



# Revisiting Aspect in Mild Cognitive Impairment and Alzheimer's Disease: Evidence From Greek

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The study investigates the ability of Greek-speaking individuals diagnosed with mild Alzheimer's Disease (mAD) and Mild Cognitive Impairment (MCI) to produce verbs that vary with respect to their grammatical and lexical aspect. While grammatical aspect has been examined in aphasia, there are only a few studies dealing with this in neurodegenerative conditions and their findings are contradictory. Motivated by this, we further investigate aspect by examining not only grammatical but lexical aspect as well and how their semantic and temporal features affect mAD and MCI individuals' performance. Thus, the major innovation of the study is that it examines aspect not only as a functional feature but also as a lexical variable, something addressed for the first time in the literature. We also address whether grammatical aspect interacts with lexical aspect and with time reference. Finally, by looking at Greek, we further contribute to cross-linguistic perspective of aspect investigation. 11 MCI and 11 mAD individuals participated in a picture naming task, targeting the investigation of lexical aspect, and a sentence completion task, targeting the investigation of grammatical aspect and its interaction with lexical aspect and time reference. Both groups of participants were found to be impaired in both tasks when compared to healthy controls. In the naming task, both group and lexical aspect were significant predictors for participants' performance. Specifically, more impaired performance was found in *states* (*believe*), *achievements* (*break*), and *semelfactives* (*hit*) compared to *activities* (*run*) and *accomplishments* (*build*) for both AD and MCI participants. In the sentence completion task, apart from group, neither grammatical or lexical aspect nor tense were significant predictors for participants' performance. While results indicate that both grammatical and lexical aspect are impaired in AD and MCI, a closer look suggests a dissociation regarding the temporal feature of *duration*. Specifically, as grammatical feature, *duration* does not appear to affect participants' choice between perfective and imperfective aspect. As a lexical variable, on the other hand, and as part of the lexical representation of a verb, *duration* (together with internal structure) appears to play a role in verb naming. Finally, the lack of interaction between lexical and grammatical aspect also indicates that these two subsystems can be affected differentially.

**Keywords:** sentence completion task, picture naming task, grammatical aspect, lexical aspect, Alzheimer's disease, mild cognitive impairment, Greek language

## INTRODUCTION

Alzheimer's disease (AD) is a chronic neurodegenerative disease and the most common type of dementia (Visser et al., 1999), characterized by progressive cognitive dysfunction. Diagnosing dementia based on neuropsychological assessments requires the presence of impairment in the domain of memory and in one of the other cognitive domains (Lindeboom and Weinstein, 2004). At the initial stages of AD, working memory is impaired (Braaten et al., 2006), leading to difficulties in learning new things. As the disease progresses, dysfunction in other cognitive domains, such as executive functions, attention and visuospatial skills, is observed. The term Mild Cognitive Impairment (MCI), refers to the clinical stage between normal aging and dementia. Individuals diagnosed with MCI suffer from loss of cognitive and functional abilities, yet they do not meet the criteria to be diagnosed with dementia (Petersen et al., 2001). Patients who demonstrate impairment in multiple cognitive domains, with or without degraded memory, including language, are more likely to develop dementia (Petersen et al., 2001; Petersen, 2003; Alexopoulos et al., 2006).

Language abilities in AD are affected during all stages of the disease with patients having difficulties in both production and comprehension of both grammatical and semantic aspects of language (Altmann et al., 2001; Kavé and Dassa, 2018; Kavé and Goral, 2018). An early symptom of AD is difficulties in producing and recalling single words due to impairment at different levels of lexical processing. Recent studies employing a revised version of Boston Naming Test and a picture-naming task (Silagi et al., 2015; Salehi et al., 2017) report noun naming deficits in AD patients. These studies revealed that naming errors are different in terms of quantity and quality among the different stages of the disease (mild and moderate), with patients at the initial stage producing more semantic errors and patients at the moderate stage producing fewer correct responses and mainly no-responses at all. According to the authors (Silagi et al., 2015; Salehi et al., 2017), patients' lexical retrieval difficulties might indicate either deficit in accessing the semantic content of a word or difficulties in recalling its phonological form. While nouns are, in general, more impaired than verbs (Whatmough and Chertkow, 2002), Masterson et al. (2007) observed more errors and slower reaction times to verbs compared to nouns in a picture-naming task and a word-picture verification task. The above findings are in line with other studies which reveal that verb production and comprehension abilities are more impaired than noun naming abilities in AD (Kim and Thompson, 2004; Druks et al., 2006). Finally, verb impairment in AD has also been observed in verbal fluency tasks, where patients demonstrated recall and production difficulties (Alegret et al., 2018). In general, it appears that impaired naming abilities of individuals with AD result from patients' general cognitive impairment and specifically from their manifested memory limitations. Specifically, it has been suggested that degraded semantic memory, the part of long-term memory which includes language and mental lexicon information, might interfere with patients' naming abilities (Vogel et al., 2005; Braaten et al., 2006).

Studies investigating morphosyntactic abilities in AD have produced mixed results. For instance, Kavé and Levy (2003) found AD patients' speech to be less informative with more semantic errors compared to controls, but patients' syntactic (e.g., production of independent and declarative clauses) and morphological (e.g., word inflection, verb formation) abilities were comparable to the abilities of the cognitively intact participants. However, other studies reveal general morphosyntactic impairment in AD, such as impaired verb morphology (Walenski et al., 2009), morphosyntactic errors (e.g., incorrect inflections, word order errors, and missing matrix or subordinate clauses) in spontaneous speech and oral production (Altmann et al., 2001), and difficulties in interpreting thematic roles of verbs (e.g., Manouilidou and de Almeida, 2009; Manouilidou et al., 2009). Mixed results have also been reported for functional categories associated with verbs, like tense, aspect, agreement and mood. Some studies report unimpaired performance in tense and agreement (Appell et al., 1982; Bayles, 1982; Kaprinis and Stavarakaki, 2007) while others describe difficulties in production of tense, aspect, agreement and mood (Fyndanis et al., 2013, 2018; Roumpea et al., 2019).

Fyndanis et al. (2013) found Greek-speaking mAD individuals to be impaired in production and comprehension of agreement, tense and grammatical aspect in a sentence-completion task and a grammaticality judgment task. Grammatical aspect was found to be more impaired than tense and agreement both in production and grammaticality judgment. The authors attributed this finding to the higher processing demands of grammatical aspect which requires the integration of both grammatical and conceptual information (following Kok et al., 2007). Moreover, a difference between perfective (*I broke*) and imperfective (*I was breaking*) emerged, with imperfective being significantly more impaired contra to the suggestion that unmarked values are better preserved than marked values (Lapointe, 1985). In a pilot study, Roumpea et al. (2019) examined perfective and imperfective grammatical aspect in MCI and AD. The authors predicted that the different features of perfective and imperfective (see section Grammatical Aspect) would affect participants' choice leading to a better performance on perfective given that its semantic and temporal features might make it less complex and easier to process compared to the imperfective. More specifically, imperfective aspect (*I was building*) presents the situation as an event that lasts in time and consists of different phases. In other words, it encodes an event that has duration as well as internal structure. This means that whenever AD and MCI individuals want to present an event in an imperfective way, they first have to think and create in their minds a continuous process with all its stages (beginning, middle, and end) which is probably highly demanding and difficult for them. On the other hand, perfective aspect (*I built*) presents a situation as a whole, complete event with no duration and no internal structure. Thus, whenever AD and MCI individuals present an event in a perfective way, they have to create in their minds a process that has already been completed with no internal structure, which probably makes it less complex and less demanding compared to imperfective. Thus, it can result in better performance. Three MCI individuals and one mild AD individual were tested in a sentence completion

task tapping into production of grammatical aspect. Both MCI and mAD participants were found to be significantly impaired compared to controls. However, results reported no significant preference of perfective (*I broke*) over imperfective (*I was breaking*) aspect (contra Fyndanis et al., 2013). These findings suggest that grammatical aspect as a functional category is degraded, but the different semantic and temporal features of perfective (no duration, no internal structure) and imperfective (duration and internal structure) aspect do not seem to affect participants' performance.

With respect to language impairment in individuals with MCI, there exists plentiful evidence from standardized tests (for a review, see Taler and Phillips, 2008) but not much from psycholinguistic studies. Concerning word finding abilities and verbal fluency, results are controversial. Some studies report no impairment (e.g., Albert et al., 2007), while others found word generation and retrieval process to be compromised in both phonemic and category verbal fluency tasks (Demetriou and Holtzer, 2017). MCI patients were, also, found to have difficulties in recalling and producing verbs in a verb fluency task (Alegret et al., 2018). Concerning morphological knowledge and syntactic structure, studies reveal controversial findings with MCI individuals either being impaired (Lambon Ralph et al., 2003) or performing equally well with the control group (e.g., de Jager et al., 2003). In a recent study, Manouilidou et al. (2016) examined MCI individuals' abilities to detect morphological violations in an off-line grammaticality judgment task and an on-line lexical-decision task. Results revealed that patients' structural knowledge was not affected but processing morphological structure was impaired especially in the lexical-decision task due to time pressure. Also, functional categories, such as grammatical aspect, have also been found impaired (Roumpea et al., 2019).

MCI individuals' language difficulties have been attributed to impairments in episodic, working (Summers and Saunders, 2012) and semantic memory (Wilson et al., 2011), processing speed limitations, impaired attention and executive dysfunction (Summers and Saunders, 2012). Duong et al. (2006), by employing the Stroop picture naming task, suggested that MCI patients' performance might be affected by the type of task they are asked to perform and not only by their language abilities. Increased task complexity might lead MCI patients to a low performance, indicating that impaired executive functions can also interfere with language processing. In a similar vein, Manouilidou et al. (2016) found strong correlations between executive dysfunction in MCI and impaired language performance.

Language impairment in functional categories, such as tense and grammatical aspect, has been the focus of studies dealing not only with MCI or AD, but with aphasic populations too. Dragoy and Bastiaanse (2013) examined tense reference (past, present and future) and aspect (perfective and imperfective) in the Russian version of the Test of Assessment of Time reference. They report that non-fluent and fluent aphasic Russian-speakers are better on producing past-reference, especially in perfective context (compared to imperfective), and non-past reference in imperfective context (compared to perfective). The authors

explained these findings in terms of prototypical matches between tense and aspect semantics. Imperfective verbs are prototypically used to refer to on-going events, thus, non-past tenses (present, future), while perfective ones prototypically describe completed events, thus past tenses. Also, Koukoulioti (2013) examined aspect in Greek-speaking individuals with semantic dementia and observed an interaction with verbal telicity. That is, in present tense (always imperfective in Greek), unaccusative verbs (telic) yielded worse performance than unergatives (atelic), a difference which was not observed in the past tense. Dragoy and Bastiaanse's (2013) findings were not supported by Fyndanis and Themistocleous (2019) who provided evidence from Greek-speaking aphasic and healthy participants. Tense and aspect reference were examined in a sentence-completion task. Both aphasic and healthy participants performed comparably on past and future reference independently of aspectual context. Furthermore, no dissociation between perfective and imperfective aspect was found and no interaction emerged between aspect and time reference in both aphasic and healthy participants.

Taking into account the few studies on functional and lexical categories associated with verbs, as well as the existing contradictory results, the present research aims to further investigate Greek-speaking mAD and MCI individuals' ability to produce verbs that vary with respect to their grammatical and lexical aspect. In particular, we investigated how the different temporal and semantic features of these categories would affect patients' language performance. An interaction between grammatical and lexical aspect was expected to emerge, given that the temporal properties of lexical and grammatical aspect not always overlap. For instance, non-durative verbs, like achievements, are more naturally expressed in perfective aspect while durative verbs are more naturally expressed in imperfective aspect (see section Lexical Aspect). To our knowledge this study is the first attempt to examine whether these two types of aspect interact and how this could interfere with language processing in Greek pathological populations. Finally, we also examined our results with respect to time reference and its interaction with grammatical aspect, an issue mainly investigated in aphasic populations.

## LINGUISTIC BACKGROUND

### Grammatical Aspect

Grammatical aspect is considered to be a functional category (Chomsky, 1995, 2000, 2001) which conveys information about time and it is often confused with tense. In fact, tense refers to *when* a situation takes place and relates it usually with the moment of speaking (past, present, future), while aspect provides information about *how* a situation takes place, or in other words about the internal temporal constituency of a situation (Comrie, 1976).

In Greek, like in other languages, grammatical aspect is overtly marked on the verb (Comrie, 1976; Holton et al., 2010; Moser, 2013). Consider, for example, the singing event in (1a) and (1b). Although both sentences refer to the past, describing an event prior to the moment of speaking, they differ regarding

**TABLE 1** | Time reference and aspect of the verb *pezo* “I play” in Greek, with the imperfective stem *pez-* and the perfective stem *peks-*.

	Perfective	Imperfective
Present	N.A.	péz-o “I play”
Past	é-peks-a “I played”	é-pez-a “I was playing”
Future	θα péks-o “I will play”	θα péz -o “I will be playing”

how the event pertains to the past (progressively or non-progressively). This internal difference refers to grammatical aspect and more specifically to the aspectual distinction, that is, the distinction between imperfective (1a, *τραγουδύσα* “I was singing”) and perfective (1b, *τραγύδισα* “I sang”). These two grammatical aspect values have different semantic features. Perfective aspect describes a situation-action as a whole and complete event with no duration and pays no attention to its internal phases (Comrie, 1976; Holton et al., 2010; Moser, 2013). In contrast, imperfective aspect refers to the situation as an event with duration and internal phases (beginning, middle, and end).

(1a) *Xθes, eγó τραγουδύσα, ótan to korítsi χ típise to kuδúni.*

“Yesterday, I was singing when the girl rang the bell”

(1b) *Xθes, eγó τραγύδισα δίο τραγύδja.*

“Yesterday, I sang two songs”

In Greek, time reference interacts with grammatical aspect. Perfective and imperfective are distinguished in past and future tenses, while the present tense morphologically encodes only imperfective aspect as it usually refers to a situation happening simultaneously with the moment of speaking and as such it cannot form perfective aspect (Comrie, 1976; Holton et al., 2010; Moser, 2013). **Table 1** illustrates the interaction of time reference and aspect in Greek.

## Lexical Aspect

Lexical aspect is a semantic category inherent to the verb (Comrie, 1976; Smith, 1997; Moser, 2013). Verbs are divided into five categories with different semantic and temporal features: activities (*run*), accomplishments (*build*), semelfactives (*hit*), achievements (*break*) and states (*know*) (Smith, 1997).

Activity and accomplishment verbs share some temporal features, but they differ with respect to their end point. Both activities and accomplishments are durative, describing processes which last in time and, dynamic, which means that they are subject to an input of motion and involve change (Comrie, 1976). These verbs have internal structure as they are not homogeneous processes (Comrie, 1976; Smith, 1997). Consider a “*running*” (activity) event and a “*building*” (accomplishment) event. In both processes there is a necessary change of state as they evolve. When someone runs, there are moments that one foot is on the ground, the other one is not and so on (Comrie, 1976). Similarly, during the process of “*building*” there are different successive phases in which the process advances to its end point. The difference between activities and accomplishments is on the feature of telicity (Smith, 1997). Activities do not have a natural

end point in which they complete (atelic), while accomplishments are processes with a natural final endpoint (telic) and when they reach this outcome, they are complete and no longer continue.

Concerning semelfactive and achievement verbs, they are dynamic and instantaneous, describing single-stage events, which occur very quickly and cannot be associated with the notion of duration (Smith, 1997). Examining the events of “*coughing*,” “*I coughed*” (semelfactive), and “*breaking*,” “*I broke the vase*” (achievement), we observe that “*coughing*” has no result or outcome, while “*breaking*” leads to a change of state, which is not, however, part of the event. Thus, semelfactives are atelic, while achievements are telic. Also, both semelfactives and achievements lack internal structure as they refer to dynamic situations as a single complete whole (Comrie, 1976). State verbs, on the other hand, are static and durative, and as such they refer to situations that are stable and last either for a moment or an interval (Smith, 1997). State verbs still retain the property of duration, even in cases that they last for a moment. Consider the sentence “*The temperature is ninety and rising*” [as mentioned in Smith (1997)], where the state (*temperature is ninety*) has short duration. This sentence, according to Smith (1997), is true as there is a minimal period where the state (*temperature is ninety*) remains and then there has to be a change of state (*temperature rising*). Finally, state verbs do not have internal structure, as they consist of undifferentiated stages (Comrie, 1976; Smith, 1997). For example, in the sentence “*I know how to write*,” all phases of “*know*,” whenever we choose to examine them, are going to be identical.

Based on their temporal features, verbs appear more commonly either in their perfective or in their imperfective form. Instantaneous verbs which do not last in time do not commonly appear in their imperfective form (Comrie, 1976; Moser, 2013). Thus, achievement and semelfactive verbs might appear more in their perfective aspect as instantaneous verbs without duration. As far as state verbs are concerned, they are likely to appear more in the imperfective aspect as they describe a stable situation, without alternations in time (Moser, 2013). Similarly, activity and accomplishment verbs might appear more in the imperfective aspect as verbs describing processes with duration (Comrie, 1976). **Table 2** summarizes the main features of each verb category by using examples from Greek.

## RESEARCH QUESTIONS AND PREDICTIONS OF THE CURRENT STUDY

In the current study, we seek new evidence regarding the production and comprehension of grammatical and lexical aspect in mAD and MCI and how the two might interact or how performance on lexical aspect might significantly predict performance on grammatical aspect. In this section, we outline our predictions with a particular focus on the role of duration which is a feature found in both lexical and grammatical aspect.

Our prediction about *grammatical* aspect is that it will be impaired in both MCI and mAD participants, similarly to our previous study (Roumpea et al., 2019). With respect to the distinction between perfective and imperfective, if indeed

**TABLE 2** | Summary of verb categories in lexical aspect together with their temporal features and examples in Greek.

Lexical aspect	Durative	Dynamic	Instantaneous	Stable	Telic	Atelic	Verb example
Activity	+	+	-	-	-	+	τρέχο "run"
Accomplishment	+	+	-	-	+	-	χτίζο "build"
Semelfactive	-	+	+	-	-	+	χτίπáo "hit"
State	+	-	-	+	-	-	κséro "know"
Achievement	-	+	+	-	+	-	spáo "break"

*duration* is a decisive factor when processing aspect, then we expect participants to perform better on perfective (*I broke*) than imperfective aspect (*I was breaking*), even though the former is the marked value in Greek. Finally, it seems possible that grammatical aspect will interact with time reference, that is we hypothesize that tense will predict grammatical aspect, leading participants to perform better on perfective aspect within a past context and better on imperfective aspect within a future context. While this assumption is supported by evidence from Russian-speaking individuals with aphasia (Dragoy and Bastiaanse, 2013) but not by evidence from Greek-speaking individuals with aphasia (Fyndanis and Themistocleous, 2019) there is no evidence coming from any language about AD and MCI individuals, highlighting the contribution of the current study.

When it comes to *lexical aspect*, impaired recall and verb naming is expected in general, based on evidence provided by previous studies (Druks et al., 2006; Alegret et al., 2018). With respect to the different verb categories (activities, accomplishments, states, semelfactives, and achievements) our predictions are based on what we know about grammatical aspect, given that there are no studies dealing with lexical aspect in neurodegenerative conditions. Therefore, given that imperfectivity was found to pose more difficulties for participants, we can also assume that the feature of duration, as a lexical variable, will interfere with participants' performance. In other words, we would expect lower performance in inherently durative verbs. Thus, achievements (*break*) and semelfactives (*hit*) are expected to be better preserved as they describe instantaneous events, which lack duration and internal structure. On the other hand, activities (*run*), states (*know*), and accomplishments (*build*) are temporally more complex as they describe processes or events with duration and internal structure. They can be perceived as on-going and continuous events and as such they might be more demanding in terms of processing for MCI and mAD participants compared to instantaneous verbs.

Of particular interest is the possibility of an interaction between grammatical and lexical aspect given that they both convey temporal information which might not always be on a par. Namely, participants might have difficulties in attributing durative meanings to instantaneous verbs (achievement "*break*," semelfactive "*hit*"), in other words, in selecting imperfective aspect for these verb categories. In contrast, perfective forms could be favored even in contexts where the right form is the imperfective. Similarly, although activity (*run*), state (*know*) and accomplishment (*build*) verbs, appear mainly in imperfective forms (Comrie, 1976), a better performance

on the perfective might be expected, if processing duration poses difficulties.

Before launching into a description of the current investigation, it is important to situate it within the "Words in the World" scope and discuss the essential role *aspect* plays in communication. As situations unfold in time, their accurate temporal description plays a key role in our understanding. There are many ways languages of the world convey such temporal information but it is mostly through tense which specifies the location of an event in time. Whether an event has taken place in the past or will take place in the future constitutes an objective, undeniable fact which leaves each speaker with no personal choice. The correct choice of tense guarantees accuracy in communication.

Apart from accuracy, languages also express subjectivity through temporal expressions and this is mainly done through *aspect*. Aspectual information encodes the viewpoint of the speaker on a particular situation. It reflects the speaker's subjective choice to see an event as a whole, in its totality (by choosing perfectivity) or as it unfolds in time (by choosing imperfectivity). The event remains the same but what aspect does is that it adds an additional dimension to it which is bound by the speaker's perspective. Even though this is extralinguistic, subjective information, it is encoded in languages of the world in a variety of ways. Thus, expressing *aspect* requires an extra effort of combining linguistic with extra-linguistic information, a process which becomes fairly demanding for people with cognitive decline.

The interaction of the two, *tense* and *aspect* has already been examined in pathological populations (see references above). What has not been examined yet is their interaction with *lexical aspect* as well. Lexical aspect of a verb provides a sort of guide as to how to regulate tense and grammatical aspect. That is, imperfective grammatical aspect takes an internal view of an event and as such it is compatible with durative predicates of activities and accomplishments as it is congruent with progressive meaning. Similarly, perfective aspect is compatible with achievements given that their inherent lack of duration. Having said that, languages do allow combinations of perfective aspect and durative verbs (*she built a house*) as well as combinations of imperfective aspect and non-durative predicates (*as she was reaching the peak*). Such cases of incompatibility can be proven especially challenging for populations with cognitive decline, such as MCI and AD. The source of this incompatibility is not linguistic in nature, but it is very often encoded in languages.

The challenge of all this lies in the combination of linguistic with extra-linguistic information which heavily affects the processing of these forms by patients with cognitive decline. Additionally, the significant theory of mind deficit that patients with AD present (Moreau et al., 2016) makes it particularly challenging for them to attribute knowledge to their interlocutor in a real social interaction and detect perspectives that are different from their own. Thus, cases of incompatibility in terms of aspectual (grammatical and lexical) and temporal information can turn out to be very problematic. Therefore, a deeper understanding of the nature of the impairment in AD is very crucial given its essential role in communication and its special nature of bridging linguistic with extra-linguistic knowledge.

Related to this is the fact that languages mark tense and aspect in different ways. For instance, in English, grammatical aspect is encoded in auxiliaries and inflections (*I walked* vs. *I was walking*) while in Greek inflectional suffixes, infixes as well as stem changes denote a change in aspect (*e-graf-a* vs. *e-grap-s-a*). Cross-linguistic differences of this sort suggest that not only the conceptual knowledge, usage and perception of aspect might pose a problem for populations with cognitive decline but also its realization in specific languages. Taken all this together, the current contribution to “Words in the World” aims to highlight the multi-dimensional complexity of words, such as Greek verbs, in conveying subtle meanings which are encoded in standard linguistic tools, such as morphemes, and which might interact in various ways with the roots they attach to and with the sentential environment they appear in.

## METHODOLOGY

### Participants

Nine individuals with no neurological impairments (three males, six females, aged 70–85, MEAN: 79.5), 11 MCI (five males, six females, aged 65–84, MEAN: 73.8), and 11 mAD (five males, six females, aged 73–84, MEAN: 78), all native Greek-speakers, participated in the study. Participants were recruited from the Center of Physical Medicine and Rehabilitation in the area of Ioannina, Day Care Institution in the area of Ioannina and Larisa, and from the Laboratory of Logopathology of Technological Educational Institute of Epirus, in Greece. All were diagnosed by a qualified neurologist (GN).

The diagnosis of MCI was made in accordance with Petersen’s criteria (Petersen et al., 2013). According to Petersen et al. (2013), the diagnostic criteria of MCI are: (1) memory complaints, (2) intact activities of daily living, (3) a score of 1.5 SD below the mean on neuropsychological measures (which is considered to be the standard cut-off point between healthy subjects and subjects with cognitive deficits), (4) Clinical Dementia Rating (CDR) from 0 to 0.5, (5) no dementia, (6) impairment in at least one cognitive domain (e.g., complex attention, executive function, learning, memory), and (7) general cognitive function (MoCa score from 20 to 25).

Regarding mAD, participants were included in the study if they fulfilled the following criteria: (1) a diagnosis of AD according to the National Institute of Neurological and Communicative Disorders and Stroke and the

Alzheimer’s and Related Disorders Association (NINCDS-ADRDA), (2) Clinical Dementia Rating (CDR) score = 1, (3) impairment in at least two cognitive domains (e.g., complex attention, executive function, learning, memory), and (4) general cognitive function (MoCA score from 14 to 20).

Neuropsychological examination revealed that patients did not suffer from any other (1) major psychiatric disorders (e.g., psychotic symptoms or disorders, alcohol or illegal drug abuse, depression), (2) neurological disorder (e.g., stroke, epilepsy, traumatic brain injury), and (3) visual/hearing impairment or writing/reading disability sufficient to impair performance in the assessment.

All participants had undergone clinical neurological assessment, blood tests and brain magnetic resonance imaging scans that presented no evidence of other diseases. To collect more information about the cognitive, functional and linguistic profile of the participants, we administrated additional neuropsychological tasks, translated and adapted versions for Greek. MoCA test (Nasreddine et al., 2005) was conducted to detect cognitive decline (working memory, repetition, audiovisual skills, etc.). To measure participants’ attention, speed of processing and executive functions (task switching, ability to execute and modify a plan of action, ability to maintain two trails of thought simultaneously) the Trail Making tests (part A and part B) (Reitan and Wolfson, 1993) were used. Attention span and working memory capacity were evaluated with the Forward and Backward Digit Span (Sattler and Ryan, 2009; Holdnack, 2019). Language abilities were tested by a verbal fluency semantic task. The Boston Naming Test (Kaplan et al., 1983) was used to measure participants’ naming abilities. Participants performed below the expected score in most of the tasks, suggesting the presence of cognitive dysfunction. Independent samples *t*-tests and Mann-Whitney test revealed that participants did not differ significantly in terms of mean age and education. Significant differences between the groups emerged in MoCA, Verbal Fluency Semantic task and Trail Making Test (part A) suggesting differences between MCI and mAD groups in cognitive decline, executive function and language abilities. In all other cognitive measurements no difference in their performance was observed. Participants’ demographic and neuropsychological information, as well as statistical comparisons are presented in **Table 3**.

### Experimental Tasks

A picture-naming task and a sentence-completion task were conducted. We scored correct responses, calculated percentages and also performed error analyses.

#### Naming Task Design

For the naming task 100 colored pictures were gathered from online sources. There were 20 pictures for each verb category (activity, accomplishment, state, semelfactive, and achievement). In order to avoid visual complexity that could affect participants’ performance we only used pictures that depict one or maximum two people for all the five verb categories. Moreover, no background actions or objects, that could disorient participants,

**TABLE 3** | Participants' demographic and neuropsychological mean scores (with standard deviations) and their statistical comparisons by using *t*-tests (for normally distributed data) and Mann-Whitney tests (for not normally-distributed data).

	MCI	mAD	Control group	MCI vs. mAD	mAD vs. Control group	MCI vs. Control group
Mean age	73.8	78	79.5	$t = -1.832$ $p = 0.082$ $df = 20$	$t = -0.675$ $p = 0.508$ $df = 18$	$t = -2.06$ , $p = 0.054$ $df = 18$
Education	8.4 (3.0)	9.6 (3.7)	6.7 (1.5)	$U = 50$ $p = 0.458$ $r = 0.16$	$U = 28$ $p = 0.065$ $r = 0.41$	$U = 35$ $p = 0.195$ $r = 0.33$
				<b>Statistical comparisons</b>		
MoCA	22.0 (1.1)	17.0 (1.4)	$U = 0$ , $p < 0.01$ $r = 0.85$			
Boston Naming	13.6 (1.2)	12.3 (1.8)	$t = -1.905$ $p = 0.071$ $df = 20$			
Verbal Fluency Semantic	32.9 (9.4)	23.7 (8.7)	$t = -2.360$ $p = 0.029$ $df = 20$			
TMTa	108.1 (36.6)	171.4 (55.4)	$t = 3.158$ $p < 0.01$ $df = 20$			
TMTb	266.6 (52.4)	290.9 (30.1)	$U = 86$ $p = 0.065$ $r = 0.40$			
Backward digit span	5.9 (0.94)	5.9 (1.9)	$U = 53.5$ $p = 0.638$ $r = 0.10$			
Forward digit span	4.2 (1.0)	3.7 (1.1)	$U = 38.5$ $p = 0.133$ $r = 0.32$			

were illustrated. Also, four graduate students performed the task before the experimental groups of participants, in order to ensure that the pictures were recognized easily. We used Microsoft PowerPoint to present each picture separately to the participants.

### Sentence-Completion Task

The sentence-completion task included 100 source sentences (SS) and target sentences (TS) pairs: 50 sentences were designed to test perfective aspect and 50 imperfective aspect. For each verb category (activity, state, achievement, semelfactive, and accomplishment) 20 pairs of sentences were constructed, 10 targeted the perfective aspect and 10 the imperfective. Only past and future tenses were used for the sentences with the majority of them being in past tense [79 past (38 imperfective, 41 perfective), 21 future (12 imperfective, nine perfective)]. Concerning time reference, past and future were distributed in the five verb categories as follows: activities (past 13, future seven), accomplishments (past 13, future seven), achievements (past 15, future five), states (past 19, future one), semelfactives (past 19, future 1). (2) and (3) are examples of perfective and imperfective aspect, respectively.

(2)SS: *Ávrio, i María tha potízi ton cípo óli méra.*

“Tomorrow, Maria will be watering<sub>3rd imperfective</sub> all day”

TS: *Ávrio, i María tha potísi ton cípo mésa se mía óra.*

“Tomorrow, Maria will water<sub>3rd perfective</sub> the garden within an hour”

(3)SS: *Xθes, to pedí djávase mésa se mía óra.*

“Yesterday, the child studied<sub>3rd perfective</sub> within an hour.”

TS: *Xθes, to pedí djávaze epí mía óra.*

“Yesterday, the child was studying<sub>3rd imperfective</sub> for an hour.”

### Stimuli

The same 100 verbs were used in both tasks (see **Appendix**). Materials were split in two lists (List 1 and List 2) for counterbalancing purposes and also to ease and shorten the tasks in order to make them more suitable for brain-damaged participants. Each list contained 50 verbs (10 per lexical aspect verb category). Verbs were matched for number of syllables and number of letters by performing a *t*-test of independent samples ( $p > 0.05$ , in all comparisons). Frequency and argument structure were also taken into account and matched when possible. Concerning frequency, a *t*-test of independent samples revealed that state verbs were more frequent compared to semelfactives ( $t = -3.881$ ,  $p < 0.01$ ,  $d = 1.22$ ), achievements ( $t = -2.355$ ,  $p = 0.024$ ,  $d = 0.74$ ) and accomplishments ( $t = -4.544$ ,  $p < 0.01$ ,

$d = 1.43$ ). Activities were more frequent than accomplishments ( $t = -2.117$ ,  $p = 0.041$ ,  $d = 0.68$ ). All other verb categories were matched for frequency as well. In terms of argument structure, with the exception of state verbs and semelfactives, there is no difference between accomplishment, achievement and activity verbs. More specifically, all accomplishment (20) and all achievement (20) verbs were transitive, which means that they require at least two arguments (subject and object) to predicate their semantic and syntactic properties. Concerning activity verbs, 17 of the 20 verbs were transitive and the rest were intransitive. State verbs only included intransitive verbs, while semelfactives consisted of 11 intransitive verbs and 9 transitive verbs.

### Imageability Ratings

Data for imageability and age of acquisition were collected by creating web-based questionnaires (Google forms). We collected data from 24 participants (eight males, 16 females), all native Greek-speakers, aged 18–35, University graduates, some with postgraduate degrees. The data were obtained following the instructions by Paivio et al. (1968), as they were presented in Rofes et al. (2018). Participants were instructed to rate a list of 100 words with respect to the ease or difficulty with which they arouse mental images based on their estimation. A 7-point scale was used, with one indicating low imageability rating, while seven indicating high imageability rating. Values of 2–6 indicated intermediate ratings. Statistical analysis (non-parametric Mann-Whitney test of two independent variables) revealed that activity verbs were rated significantly higher in terms of imageability, compared to all the other categories (activities vs. achievements:  $U = 69.5$ ,  $p < 0.01$ ,  $r = 0.55$ ; activities vs. states:  $U = 83$ ,  $p < 0.01$ ,  $r = 0.50$ ; activities vs. accomplishments:  $U = 85$ ,  $p < 0.01$ ,  $r = 0.49$ ; activities vs. semelfactives:  $U = 108.5$ ,  $p < 0.01$ ,  $r = 0.39$ ). Accomplishment verbs were rated significantly higher only compared to state verbs ( $U = 94$ ,  $p < 0.01$ ,  $r = 0.45$ ). Achievements did not differ significantly in terms of imageability compared to states and semelfactives ( $p > 0.05$  in all comparisons), with the latter being statistically higher compared to states ( $U = 118$ ,  $p = 0.026$ ,  $r = 0.35$ ).

### Age of Acquisition Ratings

We collected data from 28 participants (eight males, 20 females), all native Greek-speakers, aged 18–35, University graduates, some with postgraduate degrees. The data were obtained following the instructions by Dimitropoulou et al. (2009), as they were presented in Łuniewska et al. (2016). Participants were instructed to give an estimate of the age at which they thought they learned each of the 100 words in its written or oral form. A 5-point scale was used, with each number indicating the following age-bands: (1) 0–3 years, (2) 4–6 years, (3) 7–9 years, (4) 10–12 years and (5) at 13 years or later. Statistical analysis (non-parametric Mann-Whitney test of two independent variables) revealed no significant differences among verb categories ( $p > 0.05$  in all comparisons), except for semelfactives which were acquired earlier compared to accomplishments ( $U = 108$ ,  $p < 0.01$ ,  $r = 0.25$ ).

## Procedure

The two lists were randomly assigned to participants and each participant was assigned one list only. Testing was completed in one session and it lasted approximately 20–25 min. The two tasks were presented to the participants in fixed order (picture-naming first followed by sentence completion) with a break in between.

### Picture-Naming Task

Thirteen participants (5 MCI and 8 mAD) were examined on List 1 and 9 (6 MCI and 3 mAD) on List 2. PowerPoint was used to present each picture separately to the participants. Participants had to name the verb, which described the illustrated event by producing the 1st person singular of present tense. Instructions on how to complete the experimental task were provided at the beginning of the procedure. Four pictures that were not included in the stimuli were presented to participants in order to familiarize them with the task. Participants' responses during the trial period were not taken into account in the analysis. Participants had as much time as they needed in order to provide their answer. Each session lasted approximately 10–15 min.

### Sentence Completion Task

Thirteen participants (5 MCI and 8 mAD) were examined on List 1 and 9 (6 MCI and 3 mAD) on List 2. Experimental materials were presented cross-modally to the participants who saw them on the computer screen and also heard the experimenter reading them aloud. Participants were asked to complete the missing verb from the TS in the correct form of grammatical aspect. At the beginning of the experimental procedure, participants were provided with instructions of how to complete the task. Four pairs of sentences that were not included in the stimuli were used as examples in order familiarize participants with the procedure. Participants' responses during the trial period were not taken into account in the analysis. The task was not chronometrized and participants had as much time as they needed in order to complete each sentence. Each session lasted approximately 10–12 min.

### Scoring

For both picture-naming and sentence-completion task we performed quantitative and qualitative analyses taking into account participants' responses. This consisted of measuring percentages of correct responses as well as an error analysis in order to reveal error patterns.

In the sentence-completion task, for the quantitative analysis, we counted as correct those responses that contained the target verb in the correct aspectual form. When a mAD or an MCI participant completed a sentence using the verb in the target grammatical aspect (perfective or imperfective) but not in the correct person for the sentence to be grammatically acceptable, we considered that answer correct (e.g., *Ávrio, i María tha potízun ton cípo óli méra* "Tomorrow, Maria will be watering <sup>3rd plural imperfective</sup> the garden all day" instead of *Ávrio, i María tha potízi ton cípo óli méra* "Tomorrow, Maria will be watering <sup>3rd singular imperfective</sup> the garden all day"). Our goal was to examine participants' ability to produce the right type of grammatical aspect (perfective or imperfective) and not their ability to produce agreement. Similarly, different morphological forms of



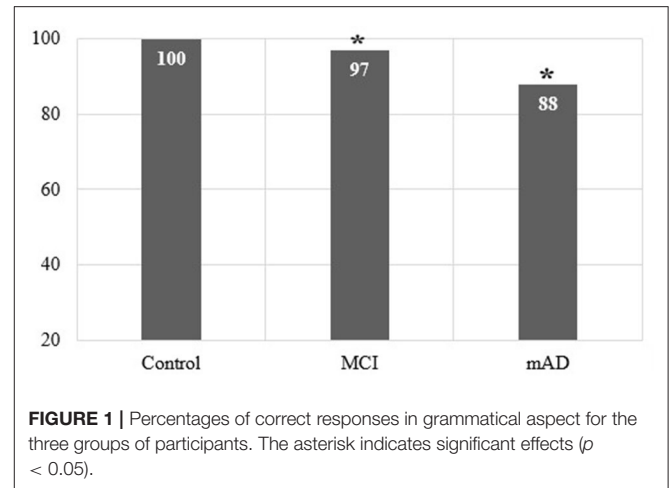
the same verb (e.g., χτίψαν “They were hitting” —χτίπαγαν “They were hitting”) that encoded the target aspectual value were taken as correct answers. Responses that contained wrong use of tense (e.g., Όταν ήμουν μικρή, εγώ ζωγραφίζω 1st singular present imperfective σινέχια “When I was young, I am drawing all the time” instead of Όταν ήμουν μικρή, εγώ ζωγράφιζα 1st singular past imperfective σινέχια “When I was young, I was drawing all the time”) were considered to be incorrect even when the aspectual characteristics of the verb were the targeted ones. For the error analysis, we checked for substitutions of aspect (e.g., perfective instead of imperfective and vice versa) as well as for time substitutions (e.g., past tense instead of future and vice versa).

In the picture-naming task, we excluded pictures that the control group did not recognize (six pictures from both List 1 and List 2 were excluded, out of which 4 depicted state verbs, one achievement verb and 1 semelfactive verb). We scored the ability of recalling and producing verbs and not the categories of agreement and tense, thus, responses that were in a different than the present tense (e.g., spáo “I break” —έσπασα “I broke”) were considered to be correct. Similarly, responses where participants used a different than the first person singular (e.g., spáme “We break” instead of spáo “I break” -) were not regarded as incorrect. Finally, we counted as correct responses that included a prefix (kliðóno “I lock” —ksekliðóno “I unlock”), provided that the produced word belonged to the same verb category and shared the same semantic and temporal features as the target, independently of change in meaning. With respect to error analysis, we checked for errors such as anomia (no response at all), responses unrelated to the target word, phonemic paraphasias and semantic paraphasias, which are common in naming tasks.

## Statistics

In both tasks, logistic regression models were used to examine how *aspect* (grammatical vs. lexical), *tense* (past vs. future) and *group of participants* (control, MCI and AD) contributed to participants’ responses (correct or wrong) and interacted with one another. When needed, additional non-parametric tasks were conducted to explore within group differences with respect to the choice of specific aspectual categories and tense.

We also performed correlation analyses by using the non-parametric Spearman rank test in order to measure the degree of association between participants’ cognitive or general language abilities (e.g., results of MoCA, Boston Naming Test etc.) and their accuracy performance on the experimental tasks (sentence-completion task, picture-naming task). Given that both AD and MCI are primarily conditions that affect general cognition (see Introduction), participants’ limited abilities might affect their accuracy in the experimental tasks. Thus, finding out whether there is an association between participants’ performance and cognitive and language abilities can provide us with additional information and help interpret our results in a more comprehensive way. Finally, additional correlation analyses were performed by using the non-parametric Spearman rank test in order to measure possible associations between the lexical properties of imageability and age of acquisition and participants’ accuracy scores in each verb category in the picture-naming task.



## Results

No difference between control group performance in List 1 and List 2 was observed in both picture-naming and sentence-completion task (naming task:  $U = 21927.5$ ,  $p > 0.05$ ,  $r = 0$ , sentence completion task:  $U = 25,000$ ,  $p > 0.05$ ,  $r = 0$ ). The same holds for the mAD group and their performance on both tasks (naming task:  $U = 26,148$ ,  $p = 0.794$ ,  $r = 0.01$ , sentence-completion task:  $U = 29,100$ ,  $p = 0.332$ ,  $r = 0.04$ ). Concerning MCI, participants who were tested on List 1 performed significantly better on the picture-naming task compared to those who were tested on List 2 ( $U = 27,570$ ,  $p < 0.01$ ,  $r = 0.20$ ), while in the sentence-completion task participants who were tested on List 2 performed better compared to those who tested on List 1 ( $U = 36,075$ ,  $p = 0.013$ ,  $r = 0.10$ ). However, based on the fact that the other two groups did not show any difference on their performance and the fact that there was no clear dissociation between List 1 and List 2 among the MCI individuals’ groups, we decided to move on an overall review of the results.

## Sentence Completion Task

Overall results are shown in **Figure 1** while the percentages of correct responses by group, tense, lexical and grammatical aspect are shown in **Table 4**.

In all analyses, a binary logistic regression was performed treating participants’ response (correct vs. incorrect) as dependent variable and *group*, *grammatical aspect*, *lexical aspect* and *tense* as predictors. The outcome is presented in **Table 5**. The results from the statistical model indicate that participants behave according to their group. That is, group is a significant predictor for their performance. The coefficient for Group (taking Controls as reference value) has a Wald statistic equal to 27.599 which is significant and the 0.001 level [ $df = 2$ ]. When performing bootstrapping, both MCI and mAD are significant predictors too. The significance of B for both the MCI group ( $-19.196$ ) and mAD ( $-17.690$ ) is  $p = 0.001$ .

There are no other statistical predictors. That is, lexical aspect ( $Wald = 0.129$ ,  $p = 0.720$ ,  $df = 1$ ), grammatical aspect ( $Wald =$

0.040,  $p = 0.841$ ,  $df = 1$ ), and tense ( $Wald = 0.001$ ,  $p = 0.975$ ,  $df = 1$ ), cannot predict participants' performance. Moreover, there is no statistically significant interaction between grammatical aspect and tense ( $Wald = 0.006$ ,  $p = 0.939$ ,  $df = 1$ ), between lexical aspect and tense ( $Wald = 0.010$ ,  $p = 0.919$ ,  $df = 1$ ), and between grammatical aspect and lexical aspect ( $Wald = 0.838$ ,  $p = 0.360$ ,  $df = 1$ ).

The model explains 17% of the variability (Nagelkerke R square = 0.178) and it correctly predicted 100% of the correct answers and 0% of the incorrect answers, giving an overall percentage of correct prediction rate of 94.8%.

Finally, we found no correlation between patients' scores in the neuropsychological tasks and their performance in

the sentence-completion. For individuals with mAD, analysis revealed the following values of no statistical significance: MoCA Rs (9) = -0.096,  $p = 0.779$ ; Boston Naming Test Rs (9) = -0.353,  $p = 0.286$ ; Verbal Fluency Semantic Task Rs (9) = -0.104,  $p = 0.761$ ; Trail Making Test (part a) Rs (9) = 0.051,  $p = 0.602$ ; Trail Making Test (part b) Rs (9) = 0.177,  $p = 0.883$ ; Backward Digit Span test Rs (9) = -0.126,  $p = 0.712$ ; Forward Digit Span test Rs (9) = -0.021,  $p = 0.950$ . Concerning the MCI groups' analysis the following values of significance were found: MoCA Rs (9) = 0.068,  $p = 0.843$ ; Boston Naming Test Rs (9) = 0.089,  $p = 0.794$ ; Verbal Fluency Semantic Task Rs (9) = 0.036,  $p = 0.916$ ; Trail Making Test (part a) Rs (9) = 0.579,  $p = 0.062$ ; Trail Making Test (part b) Rs (9) = -0.405,  $p = 0.217$ ; Backward Digit Span test Rs (9) = -0.486,  $p = 0.130$ ; Forward Digit Span test Rs (9) = -0.087;  $p = 0.799$ .

**TABLE 4 |** Percentages of correct responses by group, tense, grammatical aspect and lexical aspect in sentence completion task.

		AD	MCI
Tense	Past	87.7	97.5
	Future	89.3	95.8
Grammatical aspect	Perfective	88.5	97
	Imperfective	87.5	97.5
Lexical aspect	Activities	95.8	95.3
	Accomplishments	88	97
	Achievements	85.5	97
	Semelfactives	82.7	96
	States	90	99

### Picture-Naming Task

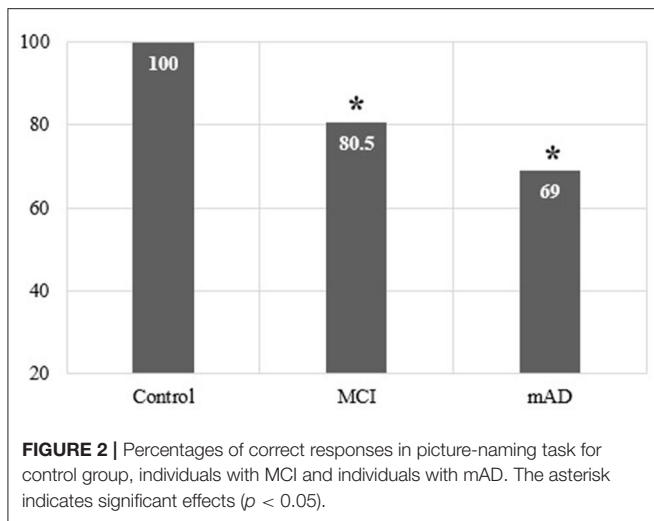
Overall results are shown in **Figure 2**, while the percentages of correct responses by group and lexical aspect are shown in **Table 6**. As with the sentence completion task, a binary logistic regression analysis was performed by using SPSS. Participants' response (correct vs. incorrect) was treated as dependent variable while *group* (controls, mAD, MCI) and *lexical aspect* (activities, accomplishments, achievements, semelfactives and states) were treated as predictors. The outcome is presented in **Table 7**.

The results from the statistical model indicate that participants behave according to their Group and according to the lexical aspect of the verb they have to name. The coefficient for Group variable (taking controls as reference value) has a Wald statistic

**TABLE 5 |** Outcome of logistic regression for sentence completion task.

		B	S.E.	Wald	df	Sig.	Exp(B)	95% CI for EXP(B)	
								Lower	Upper
<b>Variables in the equation</b>									
Step 1 <sup>a</sup>	group			27.599	2	0.000			
	Group (1)	-19.196	1888.369	0.000	1	0.992	0.000	0.000	.
	Group (2)	-17.690	1888.369	0.000	1	0.993	0.000	0.000	.
	gram.asp by lex.asp	-0.156	0.170	0.838	1	0.360	0.856	0.613	1.194
	lex.asp by tense	0.029	0.288	0.010	1	0.919	1.029	0.586	1.809
	gram.asp by tense	-0.046	0.604	0.006	1	0.939	0.955	0.292	3.120
	lex.asp	1.175	3.278	0.129	1	0.720	3.239	0.005	1998.537
	gram.asp	1.241	6.187	0.040	1	0.841	3.460	0.000	639449.570
	Tense	0.172	5.499	0.001	1	0.975	1.187	0.000	56919.279
	Constant	12.198	1889.203	0.000	1	0.995	198392.877		
<b>Bootstrap</b>									
		B	Bias	Std. error	Sig. (2-tailed)	95% confidence interval			
						Lower	Upper		
<b>Group (1)</b>		-19.196	0.003	0.137	0.001	-19.446	-18.910		
<b>Group (2)</b>		-17.690	0.043	0.264	0.001	-18.106	-17.055		

<sup>a</sup>Variable(s) entered on step 1: group, gram.asp \* lex.asp, lex.asp \* tense, gram.asp \* tense, lex.asp, gram.asp, tense. Variable coding is translated as follows: Group = control group (reference value), Group (1) = MCI, (Group 2) = mAD.



**TABLE 6 |** Percentages of correct responses by group and lexical aspect in the naming task.

	AD	MCI
Activities	82	91
Accomplishments	79	86
Achievements	49	74
Semelfactives	70.5	76
States	63	73

equal to 15.807 which is significant and the 0.001 level[ $df = 2$ ]. When performing bootstrapping, both MCI and mAD are significant predictors too. The significance of B for both the MCI group ( $-19.791$ ) and mAD ( $-20.392$ ) is  $p = 0.001$ .

Similarly, *lexical aspect* is also a statistical predictor. When taking *achievements* as reference value, *activities* and *accomplishments* yield significantly better naming (Wald = 31.351,  $p < 0.001$  and Wald = 25.502,  $p < 0.001$ , respectively), *semelfactives* yield marginally better naming (Wald = 4.026,  $p = 0.045$ ), while state verbs clearly yield worse naming than the previous categories but not compared to achievements (Wald = 1.358,  $p = 0.244$ ). No significant interaction between Group and Lexical aspect has emerged.

The model explains 27.3% of the variability (Nagelkerke R square = 0.273) and it correctly predicted 100% of the correct answers and 0% of the incorrect answers, giving an overall percentage of correct prediction rate of 82.6%.

No significant correlations between patients' scores on neuropsychological tasks and their performance in the naming task were observed. Correlation analyses for individuals with mAD revealed the following values of no statistical significance: MoCA  $R_s(9) = -0.216$ ;  $p = 0.524$ , Boston Naming Test  $R_s(9) = -0.135$ ,  $p = 0.693$ ; Verbal Fluency Semantic Task  $R_s(9) = 0.344$ ,  $p = 0.300$ ; Trail Making Test (part A)  $R_s(9) = 0.389$ ,  $p = 0.238$ ; Trail Making Test (part b)  $R_s(9) = -0.202$ ,  $p = 0.551$ ; Backward Digit Span test  $R_s(9) = -0.245$ ,  $p = 0.467$ ;

Forward Digit Span test  $R_s(9) = -0.433$ ,  $p = 0.184$ . Regarding individuals with MCI the following values of significance were found: MoCA  $R_s(9) = -0.185$ ,  $p = 0.584$ ; Boston Naming Test  $R_s(9) = -0.434$ ,  $p = 0.183$ ; Verbal Fluency Semantic Task  $R_s(9) = -0.327$ ,  $p = 0.326$ ; Trail Making Test (part A)  $R_s(9) = -0.028$ ,  $p = 0.936$ ; Trail Making Test (part b)  $R_s(9) = -0.074$ ,  $p = 0.818$ , Backward Digit Span test  $R_s(9) = 0.333$ ,  $p = 0.317$ ; Forward Digit Span test  $R_s(9) = -0.028$ ,  $p = 0.935$ . Moreover, we observed no correlation between the factors of frequency, imageability, age of acquisition and participants' performance in the picture-naming task. Specifically, for individuals with mAD a very weak negative correlation between frequency and participants' performance was observed, but it did not reach significance [ $R_s(92) = -0.127$ ,  $p = 0.222$ ]. Similarly, an insignificant very weak positive correlation between imageability and participant's score was found [ $R_s(92) = 0.156$ ,  $p = 0.132$ ]. Regarding the age of acquisition, a non-significant very weak negative correlation was observed [ $R_s(92) = -0.003$ ,  $p = 0.979$ ]. When it comes to individuals with MCI, analysis revealed the following positive or negative correlations [frequency: very weak positive correlation with no statistical significance  $R_s(92) = 0.126$ ,  $p = 0.228$ ; imageability: a weak positive correlation, which reached significance  $R_s(92) = 0.313$ ,  $p = 0.002$ ; age of acquisition: a very weak correlation, which did not reach significance  $R_s(92) = 0.168$ ,  $p = 0.106$ ].

Error analysis revealed that the most common mistake of both MCI and mAD participants (67.3 and 58.9%, respectively) were responses unrelated to the target verb (e.g., instead of *káthome "sit"* —*pézo "play"*), followed by semantic paraphasias (15.8%, and 17.3% of the cases, respectively). In the majority of semantic paraphasias, the target verb was substituted by another verb which either belonged to the same semantic category with the target (e.g., *sfugarízo "mop"* instead of *skupízo- "wipe"*) or it was connected with it by hyponymy. In the hyponymy relationship there is a hypernym word, which constitutes the general category that includes the hyponym words. Usually participants used the hypernym word (e.g., *tróo "eat"* instead of *ðagnóo "bite"*) when the target was a hyponym one. In few cases, participants used circumlocutions to name the target verb (e.g., *káno bánjo "take a swim"* instead of *kolibáo "swim"*) (7.9% MCI and 8.9% mAD). Cases where participants did not respond at all were also observed in both groups (5.9% MCI and 10.2% mAD). Finally, incorrect responses also include cases in which the target word and the answer may not necessarily belong to the same category but relate to each other based on a scenario (e.g., *nistázo "I am sleepy"* instead of *χazmurjéme "I yawn"*).

## DISCUSSION

The aim of the current investigation was to contribute to the existing literature on *aspect* and time reference in neurodegenerative conditions by providing an account that takes into consideration temporal features such as *duration*, as a dual variable, with grammatical as well as lexical instantiations. In other words, we investigated how the temporal feature of *duration* either as functional-grammatical variable or as lexical variable affects participants' performance and whether

**TABLE 7 |** Outcome of logistic regression for the naming task.

		B	S.E.	Wald	df	Sig.	Exp(B)	95% CI for EXP(B)	
								Lower	Upper
<b>Variables in the equation</b>									
Step 1 <sup>a</sup>	Group			15.807	2	0.000			
	Group (1)	-19.791	1921.475	0.000	1	0.992	0.000	0.000	.
	Group (2)	-20.392	1921.475	0.000	1	0.992	0.000	0.000	.
	Lexasp			47.300	4	0.000			
	Lexasp (1)	0.428	0.213	4.026	1	0.045	1.534	1.010	2.331
	Lexasp (2)	0.257	0.221	1.358	1	0.244	1.293	0.839	1.992
	Lexasp (3)	1.387	0.248	31.351	1	0.000	4.004	2.464	6.506
	Lexasp (4)	1.200	0.238	25.502	1	0.000	3.319	2.083	5.286
	Constant	20.623	1921.475	0.000	1	0.991	904211111.5		
<b>Bootstrap</b>									
		B	Bias	Std. error	Sig. (2-tailed)	95% confidence interval			
						Lower	Upper		
<b>Group (1)</b>		-19.791	0.004	0.116	0.001	-20.001	-19.534		
<b>Group (2)</b>		-20.392	-0.003	0.107	0.001	-20.590	-20.170		

<sup>a</sup>Variable(s) entered on step 1: group, lexasp. Variable coding is translated as follows: Group = control group (reference value), Group (1) = MCI, (Group 2) = mAD; LexAsp = achievement (reference value), LexAsp (1) = semelfactive, LexAsp (2) =state, LexAsp (3) =activity, LexAsp (4) = accomplishment.

the two interact. While clinical populations’ ability to produce grammatical aspect either under the umbrella of functional features or as an indicator of time reference has been investigated extensively, their ability to produce lexical aspect has been widely neglected. Our goal was to provide a unitary account of aspect, if possible, and address the inconsistency of previous results with respect to grammatical aspect by gaining insights from lexical aspect. To this end, we used a picture-naming and a sentence-completion task to investigate the performance of Greek-speaking mAD and MCI individuals on using and naming verbs that differ in terms of their *lexical* and *grammatical aspect*.

As far as *grammatical aspect* is concerned, previous results have been controversial with no attempt to explain this inconsistency. Our data from the sentence-completion task suggest that *grammatical aspect* is impaired in individuals with mAD and MCI and are in line with other studies with mAD participants, i.e., Altmann et al. (2001), Fyndanis et al. (2013), and Roumpea et al. (2019). With respect to MCI participants, results are in line with Roumpea et al. (2019), who reported impaired grammatical aspect in this population but at odds with de Jager et al. (2003), who found MCI participants’ syntactic abilities equally preserved as in control individuals.

A second important piece of evidence is the lack of difference between participants’ preference for perfective vs. imperfective aspect. In other words, there was no significant preponderance of perfective (*I broke*) over imperfective (*I was breaking*). This is at odds with Fyndanis et al. (2013) and also with the assumption that unmarked features (imperfective) are better preserved than the marked features (perfective) (Lapointe, 1985). In contrast, the finding suggests that grammatical aspect is generally impaired in mAD independently of markedness or of  $\pm$ duration. Thus,

the prediction that duration, as functional-grammatical feature, would affect participants’ performance leading them to prefer the perfective aspect even in imperfective contexts was not supported by the data.

When examining our results with respect to time reference, no interaction between time and grammatical aspect was found. That is, no preference of perfective over imperfective was found in past reference context and similarly no better performance was observed on imperfective in future reference context in either MCI or mAD groups. Participants performed equally well in perfective and imperfective aspect independently of the time reference context, ruling out the possibility that time reference is a factor that might interfere with participants’ ability to produce grammatical aspect and choose between perfective or imperfective aspect (contra Dragoy and Bastiaanse, 2013 and in line with Fyndanis and Themistocleous, 2019).

Finally, no interaction between grammatical and lexical aspect emerged, with patients’ performance not being affected by verb category when producing grammatical aspect. This lack of interaction suggests that the lexical aspect of the verb does not influence participants’ choice of grammatical aspect (perfective vs. imperfective). If indeed lexical aspect was a decisive factor in choosing grammatical aspect, then mismatches in term of duration (a property of both lexical and grammatical aspect) would have interferred with participants’ performance. In other words, patients would have difficulties in producing the imperfective aspect (duration) both in inherently durative verbs (e.g., activities “run”) and in verbs with instantaneous (no duration) meaning (e.g., semelfactives “hit”), a performance that was not observed in our data. The lack of interaction between lexical and

grammatical aspect in sentence completion task is indicative of the independence of the two variables which can be affected differentially in populations with semantic and cognitive decline.

Given that no significant correlations were detected with the various neuropsychological variables (see Results), we assume that degraded working memory, verbal fluency and executive dysfunction of patients of this study are not responsible for their inability to correctly produce grammatical aspect. Of course, these factors cannot entirely be excluded, especially given that the small number of participants might have prevented us from detecting potentially significant correlations. However, we cannot base our interpretation on a hypothetical possible result. Thus, we are left with the possibility that the underlying reason for participants' failure lies either in the conceptual sphere of grammatical aspect or in a difficulty to materialize the concept of grammatical aspect by constructing the corresponding morphological forms. We will explore these two possibilities in turn.

Aspect has always been considered a demanding category. It is impaired in aphasic populations as well and it is a feature which is acquired at a later stage of language acquisition as it coincides with various other cognitive developmental factors (Clark, 2009). Thus, the connection between the system of aspect and higher cognitive functions has been pointed out multiple times. The main difficulty associated with aspect is its dual status as it marks the temporal contour of events by means of inherent lexical meanings (durative vs. non-durative verbs) but also with grammatical morphology. It is exactly in the cross-road of this double status, that problems start to emerge. In the sentence completion task, we found no interaction between lexical and grammatical aspect and also no difference between perfective and imperfective which suggests that grammatical aspect *on its own and in its entirety* poses difficulties for participants. This is indicative of an event conceptualization problem. Namely, participants are not able to detect how the specific events are realized in time, that is, either as events with internal perspective that highlight the gradual development (in case of imperfective) or as events with external perspective that focus on the end state and provide a "glimpse" of the whole event (perfective). Crucial to that is also the comprehension of adverbials that were used in target sentences as well as the theory of mind deficit which is common in AD (Moreau et al., 2016) and which prevents AD individuals from identifying with the perspective of their interlocutor and in our case, the perspective surrounding the source sentences.

The second possibility follows the logic that participants can grasp the internal temporal consistency of events but they have a problem with the implementation of their choice, that is, with the creation of the correct grammatical form that describes their choice. When it comes to aspect realization in Greek, several morphophonological operations have to be performed. As mentioned in section Grammatical aspect, in order to form the perfective aspect, one needs to add the aspectual marker -s- to the verbal stem, insert the augmentative vowel *e-* and also add an inflectional suffix such as *-a* for the first person singular (e.g., líno "I solve" → éli-s-a "I solved"). Thus, it is not

impossible for individuals with mAD and MCI to have difficulties in reconstructing the morphological features connected with the expression of aspect. Even though previous studies have also discussed this possibility in light of impaired performance of tense and aspect (Bastiaanse et al., 2011; Fyndanis et al., 2013), this is an issue that calls for further investigation, especially given that mAD and MCI are not known to have serious problems with morphology itself.

Let us now discuss the results of *picture-naming task* which targeted the investigation of *lexical aspect*. MCI and mAD groups performed significantly lower than controls, with mAD being worse than MCI, suggesting that lexical aspect is impaired in both populations. These findings are in line with previous studies that report impaired recall abilities of verbs (Alegret et al., 2018) and naming difficulties (Druks et al., 2006; Masterson et al., 2007) in MCI and mAD. Despite the difference between the performance of MCI and mAD individuals, for both groups activities (*walk*) and accomplishments (*build*) were found to be better preserved compared to states (*know*), achievements (*break*) and semelfactive (*hit*) verbs. Thus, it appears that duration alone, as a lexical variable and as part of lexical representation of a verb is not a decisive factor when it comes to participants' choice. If indeed duration affected participants' performance, then either all durative verbs (states, activities, accomplishments) would have been impaired or all of them would have been better preserved.

Furthermore, correlation analyses have shown that the various psycholinguistic variables related to the stimulus set did not affect the final results with just one exception for MCI participants and high imageability of accomplishments and achievements. Specifically, the high frequency of state verbs did not lead to better performance on this category which was found to be one of the most impaired. Similarly, participants performed equally high in activities and accomplishments, even though activities were more frequent. Results were also free from any age of acquisition effects as the lack of significant correlations between participant's performance and this variable suggests. Finally, imageability did not affect the performance of mAD but there was a weak correlation between imageability and MCI participant's performance indicating that the high imageability ratings of accomplishment and activity verbs might have interfered with the results.

The fact that only *accomplishments (build)* and *activities (run)* were better preserved leads to the assumption that the key element of impaired performance in naming verbs might have to do not only with their internal duration but with the combination of duration with internal semantic complexity. Activities and accomplishments are the two types of verbs in this study which have internal structure (see section Lexical Aspect above). They both present processes that not only last in time but they also consist of different successive phases in which the processes evolve. This contrasts with *achievements (break)* which are instantaneous events with no duration and internal structure and also with states (*sleep*), which lack internal structure as they describe situations consisting of identical stages, even though they are durative. Thus, we assume that it is the combination of the semantic and temporal features of activities

and accomplishments that make them more prominent and better preserved in populations with semantic limitations, such as MCI and mAD. In general, semantic complexity has been found to affect individuals' abilities to produce verbs both in aphasia and AD (Breedin et al., 1998; Kim and Thompson, 2004). In Breedin et al. (1998) aphasic patients were found better at retrieving semantically complex verbs compared to simpler ones (e.g., heavy verbs "run" vs. light verbs "go,". specific verbs "wipe" vs. general verbs "clean"). The authors argued that semantically complex verbs (e.g., *run*, *wipe*) contain rich semantic features that make their meaning more specific and thus they are more distinctive and easier to recall compared to semantically simpler verbs. This explains very nicely the pattern we have found in the current investigation.

To sum up, apart from contributing data about grammatical and lexical aspect in neurodegenerative diseases, the current study also aimed to look at aspect at the big picture possibly as a unified category (lexical + grammatical) associated with the temporal dimension of events. Our findings do not provide grounds for a unified account of aspect. In contrast, they strongly suggest the independence of the two subsystems, lexical and grammatical. In the heart of this argument is the temporal feature of duration which has a different effect depending on whether it is processed as a lexical feature or as a functional feature. That is, as a lexical feature, combined with internal structure, duration has a positive effect in increasing the verb's saliency, thus, making it easier for retrieval. As a functional feature encoded in grammatical aspect, duration does not seem to play any decisive role in participants' performance, leaving them in the dark when it comes to the choice between perfective and imperfective. This leaves open the possibility that the observed performance of mAD and MCI participants could be related to difficulties with formulating the morphological forms that encode perfective and imperfective aspect, something which is not necessary for the production of lexical aspect. Or it is indicative of a general inability to comprehend and integrate aspectual information in a sentence. Whatever the underlying reason might be, what we learned from the current study is that grammatical aspect in its essence can be impaired in neurodegeneration and this is independent of any other factors. Any claims, of course, should take into account the limitations of the current study, such as the variables that were not possible to control for that might have affected participants' performance.

Last but not least, we would like to emphasize the importance of studies that provide linguistic evidence from populations with cognitive decline, like MCI and mAD. An accurate description of patients' linguistic performance is a pivotal first step in securing appropriate intervention processes. As our knowledge from neurolinguistic research advances, data-driven intervention programs are becoming a necessity and nowadays are also becoming a reality. Similarly, diagnostic tools have slowly started incorporating evidence from linguistically informed studies. There is still a long way to go, but it is the only way we could possibly secure precise diagnosis and appropriate intervention. This is particularly important for populations who speak understudied languages. In these cases, the majority of diagnostic

and intervention tools is mostly adaptations or even direct translations from tools created for English-speaking populations. As a result, crucial features of any specific language which differ from English are often not taken into account. The current study, with its limitations notwithstanding, falls into this scope of providing additional evidence about subtle linguistic features for Greek-speaking populations which are often neglected by both diagnostic and intervening tools. As such, it offers a ground for its use for clinical purposes as well.

## DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

## ETHICS STATEMENT

The research protocol was approved by the Ethics Committee of the Medical School of Larissa, University of Thessaly, and it was conducted in accordance with the principles of the Declaration of Helsinki. Written consent was obtained from all the participants (or their caregivers) after having been informed of the nature of the study they would take part in. However, when it comes to the participants from the Center of Physical Medicine and Rehabilitation in the area of Ioannina, the experimental tasks were conducted as part of their other daily activities and after being informed about the nature of the study they gave their oral consent.

## AUTHOR CONTRIBUTIONS

CM conceived the project, designed the experiments, supervised the whole process from data collection, and analysis to interpretation. She also wrote the final version of the manuscript. GR was responsible for reviewing the literature on theoretical background and background research, conducting the experimental tasks to healthy individuals, analyzing the data, and writing the first draft of the manuscript. CM and GR were responsible for all revisions after the first round of reviewing. AN was responsible for collecting the data and conducting the experimental tasks to MCI and AD participants. SS provided feedback and comments concerning the analysis and the writing of the manuscript. GN identified the participants, performed the clinical diagnosis, and classified them to MCI and AD groups. All authors contributed to the article and approved the submitted version.

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## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fcomm.2020.434106/full#supplementary-material>

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**Conflict of Interest:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The reviewer, VF, declared to the editor a co-authorship with one of the author GN, which occurred after their participation in this review process had been completed.

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