maintaining | 0.75 | 0.35 | 16.87 | 15.56 | 15.3 | 13.69 |
| | Shift | | - | 30.3 | 62.16 | 31.07 | 52.73 |

**Table 4.** Proportions of pronouns, over all expressions (IN, D + and PR), produced by group (AD and HC) at each discourse stage, according to three levels of referential complexity.

| | | Levels of referential complexity | | | | | |
|---|---|---|---|---|---|---|---|
| | | Level 1 | | Level 2 | | Level 3 | |
| | | AD | HC | AD | HC | AD | HC |
| **Discourse stages** | Introduction | 25 | 0 | 25.92 | 1.82 | 22.64 | 0 |
| | Maintaining | 99.25 | 99.65 | 81.32 | 82.77 | 82.24 | 83.93 |
| | Shift | - | | 65.66 | 34.24 | 58.25 | 38.18 |

The likelihood ratio tests reported a significant effect of the discourse stages ($\chi2(2) = 763.85$, $p < .0001$), a significant effect of the group ($\chi2(1) = 4.26$, $p < .05$), but no significant effect of the interaction between the group and discourse stages ($\chi2(2) = 3.53$, $p = .17$). Pseudo McFadden $R^2$ (effect size measure) for the full model was 0.46.

The significant effect of the discourse stages showed that the probability of producing indefinite expressions is higher at the introduction stage than it is at the maintaining (b = 5.36 (0.30), z = 17.83, OR = 212.72, $p < .0001$) and shift stages (b = 3.13 (0.21), z = 14.46, OR = 22.87, $p < .0001$). A significant difference between the maintaining and shift stages was also observed, revealing an increased probability of producing indefinite expressions at the shift stage (b = 2.23 (0.31), z = 7.11, OR = 9.29, $p < .0001$). The significant effect of the group indicated that the AD group presented a lower probability of producing indefinite expressions than the HC group (b = −0.73 (0.35), z = −2.08, OR = 0.48, $p < .05$).

No significant effect of referential complexity was found (level 1 vs 2–3: $\chi2(1) = 2.63$, $p = .10$; and level 2 vs 3: $\chi2(1) = 1.39$, $p = .24$), and none of the interactions between group, level of referential complexity and discourse stages was significant.

### 3.2.2. *Definite expressions (D+)*

Table 3 presents the proportions of definite expressions produced by group (AD and HC) at each discourse stage, according to the three levels of referential complexity (see also Figure 2).

The likelihood ratio tests reported a significant effect of the discourse stages ($\chi2(2) = 233.58$, $p < .0001$), a significant effect of the group ($\chi2(1) = 6.82$, $p < .01$), and a significant effect of the interaction between the two variables ($\chi2(2) = 22.91$, $p < .0001$). Pseudo McFadden $R^2$ (effect size measure) for the full model was 0.13.

The interaction between the group and discourse stages is only significant for level 2 ($\chi2(1) = 15.61$, $p < .001$). Decomposition by discourse stage revealed that the AD group presented a lower probability of producing definite expressions than the HC group at the shift stage (b = −0.68 (0.26), z = −2.62, OR = 0.51, $p < .01$). No difference between the two groups is observed for the introduction and maintaining stages (b = 0.15 (0.51), z = −0.29, OR = 1.66, $p = .77$ and b = −0.10 (0.35), z = −0.30, OR = 0.90, $p = .76$ respectively). Decomposition by group showed that no significant difference in the use of definite expressions between discourse stages is observed for the AD group (introduction vs maintaining: b = −0.12 (0.41), z = −0.31, OR = 0.87, $p = .94$; introduction vs shift: b = 0.48 (0.41), z = 1.18, OR = 1.62, $p = .46$; maintaining vs shift: b = 0.62 (0.30), z = 2.03, OR = 1.86, $p = .10$). However, a higher probability of using definite expressions at the shift stage than at the introduction and maintaining stages is observed for the control group (introduction vs shift: b = 1.81 (0.39), z = 4.68, OR = 6.11, $p < .001$; maintaining vs shift: b = 2.19 (0.29), z = 7.51, OR = 8.93, $p < .0001$). No significant difference between the introduction and maintaining stages is observed (b = −0.38 (0.40), z = −0.96, OR = 0.68, $p = .61$).

Given that the interactions between group and discourse stages were not significant for complexity levels 1 and 3, only the main effects are reported. A significant main effect of group is only observed at complexity level 3, with a lower probability of using definite expressions among the AD group than among the HC group (b = −0.69 (0.25), z = −2.42, OR = 0.50, $p < .05$). For

complexity level 3, the main effect of the discourse stages indicated a higher probability of producing definite expressions at the shift stage than at the maintaining (b = 1.49 (0.22), z = 6.89, OR = 4.44, $p < .0001$) and introduction stages (b = 1.57 (0.32), z = 4.89, OR = 4.81, $p < .001$). For complexity level 1, a higher probability of producing definite expressions is observed at the introduction stage than at the maintaining stage (b = 4.35 (0.66), z = 6.56, OR = 77.48, $p < .001$).

A significant effect of the level of referential complexity ($\chi2(1) = 41.31$, $p < .0001$) and a significant interaction between discourse stage and level of referential complexity ($\chi2(2) = 64.31$, $p < .0001$) were observed as effects of the presence of one vs two characters (level 1 vs 2–3). Pseudo McFadden $R^2$ (effect size measure) for the full model was 0.13.

The decomposition of the interaction by discourse stage revealed a higher probability of using definite expressions at the maintaining stage for levels 2 and 3 than at level 1 (b = 3.51 (0.59), z = 5.94, OR = 33.45, $p < .0001$). No difference at the introduction stage is observed (b = −0.55 (0.29), z = −.92, OR = 0.58, $p = .06$).

By contrast, no significant effect of referential complexity was observed as an effect of the presence of two characters of the same vs different gender (level 2 vs 3: $\chi2(1) = 2.26$, $p = .13$), and none of the interactions between group, level of referential complexity and discourse stage was significant.

### 3.2.3. Pronouns (PR)

Table 4 presents the proportions of pronouns produced by groups (AD and HC) at each discourse stage, according to the three levels of referential complexity (see also Figure 2).

The likelihood ratio tests reported a significant effect of the discourse stages ($\chi2(2) = 751.69$, $p < .0001$), no significant effect of the group ($\chi2(1) = 0.77$, $p = .38$), but a significant effect of the interaction between the two variables ($\chi2(2) = 83.05$, $p < .0001$). Pseudo McFadden $R^2$ (effect size measure) for the full model was 0.28.

The interaction between group and discourse stage was significant for levels 2 and 3 ($\chi2(2) = 26.44$, $p < .001$ and $\chi2(2) = 8.80$, $p < .01$ respectively). It is worth noting that only the maintaining and shift stages were included in the interaction for level 3, as the HC group produced no occurrence of pronouns at the introduction stage for complexity levels 1 and 3 (see Table 5). For complexity level 1, we then assessed the effect of the group at the maintaining stage, but the difference did not reach the threshold of significance ($\chi2(1) = 1.66$, $p = .19$).

The results of decomposing the interaction by discourse stage are presented in Table 5. The AD group produced significantly more pronouns than the HC group at the introduction stage for level 2, and at the shift stage for levels 2 and 3. No significant difference in the use of pronouns between the groups were observed at the maintaining stage.

**Table 5.** Decomposition by discourse stage of the significant interaction between group (AD and HC) and discourse stage on the use of pronouns (yes/no) for complexity levels 2 and 3.

| | Levels of referential complexity | |
|---|---|---|
| | Level 2 | Level 3 |
| **Discourse stages** | AD* vs HC | AD* vs HC |
| Introduction | b = −2.98 (1.09), z = −2.73, OR = 0.05, $p$ <.01 | - |
| Maintaining | b = 0.44 (0.34), z = 1.30, OR = 1.55, $p$ =.19 | b = 0.41 (0.25), z = 1.6, OR = 1.51, $p$ =.095 |
| Shift | b = −1.02 (0.36), z = −2.08, OR = 0.36, $p$ <.01 | b = −0.61 (0.28), z = −2.17, OR = 0.54, $p$ <.05 |

* The AD group is the modality from which the difference is assessed.

The decomposition of the interaction by group is presented in Table 6. For both groups of participants, a higher probability of producing pronouns at the maintaining stage is observed than at the shift stage, for complexity levels 2 and 3. For complexity level 2, both groups also presented a higher probability of using pronouns at the maintaining stage than at the introduction stage; similarly, there was a higher probability of using pronouns at the shift stage than there was at the introduction stage.

A significant effect of level of referential complexity (level 1 vs 2–3: $\chi2(1) = 44.32$, $p < .0001$) and a significant interaction between level of referential complexity and discourse stage ($\chi2(1) = 5.04$, $p < .05$) were observed when comparing the presence of one vs two characters (level 1 vs 2–3). Pseudo McFadden $R^2$ (effect size measure) for the full model was 0.33.

**Table 6.** Decomposition by group of the significant interaction between group and discourse stage on the use of pronouns (yes/no) at complexity levels 2 and 3.

| | Groups | |
|---|---|---|
| | AD | HC |
| **Level 2** | | |
| Introduction* vs maintaining | b = 2.41 (0.36), z = 6.58, OR = 11.13, $p$ <.0001 | b = 5.84 (1.04), z = 5.61, OR = 343.78, $p$ <.0001 |
| Introduction* vs shift | b = 1.46 (0.37), z = 3.93, OR = 4.31, $p$ <.001 | b = 3.43 (1.03), z = 3.30, OR = 30.88, $p$ <.01 |
| Maintaining* vs shift | b = −0.95 (0.25), z = −3.73, OR = 0.39, $p$ <.001 | b = −2.42 (0.29), z = −8.30, OR = 0.09, $p$ <.001 |
| **Level 3** | | |
| Introduction* vs maintaining | - | - |
| Introduction* vs shift | - | - |
| Maintaining* vs shift | b = − 0.78 (0.24), z = −3.29, OR = 0.46, $p$ <.01 | b = −1.81 (0.25), z = −7.03, OR = 0.16, $p$ <.0001 |

* This discourse stage is the modality from which the difference is assessed.

At the maintaining stage, the decomposition of the interaction for the discourse stages showed a lower probability of using pronouns for levels 2–3 than for level 1 (b = −1.19 (0.15), z = −6.95, OR = 0.30, $p < .0001$). No significant difference was observed at the introduction stage (b = 0.14 (0.41), z = −0.36, OR = 1.15, $p = .77$).

No effect of referential complexity was observed when comparing the presence of two characters of the same vs different gender (level 2 vs level 3) ($\chi 2(1) = 1.72$, $p = .19$), and none of the interactions between level of referential complexity, group and discourse stage was significant.

### 3.3. Cognitive and socio-cognitive competences involved in referential choices

As mentioned in the section on method, a model for each discourse stage (introduction, maintaining and shift) was performed. Each performance in cognitive and socio-cognitive tasks was inserted as an independent variable (see Table 1 for the performance of the AD and HC groups in these different tasks), and the category of referential expressions expected at each discourse stage as a dependent variable (i.e., indefinite expressions at the introduction stage, definite expressions at the shift stage, and pronouns at the maintaining stage). We report below only the cognitive and socio-cognitive abilities, and the interactions between these abilities and the group which contributed significantly to the models.

#### 3.3.1. Introduction stage

For the introduction stage, we found a significant effect of flexibility assessed with the category switching task ($X^2(1) = 5.92$, $p < .05$; pseudo $R^2 = 0.03$), indicating that good abilities related to a higher probability of producing an indefinite expression (b = 0.22 (0.07), z = 3.12, OR = 1.25, $p < .01$).

We found a significant interaction between group and short-term memory abilities ($X^2(1) = 5.071$, $p < .05$; pseudo $R^2 = 0.04$), working memory abilities ($X^2(1) = 4.03$, $p < .05$; pseudo $R^2 = 0.07$) and flexibility assessed with the phonemic fluency task ($X^2(1) = 6.19$, $p < .05$; pseudo $R^2 = 0.04$). Our results indicated that good abilities in these three competences related to a higher probability of producing indefinite expressions for the AD group only (short-term memory: b = 1.59 (0.07), z = 2.12, OR = 4.90, $p < .01$; working memory: b = 1.28 (0.68), z = 2.03, OR = 3.60, $p < .05$; and flexibility from the phonemic fluency task: b = 0.31 (0.16), z = 2.47, OR = 1.36, $p < .05$).

#### 3.3.2. Maintaining stage

For the maintaining stage, significant effects of flexibility assessed with the category switching task ($X^2(1) = 4.41$, $p < .05$; pseudo $R^2 = 0.05$) and episodic memory ($X^2(1) = 4.37$, $p < .05$; pseudo $R^2 = 0.05$) are found, with higher scores in these two tasks contributing to an increased probability of producing a pronoun (flexibility: b = 0.07 (0.03), z = 2.72, OR = 1.07, $p < .01$; and episodic memory: b = 0.15 (0.07), z = 2.16, OR = 1.16, $p < .05$;).

The interaction between working memory abilities and group was significant ($X^2(1) = 8.83$, $p < .01$; pseudo $R^2 = 0.06$); for the AD group, this reveals that higher scores in working memory are associated with a higher probability of producing a pronoun (b = 0.90 (0.31), z = 3.30, OR = 2.46, $p < .001$).

Additional models for complexity levels 2 and 3 were performed with the proportion of definite expressions as a dependent variable. These additional analyses were motivated by a significant increase observed in definite expressions at the maintaining stage when the stories displayed two characters rather than one (see section 3.2.2.). An effect of ToM abilities ($X^2(1) = 5.40$, $p < .05$; pseudo $R^2 = 0.01$) and planning abilities ($X^2(1) = 4.13$, $p < .05$; pseudo $R^2 = 0.01$) was found, revealing that higher ToM and planning abilities relate to a decreased probability of producing a definite expression (ToM: b = −0.12 (0.05), z = −2.39, OR = 0.89, $p < .05$; and planning: b = −0.23 (0.07), z = −3.16, OR = 0.79, $p < .05$).

A significant interaction between group and scores from the perspective taking scale was found ($X^2(1) = 4.07$, $p < .05$; pseudo $R^2 = 0.01$), indicating that higher scores relate to a higher probability of using a definite expression for the AD group only (b = 0.13 (0.07), z = 1.96, OR = 1.14, $p < .05$).

#### 3.3.3. Shift stage

For the shift stage, we found a significant effect of flexibility from the phonemic and semantic fluency tasks ($X^2(1) = 9.31$, $p < .01$; pseudo $R^2 = 0.04$, and $X^2(1) = 4.33$, $p < .05$; pseudo $R^2 = 0.03$, respectively) and the category switching task ($X^2(1) = 7.49$, $p < .01$; pseudo $R^2 = 0.04$). For the three tasks, higher scores relate to a higher probability of producing a definite expression (phonemic fluency: b = 0.15 (0.03), z = 5.08, OR = 1.16, $p < .0001$; semantic fluency: b = 0.07 (0.03), z = 4.14, OR = 1.07, $p < .05$; and category switching: b = 0.17 (0.03), z = 4.97, OR = 1.18, $p < .01$).

Finally, the interaction between group and short-term memory abilities was significant ($X^2(1) = 5.40$, $p < .05$; pseudo $R^2 = 0.04$), revealing that higher scores relate to a higher probability of producing a definite expression for the AD group only (b = 0.59 (0.29), z = 2.10, OR = 1.80, $p < .05$).

## 4. Discussion

In the present study, we assessed the referential expressions produced by AD people during narrative discourse, using a new storytelling in sequence task (Fossard et al., 2018). This task enabled us to examine the referential choices made at three discourse stages (introduction, maintaining and shift of the referent in focus) by manipulating characters' visual saliency and agentivity within a sequence of six images. In addition, between-sequence variation of the number (one vs two) and gender of the characters (different vs same gender) allowed us to distinguish the referential choices made at three levels of referential complexity: low level (one character), intermediate level (two characters of different genders) and high level (two characters of the same gender). Following Fossard et al. (2018), our analyses focused on three categories of referential expression which were shown to be produced at specific discourse stages: indefinite expressions at the introduction stage, pronouns at the maintaining stage and definite expressions at the shift stage.

Based on previous studies on referential choices by people with AD (for instance, Drummond et al., 2015; Kavé & Dassa, 2018; Laine et al., 1998), for our first objective we hypothesized that AD participants would produce more pronouns than control participants at the introduction and shift stages, but not at the maintaining stage. At a given discourse stage, we also expected to observe fewer variations in referential choices according to the level of referential complexity than would be observed for control participants. Indeed, in Fossard et al. study (2018), an increased use of definite expressions (like "the girl") was observed at the maintaining stage when the sequences displayed two characters (different and same gender) rather than sequences displaying one character. This referential adjustment made by speakers might allow the addressee to identify the intended referent more precisely when there is a competitor (i.e., another referent) in the discourse. While no previous study has – to our knowledge – assessed referential choices at different levels of referential complexity in AD, we hypothesized that AD participants might experience difficulties adjusting their referential choices when the discourse context changes, resulting in lower variation in referential expressions produced than would be observed among control participants.

First, our results confirmed that AD participants produced more pronouns than control participants at the introduction and shift stages, for all levels of referential complexity. The proportion of pronouns produced between the two groups did not reach the threshold of significance at the maintaining stage. These observations are in line with previous results showing that people with AD tend to use many pronouns during discourse. However, using a task enabling discourse stages to be controlled during discourse, our study revealed how this behavior occurs within the dynamics of the narrative, when the discourse factors modify the referents' level of accessibility. We observed that some AD participants began their stories with a pronoun (about 25% of expressions produced at the introduction stage), whereas we observed only a single occurrence of a pronoun in the control group. This might indicate that the use of pronouns at the introduction stage appears to be more specific to the AD group. At the shift stage, we observed that the control group used pronouns to shift toward a referent in focus in more than one third of cases (level 2: 34.24% and level 3: 38.18%). While these proportions are still significantly lower than those for the AD group (level 2: 65.66% and level 3: 58.25%), they nevertheless suggest that the use of pronouns at the shift stage is not atypical behavior (for instance, the young adults in Fossard et al.'s study (2018) produced about 15% of pronouns at this same stage).

One important finding of our study is that the expected use of referential expressions according to discourse stage was observed to be the same in the AD group as it was in the control group. Indeed, the use of pronouns between the three discourse stages varies significantly in the same way as in the control group, with pronouns preferentially used at the maintaining stage rather than the other stages (introduction and shift). Likewise, our results showed that indefinite expressions are preferentially used at the introduction stage, and definite expressions at the shift stage, with the exception of referential complexity level 2. At this level, although the AD group produced more definite expressions at the shift stage than at the other stages, the results did not reach the threshold of significance. In summary, although the AD group tended to use more pronouns than the control group, they nevertheless presented the same pattern of favored referential expressions between the discourse stages as the control group. This important finding could indicate that sensitivity to discourse stage is still present in this group, leading to the expected variation in referential expressions.

A second significant finding comes from the variation we observed in the level of the sequences' referential complexity. At the maintaining stage, when the sequences displayed two characters rather than one, we observed a decrease in the use of pronouns and an increase in the use of definite expressions. This adjustment in referential choices according to the presence of

another character in the stories was also reported in Fossard et al. (2018), and could be interpreted as a competition effect between the two characters. While the character is salient at the maintaining stage (having been mentioned in the preceding clause), the presence of another character may decrease accessibility to the first (see also Arnold & Griffin, 2007; Contemori & Dussias, 2016: Experiment 1; Fukumura et al., 2010). It is worth noting that no significant difference between the groups reached the threshold of significance, suggesting that the presence of another character in the discourse had a similar effect on both groups of participants.

To sum up, our results emphasize the importance of controlling for discourse factors in the assessment of referential choices. Recently, Kavé and Goral (2018) conducted a meta-analysis of studies examining discourse in AD. They noted that numerous studies find significant use of pronouns by people with AD, and suggested that this could be used as an indicator of communicative difficulties in this population. In order to extract pronouns within a discourse sample quickly, Kavé and Goral (2018) recommended the use of automated tools, especially for clinical purposes. While we fully agree on the need to have tools which allow us to identify discursive difficulties for clinical utility, our results nevertheless showed that this analysis must take into account the dynamics of referential adjustment throughout the narrative.

Our second objective focused on the cognitive and socio-cognitive abilities contributing to referential choices. We conducted our analyses for the category of referential expressions expected at each discourse stage (i.e., indefinite expressions at the introduction stage; pronouns at the maintaining stage; and definite expressions at the shift stage). First, our results indicated that flexibility abilities relate to referential choices at every discourse stage, suggesting that the process of selecting an appropriate expression according to the discourse stage relies on executive abilities. In addition, we found a significant effect of episodic memory abilities related to the production of pronouns at the maintaining stage. These results are not in line with Kuijper et al. (2015), which did not report any contribution of executive or episodic memory abilities at the introduction or maintaining stages. Their predictions were based principally on the cognitive abilities involved at the reintroduction stage, at which speakers must pay particular attention to the addressee's perspective. Indeed, to indicate to their addressees that the intended referent is no longer the one which was in the discourse focus, speakers must produce a full NP, instead of a pronoun, possibly involving cognitive resources (for a recent theoretical account, see also Hendriks, 2016). However, our results suggest that the reintroduction of a referent is not the sole discourse stage to involve cognitive resources.

In terms of the AD group in particular, our results showed that additional cognitive competences are related to referential choices. Working and short-term memory abilities were found to contribute to the production of the expected referential expression at every discourse stage (i.e., indefinite expressions at the introduction stage, pronouns at the maintaining stage and definite expressions at the shift stage). These results support previous studies suggesting that keeping the referents' representation active during discourse requires memory capacities (Almor et al., 1999; March et al., 2009; Hendriks, 2016). In contrast to previous studies demonstrating significant correlations between lexical deficits and the proportion of pronouns used by people with AD (Drummond et al., 2015; Kavé & Goral, 2016), we did not find significant involvement of lexical retrieval abilities, assessed with the picture denomination task, at any discourse stage. This absence of a significant result might reveal that performance in a picture naming task does not reflect performance in word retrieval during discourse, where several other linguistic and cognitive competences interact in a complex manner (for a discussion, see Kavé & Goral, 2018). Nevertheless, at the introduction stage, the significant effect of performance in the phonemic fluency task on the use of indefinite expressions could suggest that lexical evocation abilities to some extent relate to the production of informative referential expressions. While the phonemic fluency task involves executive abilities (Aita et al., 2019), it has also been related to language performance, as it requires efficient access to the mental lexicon (Whiteside et al., 2016).

Finally, we performed additional analyses on the proportion of definite expressions at the maintaining stage, as a result of the observation that these expressions increased when the sequences displayed two characters rather than one. The results showed that ToM and planning abilities related negatively to the production of definite expressions, for both groups of participants. These results are quite surprising, given that the use of more informational expressions (i.e., full NPs instead of pronouns) when the discourse involves several referents could be seen as a strategy enabling the addressee to identify the intended referent more precisely. One possible explanation is that the use of a definite expression to maintain a referent in focus, regardless of the discourse context, is not related to "addressee oriented" behavior, and instead reveals poor discourse planning. Indeed, the use of

a definite expression to indicate a highly accessible referent may disrupt the addressee's representation of the active referent, instead indicating a shift to another referent, as claimed by the cognitive models of reference (Ariel, 1990; Gundel et al., 1993). Further studies are required to examine the mechanisms underlying referential choices where there are increasing levels of referential complexity.

To conclude, our study highlights the importance of examining referential choices in AD according to specific discourse constraints, in order to determine how pronouns are used within the referential dynamics. While our results did show that pronouns are used in the AD group more than they are in the control group, they also showed that modulation of referential expressions is still present. Thus, examining only the overall number of pronouns produced may be misleading, and might conceal certain referential abilities which are preserved. We suggest that further studies on referential choices in AD should take these considerations into account, so as to provide a better overview of how people with AD manage referential expressions during discourse; it might also be interesting to examine how referential abilities progress in the course of the disease. Identifying the discourse factors which might lead people with AD to experience difficulties could be useful within clinical practice, in order to prevent the occurrence of communicative breakdowns.

Finally, our results might help to refine certain theoretical models of reference production. Recent models have largely emphasized the cognitive competences involved when a referent has to be reintroduced in the discourse focus (Hendriks, 2016; Kuijper et al., 2015); however, it seems that referential choices rely on many cognitive competences, especially executive and memory abilities, throughout the discourse. While we acknowledge that the population of our study presents a particular cognitive profile (i.e., people with AD and elderly adults), and that our results may therefore not apply to healthy young speakers, our study still provides an insight into the cognitive processes which could be employed during complex discursive activity. The fact that we observed more competences related to referential choices in the AD group than we did in the control group might reflect a compensatory mechanism to provide appropriate referential expressions, despite the presence of reduced cognitive resources.

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