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1 **Effect of a cat's permanent presence on the health and social network of older**
2 **adults with Alzheimer's disease or disabilities in a nursing home**

3
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30

31 **Ethical Statement:** *Ethics approval*

32 Our study was approved by the management of the Centre Féron-Vrau at the Université Catholique
33 de Lille (France), comprising 5 nursing homes, including Saint-Antoine de Padoue nursing home.
34 This approval is based on a similar methodology to a research project to be carried out in 2021 at
35 the Université de Strasbourg (UNISTRA/CER/2021-10).
36

37 **Credit authorship contribution statement**

38 Héloïse Vesque-Annear: Conceptualization, methodology, investigation, writing, review & editing

39 Cédric Sueur: Conceptualization, methodology, original draft, supervision, review & editing

40 Marine Grandgeorge: Conceptualization, methodology, supervision, review & editing

41 Angélique Stachowiak: Investigation

42 Marie Pelé: Conceptualization, methodology, original draft, supervision, review & editing, funding
43 acquisition
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48 de Lille.

49 **Effect of a cat’s permanent presence on the health and social network of**
50 **older adults with Alzheimer's disease or disabilities in a nursing home**

51 **Abstract:** Our study analyzes the effects of the permanent presence of cats on the health and
52 social network of residents with pathologies in nursing home. Fifty-three residents, thirty-six
53 caregivers and four cats in three Alzheimer’s Disease units (“ADU”) and one Disability unit
54 (“DISU”) were observed for 180 hours. Social networks were created via instantaneous
55 sampling of physical proximities and social exchanges between residents, caregivers and the
56 cats. Our results showed that: 1) the four units behave similarly in the presence or absence of
57 a cat 2) cats are placed at the periphery of the network and interact with residents showing a
58 keen interest in them and 3) caregivers who are in strong contact with the cat show a greater
59 number of social interactions in their unit. This study, using for the first time a social network
60 approach, opens up a new field of understanding of human-animal relationships in a care
61 dimension.

62 **Keywords:** cat, social interaction, nursing home, older adults, Alzheimer, disability

63

What this paper adds

- This study makes a significant contribution to public health research by addressing various aspects related to the permanent presence of cats in a nursing home. It offers valuable insights into the determinants of health, quality of life, social interactions, research methodology and ethics, thereby strengthening the field of public health in the context of institutional care for older adults.
- By focusing on the impact of the presence of animals on residents with Alzheimer's versus disabled residents, the study stands out for its recognition of the diversity of needs within the institutional population, and reflects a move towards more personalized care.

Applications of study findings

- This study explores the impact of pets in a nursing home on the health of older residents, enriching research in geriatrics and gerontology. In addition, it also analyzes social networks within living units, offering insights into relational dynamics, with potential implications for quality of care.
- Finally, this study has significant potential in the fields of geriatrics, psychology, sociology and ethology with potential impacts on institution practices and the quality of life of older residents.

64

65 Introduction

66 In France, Alzheimer's disease affects more than a million people, and the first
67 symptoms, correlated with aging, appear around age 60 (Institut Pasteur de Lille, 2020).
68 According to the French Health Authority (FHA), it has become the leading cause of
69 institutionalization (e.g. nursing homes). Unfortunately, the treatments currently being
70 developed only reduce the physical symptoms of the disease without halting its progression,
71 demonstrating the limited effectiveness of pharmacological therapies. The FHA (2011) has
72 recommended using non-pharmacological therapies as a complement to treat and prevent the
73 onset of health problems. Among the recognized non-pharmacological therapies is animal-
74 assisted intervention (AAI). These interventions are defined as having directed objectives
75 where the animal is intentionally present to act in the health, educational and social fields with
76 the aim of bringing therapeutic effects to the beneficiary (IAHAIO, 2015).

77 The social environment of older people is often perceived as only human (family,
78 friends, caregivers) although pets (dogs, cats or even exotic animals) are also an integral part
79 of people's social networks (Kohler, 2011). At the same time, the positive effects of AAI on
80 physical, psychological or emotional well-being have been highlighted in the literature

81 (Santaniello et al., 2020; Forget, 2021). Notably, in older adults with or without Alzheimer's
82 disease, interaction with animals brings a reduction in behavioral disorders (agitation,
83 aggression) and mood disorders (anxiety, apathy and depression) (Tomaszewska et al., 2017).
84 One of the benefits observed in elderly people with dementia is the ability to create social links
85 in the presence of the animal, which acts as a social 'lubricant' (McNicholas & Collis, 2000).
86 Indeed, the animal facilitates social contact (conversations, smiles, gestures) (Forget, 2021)
87 and can stimulate cognitive and sensory functions (memory and communication). The presence
88 of the animal also brings benefits to the psychosocial sphere, as it satisfies attention and
89 feelings of affection (Majić et al., 2013; Santaniello et al., 2020).

90 In nursing homes, the presence of animals can stimulate conversation and increase
91 residents' responsiveness, while making them feel "at home" increasing social interaction and
92 helping people to relate better to others (Foster, 2005). The animal's presence thus benefits not
93 only the quality of life of residents, but also that of caregivers; indeed, the presence of an animal
94 reduces the impact of residents' troubles on caregivers (reduced agitation, aggressiveness,
95 irritability) (Forget, 2021). Pets are increasingly welcomed into French institutions, with dogs
96 accounting for 20% and cats for 37% of the animals present (Kohler, 2011). The presence of
97 cats within nursing homes can be divided into two categories: so-called "resident" cats, who
98 live in the living units, and "visitor" cats, who accompany a therapist for a one-off encounter
99 (Pongrácz & Szapu, 2018). Despite the strong presence of cats within French institutions
100 (Kohler, 2011), very few articles have focused on the high level of socio-cognitive abilities
101 possessed by felines (Pongrácz & Szapu, 2018). This lack of studies is explained by our "weird
102 society's" (Henrich et al., 2010) biased view believing that the cat is "opportunistic",
103 "independent" and "egocentric" compared to the dog (Vitale Shreve & Udell, 2015). However,
104 recent studies show that the cat demonstrates a strong attachment to its owner and highlight the
105 existence of a strong emotional bond between the older adult and the cat (Pongrácz & Szapu,

106 2018). Branson and colleagues (2017) point out that cats (compared with dogs) are more
107 effective in reducing the level of expression of depressive symptoms in the older population.

108 The objective of this study was therefore to evaluate the effects of the presence of
109 “resident” cats within Alzheimer's and Disability units on the health and social network of
110 residents and caregivers in a nursing home. The study of the social network and its impact on
111 human health is still too little studied in gerontology. Thus, the innovation of our study is to
112 reflect (1) the social interactions between residents and caregivers, (2) the social interactions
113 between humans and animals (so called pseudo-social interactions) and (3) the entire social
114 network of the units without modifying their daily lives. Firstly, we compared the Alzheimer's
115 living units with cat and without a cat. We hypothesized that units with cats would present a
116 different social network with a strengthening of social proximity between residents and
117 caregivers and the cat placed at the heart of the network (i.e. at the center of interactions).
118 Secondly, we compared the Alzheimer's living units with cats and the Disability Living unit
119 with cats to study the effect of the pathology of older adults. Our hypotheses assumed that the
120 effect of the pathology differently impacts social interactions in the presence of cat or even
121 directly impacts the cat's behavior.

122

123 **Methods of observational study**

124 **1) Ethics**

125 The study was approved by the management of the Centre Feron-Vrau at the Université
126 Catholique de Lille (France), a group of five nursing homes including Saint-Antoine de Padoue.
127 The authorization is based on a methodology similar to that of a previous research project
128 conducted in 2021 at the Université de Strasbourg, (UNISTRA/CER/2021-10). Residents and
129 caregivers observed gave their verbal agreement to participate in the study. Cats have food and
130 water ad libitum, reserved sleeping areas and access to veterinary care.

131 **2) Study location**

132 The Saint-Antoine de Padoue nursing home (private institution), created in 2017 at Lille
133 (France), took the decision to welcome cats following the admission of a resident forced to part
134 with hers. The resident's physical and emotional discomfort led healthcare professionals to
135 support the welcoming of her cat into the unit. This decision subsequently enabled other cats
136 to be welcomed into the facility's closed units. The institution is home to 319 residents in 14
137 living units: eight conventional units (CU), four Alzheimer's Disease living units (ADU), one
138 reinforced accommodation unit (RAU) and one living unit for older disabled adults (DISU). In
139 agreement with healthcare professionals, the study was carried out in the following four living
140 units: "E" ADU with one cat, "M" ADU with one cat, "N" ADU without cat and finally the
141 DISU with two cats.

142

143 **3) Participants**

144 Information on the study residents was collected from the referring educator of the units
145 concerned (Supplementary material 1). In this study, 4 cats (Gizmo, Mitsy, Felix and Gizmo),
146 53 residents, 36 caregivers and 5 nurses (working occasionally in the ADU) were observed.
147 For each unit, information about the cats, caregivers/nurses and residents is summarized in
148 Table 1.

149

150 **4) Behavioral observations**

151 Prior to the observation phase, a habituation period of 20 half-days spread over four
152 weeks was carried out in the units concerned (February 2023) allowing the observer (HVA) to
153 be familiar with the life units members. The observation phase took place over 30 days spread
154 over seven weeks of observation (March-April 2023). Each of the four units was observed 1h30
155 per day over four time slots: 8:30 – 10:00 am, 10:15 – 11:45 am, 12:00 am – 1:30 pm and 2:30

156 – 4:00 pm. These time slots were chosen according to the rhythm of life in the units. The order
157 of the units observed during the day and week was established after a pseudo-random draw.
158 Each unit was observed over a total period of 45 hours.

159 Behavioral observations were performed live using BORIS software version 8.9.17
160 (Friard, 2016) on a laptop PC. The cat's general activity and location in space were recorded
161 continuously using the all-occurrence sampling method (Altmann, 1974) and based on existing
162 studies (Stanton et al., 2015). These behaviors are defined in Supplementary material 2. The
163 results were expressed as an average percentage of total observation time devoted to each
164 activity and area frequented. Both for ethical reasons of respect for residents' privacy and for
165 the difficulty of observation, behaviors emitted and received by the cat in residents' bedrooms
166 were not observed.

167 In addition, the number of pseudo-social interactions issued by residents and caregivers
168 towards the cat, as well as the number of verbal social interactions issued between caregivers,
169 between caregivers and residents and between residents about the cat, were recorded
170 continuously using the all-occurrence sampling method. Pseudo-social interactions emitted by
171 residents and caregivers towards the cat are defined in Supplementary material 3.

172 Social proximity between members of the unit (caregivers, residents and cat(s)) was
173 observed by instantaneous sampling (Altmann, 1974) and defined in Supplementary material
174 4 for a total of 300 scans/individual. Every 10 minutes, the individual's position and physical
175 social proximity to others were noted. In the particular case where the cat was in the presence
176 of the resident and/or caregiver(s) in a bedroom, the “bedroom with” proximity was included
177 in the social proximity ethogram. Subsequently, the social proximities presented in
178 Supplementary material 4 were grouped into three categories: “in contact”, “nearby” and
179 “talking to /looking at each other” described in Supplementary material 5.

180

181 **5) Data analysis**

182 Analysis and statistical processing were carried out using R software (version 4.3.0).

183

184 *Analysis of cat behavior, social and pseudo-social interactions:*

185 Comparisons of the four cats focused on: areas frequented by the cats, behaviors
186 exhibited by residents/caregivers towards the cat, and the number of verbal social interactions
187 issued between caregivers, between caregiver(s)-resident(s) and between residents. For verbal
188 social interactions, only residents able to express themselves verbally were considered (n = 44).
189 Comparisons were made using Chi² tests (noted χ^2).

190

191 *Analysis of social proximity between cat(s) and caregivers:*

192 This analysis was carried out for residents and caregivers. Only the analysis for
193 caregivers was retained due to the presence collinear variables: “proximity to” and “talk to/look
194 at” the cat (Variance Inflation Factor > 5). Thus, a Principal Component Analysis (PCA) was
195 performed on the social proximity between the cat(s) and the 36 caregivers (1C PCA) in order
196 to visualize the correlations between the three proximity variables described in Supplementary
197 material 6. The results of this PCA are described in the Supplementary material 6. Component
198 1 was named “in contact with the cat” and component 2 “proximities and exchanges with the
199 cat”.

200

201 *Analysis of residents' health data:*

202 A PCA was performed on the health data of the 53 residents (1R PCA) to visualize the
203 correlations between the five variables described in Supplementary material 7. The results of
204 this PCA are described in the Supplementary material 7. Component 1 was renamed
205 “autonomy” and component 2 “perception problems”.

206 ***Social network (SN) analysis:***

207 Visualization of the “in contact”, “talking to/looking at each other” and “nearby” social
208 networks was carried out for the four units using Gephi software (version 0.10.1). Networks
209 were visualized using the “Force Atlas 2” spatialization module, which places the nodes
210 (individuals) with the most connections and links at the center of the network. The main
211 descriptive measures of the network, namely density, modularity, node degree, weighted
212 degree and eigenvector centrality, were recorded and are explained in Table 2 (Croft et al.,
213 2008; Wasserman & Faust, 1994). These indices were calculated for this study following the
214 choice process described in Sosa and collaborators (2021).

215

216 ***Analysis of residents' and caregivers' sociality:***

217 Two PCAs were performed on the sociality data of the 53 residents (2R PCA) and 36
218 caregivers (2C PCA) to visualize the correlations between the nine different variables derived
219 from the construction of the “in contact”, “nearby” and “talking to/looking at each other” social
220 networks (SN) (Supplementary material 8). The results of these two PCAs are described in
221 Supplementary material 8. Results differed between residents and caregivers. For residents,
222 component 1 was renamed “proximity and exchange” and component 2 “in contact”. For
223 caregivers, component 1 has been renamed “quantity and quality of social ties” and component
224 2 “number of social ties”.

225 PCAs were performed using the varimax function (packages "FactomineR" (Lê et al.,
226 2008), “psych” (Revelle, 2023)), which allows correlations to be made between components
227 and variables. PCA results for each individual and each component were obtained via
228 `acp.varimax$score`. The selection criterion for principal components was an eigenvalue > 1 .
229 Variables strongly correlated (eigenvector $> |0.5|$) with each component were considered to
230 explain the component. Generalized linear models (GLM) (package “glm2” (Marschner,

231 2011)) followed by permutation tests (package “pgirmess” (Giraudoux, 2018)) were used to
232 study the links between sociodemographic parameters and cat proximity on “autonomy” and
233 “perception problems” in residents, as well as between health parameters and cat proximity on
234 residents' sociality. These tests were also used to study the effects of cat presence and proximity
235 on caregivers' sociality. Permutation tests are a robust approach based on data randomization
236 and resampling, enabling parametric tests to be used without the validity of results being based
237 on a theoretical distribution. As a result of multiple comparisons where sample data have been
238 randomized, the permutation test gives only a single p-value. For each GLM, the variance
239 inflation factor (VIF) of the explanatory variables tested was close to 1, indicating that these
240 variables were not influenced by each other (absence of multicollinearity). Post-hoc pairwise
241 comparison tests after GLM were performed using a T-test with the Benjamini-Hochberg
242 method (package “rcompanion”, (Mangiafico, 2023)) for the qualitative variable "number of
243 cats" and by linear regression for the quantitative variables. The significance level was ≤ 0.05
244 for all analyses. A probability between $0.05 < p < 0.06$ was qualified as a tendency.

245

246 **Results**

247 **1) General activity and areas frequented by cats**

248 A total of 4,532 behaviors emitted by the four cats were recorded over the 180 hours of
249 observation, *i.e.* $1,133 \pm 121.0$ [835/1,489] behaviors emitted/cat (mean \pm Standard Error of
250 the Mean [min/max]). During the 45 hours of observation, the four cats spent $70.1 \pm 2.4\%$ of
251 their time inactive (*e.g.* lying) (Figure 1). They also spent, in descending order, $9.8 \pm 1.8\%$ of
252 their time in activity (*e.g.* walking), $6.4 \pm 2.0\%$ of their time on feeding, $4.6 \pm 1.0\%$ of their
253 time exploring, $3.1 \pm 1.9\%$ of their time performing avoidance behaviors, $3.0 \pm 0.8\%$ of their
254 time in maintenance (*e.g.* grooming) and $1.0 \pm 0.3\%$ of their time playing. ADU cats spent
255 more time in residents' bedrooms ($64.0 \pm 5.7\%$ of time) than DISU cats ($9.2 \pm 0.3\%$) ($\chi^2 =$

256 83.62; $df = 3$; $p < 0.001$). On the other hand, the ADU cats spent less time outside ($1.15 \pm$
257 0.25%) than the two DISU cats ($28.3 \pm 17.8\%$) ($\chi^2 = 93.1$; $df = 3$; $p < 0.001$); one of the two
258 DISU cats (Felix) spending more time outside than the second (Gizmo) (46.1% vs. 10.5%) (χ^2
259 $= 22.39$; $p < 0.001$). The ADU cats also spent less time in the living room ($24.5 \pm 1.4\%$) than
260 the DISU cats ($59.5 \pm 17.5\%$), ($\chi^2 = 43.88$; $df = 3$; $p < 0.001$); one of the two DISU cats (Gizmo)
261 spending more time in the bedroom than the second cat (Felix) (77.1% vs 42.0%) ($\chi^2 = 10.34$;
262 $p = 0.001$). Finally, "E" ADU cat (Gizmo) spent more time in the corridor than the other three
263 cats ($\chi^2 = 22.83$; $df = 3$; $p < 0.001$).

264

265 **2) Human-cat behaviors and interactions**

266 *Social interactions between residents and caregivers about the cat:*

267 On average, over the 180 hours of observation and in the three units with cat(s),
268 residents talked little about the cat (1.4 ± 0.3 times/resident) as did caregivers (1.3 ± 0.4
269 times/caregiver); no significant difference could be demonstrated between the three units with
270 cat with regard to behaviors: "residents talk to each other about cat" and "caregivers talk to
271 each other about cat" ($\chi^2 = 0.47$ and $\chi^2 = 1.29$; $df = 3$; $p > 0.05$). On the other hand, a trend
272 towards significance was observed for the behavior "residents and caregivers talk to each other
273 about cat" ($\chi^2 = 7.72$; $df = 3$; $p = 0.052$); DISU residents and caregivers tended to talk more
274 about one of their cats (Gizmo) (4.29 times/individual) compared to residents and caregivers
275 in the "E" ADU (0.45 times/individual) and "M" ADU (0.32 times/individual) over the entire
276 observation period. In the case of DISU, the cat was mainly the subject of conversations
277 between a resident (R43) and caregivers (87% of behaviors observed).

278

279

280

281 ***Pseudo-social interactions emitted by residents and caregivers towards their cat(s):***

282 Over 180 hours, the cats received a total of 486 behaviors from residents, *i.e.* 121.5 ±
283 35.3 [27/224] behaviors received/cat, and 324 behaviors from caregivers, *i.e.* 81.0 ± 16.7
284 [42/130] behaviors received/cat. No significant difference was observed between units with
285 regard to the different behaviors emitted by residents (χ^2 ; $p > 0.05$) and by caregivers towards
286 their cat(s) (χ^2 ; $p > 0.05$). Similarly, within each unit, no difference was observed between the
287 behaviors expressed by the residents and those expressed by the caregivers (χ^2 ; $p > 0.05$),
288 suggesting that the latter behave similarly with the animal. However, in the DISU, one resident
289 (noted R43 on the SN) performed 94.3 and 100% of the “touches cat” and “gives the cat a treat”
290 behaviors. Finally, in “M” ADU, Mitsy was the only cat who received agonistic behaviors from
291 a resident. During the 45 hours of observation, 4 “verbal” and 5 “physical” agonistic behaviors
292 were directed at this cat, without ever physically touching it.

293

294 **3) Social network analysis**

295 The visualizations of the three social networks (SN) studied: “in contact”, “nearby”,
296 “talking to/looking at each other” are presented in Figures 2, 3 and 4. For each of these three
297 SNs, social network density is not significantly different between the four units (χ^2 test; $p >$
298 0.05), and network modularities are not significant (values < 0.3). Of the mean centrality values
299 obtained for residents, caregivers and cat in all networks, cats obtained 63% of the lowest
300 centralities (100% for the “in contact” SN; 88.8% for “talking to/looking at each other” and
301 45.5% for the “nearby” SN) whereas normally, the lowest average centrality obtained by
302 random chance is 3.83%. Descriptive network analysis suggests that cats have enhanced
303 pseudo-social interactions with certain residents. In “E” ADU, Gizmo is frequently in contact
304 and/or close to two residents (R4 and R8), in “M” ADU, Mitsy is frequently close to one

305 resident (R22) and finally in DISU, cats are mainly in contact and/or close to one resident
306 (R43).

307

308 ***Link between unit context and cat number:***

309 From the outset of the study, a link between the context of the unit (Alzheimer's versus
310 Disability) and the number of cats per unit was observed. The generalized linear model (GLM)
311 showed a link between the number of cats and resident autonomy (GLM PermTest: $p = 0.002$),
312 perception problems (GLM PermTest: $p = 0.002$) and resident age (GLM PermTest: $p < 0.001$).
313 Indeed, in the unit with the two cats, residents' autonomy was lower (2.09 ± 0.34) (mean \pm
314 SEM) than in the units with one cat (3.18 ± 0.15) (BH post-hoc test; $p = 0.001$) or in the absence
315 of a cat (3.41 ± 0.18) (BH post-hoc test; $p = 0.001$). Perception problems were lower ($2.08 \pm$
316 0.21) than in units with a single cat (3.15 ± 0.19) (BH post-hoc test; $p = 0.001$) or in the absence
317 of a cat (3.51 ± 0.2) (BH post-hoc test; $p < 0.001$). Finally, residents in this unit were younger
318 (67.3 ± 1.6 years) than those in units with single cat (84.3 ± 1.5 years), (BH post-hoc test; $p <$
319 0.001) or without cat (80.9 ± 2.1 years) (BH post-hoc test; $p < 0.001$).

320 The unit with the two cats is the living unit for older disabled adults (DISU), catering
321 for people who are aging (*i.e.* younger) and have a physical and/or verbal disability (*i.e.* less
322 autonomy). The lesser perception problems in this unit may be explained by the difficulty of
323 assessing these two modalities with people who do not communicate verbally. As the number
324 of cats was linked to the pathological context of the unit, it was decided to study for each
325 resident ($n = 53$) their proximity to the cat (number of times a resident is “in contact with the
326 cat”, “proximity to the cat” or “talk to/look at the cat”) and not the “cat presence effect”.

327

328

329

330 *Effects of sociodemographic parameters and cat proximity on residents' health:*

331 The generalized linear model (GLM) revealed no effect of age (GLM PermTest: $p =$
332 0.15) or gender (GLM PermTest: $p = 0.89$) on autonomy. However, as residents' seniority in
333 the unit increased, their autonomy decreased ($R^2 = 0.139$; $F = 9.39$; $p = 0.005$). Gender (GLM
334 PermTest: $p = 0.57$) and seniority (GLM PermTest: $p = 0.12$) also had no effect on perception
335 problems. On the other hand, as residents' age increased, so did their perception problems (R^2
336 $= 0.16$; $F = 10.95$; $p = 0.0017$). Finally, no effect was observed between physical proximity to
337 cats and residents' autonomy (GLM PermTest: “in contact” $p = 0.90$; “proximity” $p = 0.81$;
338 “talk/look” $p = 0.70$) or perception problems (GLM PermTest: “in contact” $p = 0.25$;
339 “proximity” $p = 0.92$; “talk/look” $p = 0.26$).

340

341 *Effects of sociodemographic parameters and cat proximity on residents' sociality:*

342 No effect of gender (GLM PermTest: $p = 0.35$), seniority in the unit (GLM PermTest:
343 $p = 0.63$), perception problems (GLM PermTest: $p = 0.16$) or autonomy ($R^2 = 0.07$; $F = 5.19$;
344 $p = 0.08$) on “in-contact” sociality could be demonstrated. However, as age increased, “in-
345 contact” sociality decreased ($R^2 = 0.10$; $F = 6.71$; $p = 0.012$). Similarly, no effect of gender
346 (GLM PermTest: $p = 0.86$), age (GLM PermTest: $p = 0.59$), seniority (GLM PermTest: $p =$
347 0.57) or perception problems (GLM PermTest: $p = 0.97$) on “proximity and exchanges”
348 sociality could be demonstrated. On the other hand, the greater the autonomy, the lower the
349 “proximity and exchanges” sociality ($R^2 = 0.18$; $F = 12.2$; $p < 0.001$). Finally, no link was
350 observed between proximity to the cat and residents' “proximity and exchanges” or “in-
351 contact” sociality (GLM PermTest: $p > 0.05$).

352

353

354

355 *Effects of cat presence and proximity on caregivers' sociality:*

356 No association was observed between proximity/exchanges with the cat and the number
357 of caregivers' social ties (GLM PermTest: $p = 0.07$). However, the more caregivers were “in
358 contact with the cat”, the greater their number of social ties with other members of the unit (R^2
359 = 0.41; $F = 24.88$; $p = 0.001$). Finally, no association was found between the presence (GLM
360 PermTest: $p = 0.17$) and proximity/exchanges (GLM PermTest: $p = 0.72$) with the cat and the
361 quantity/quality of social ties.

362

363 **Discussion**

364 The aim of this study was to evaluate the effect of the cat's presence on the social
365 network and health of residents with Alzheimer's disease, and the effect of the residents'
366 pathology on the social network of units hosting one or more cats. In our study, the presence
367 of the cat is strongly linked to the pathological context of the unit's residents (two cats in the
368 disability unit), which is why we focused not on the presence but on the effect of the cat's
369 proximity. Contrary to our expectations, the construction of none of the social networks studied
370 revealed any differences between the four units; this suggests that these units have similar
371 behaviors whether they have a cat or not. Similarly, no effect could be observed between cat
372 proximity and residents' sociality or health. The same was not true for caregivers. Indeed,
373 caregivers with a high level of contact with the cat had a greater number of social ties within
374 their unit, whether these ties were established with the rest of caregivers or with the residents.
375 Finally, residents and caregivers seem to have similar behavior with the cats, although one cat
376 in particular (Gizmo DISU) tends to be more of a topic of conversation in its unit than the other
377 cats.

378 Studying social networks involves examining the number of personal relationships a
379 person maintains, but it is challenging to define, as terms like social network, social integration

380 and social contact are used interchangeably, typically measured through questionnaires,
381 allowing for subjective responses (Gustafsson et al., 2017; Kermani et al., 2021).

382 Here, our methodology was based on recordings of social proximity or physical contact
383 (300 scans/individual) rather than questionnaires, enabling us to better quantify interactions
384 and therefore the social networks of different living units. This study is therefore the first to
385 focus on the measured, non-subjective social network of living units in nursing homes,
386 including residents, caregivers and their pets.

387 Descriptive analysis of social networks (SN) suggests that caregivers and residents in
388 the four units observed behave similarly, regardless of proximity distance and social
389 exchanges. The "in contact" SN show a homogeneous distribution of interactions between
390 residents and caregivers, which could be explained by the socio-medical context. Indeed,
391 according to the article by Garcia and colleagues (2011), caregivers spend 31.2% to 63.1% of
392 their working time providing direct care to residents, such as personal hygiene, meal and
393 mobility assistance. According to our results, this direct care, involving physical contact, is
394 mainly lavished on the oldest residents.

395 At the same time, our results show that residents with little physical contact with others
396 have greater autonomy. On the other hand, descriptive analysis of the "nearby" and "talk/look"
397 networks shows a heterogeneous distribution of interactions between residents and caregivers,
398 whatever the unit; residents and caregivers forming two quite distinct groups. This observation
399 could be linked to motor activity. Indeed, in the course of their work, caregivers are constantly
400 on the move, which reinforces their social distance with both other caregivers and residents
401 (Garcia et al., 2011). Residents, on the other hand, have reduced physical activity (Borges et
402 al., 2019) and are therefore spatio-temporally closer to each other.

403 Regarding the cat's place in the unit's social network, our initial hypothesis assumed
404 that cats would be placed at the heart of the network. However, our results suggest that cats

405 have privileged interactions with certain residents. This observation could be linked to the cat's
406 desire alone, which, according to Turner (1991), is the only one to control the duration of
407 interaction with humans. And this is all the truer when the cat initiates the interaction (Mertens,
408 1991).

409 On the one hand, we can therefore assume that the absence of interaction with all the
410 members of the unit is due to the cat's willingness. It is important to remember that the units
411 observed accommodate residents prone to depressive symptoms and anxiety. According to
412 Turner and Rieger (2001), depressed owners initiate fewer interactions with their cats. On the
413 other hand, if the cat initiates the interaction, these people accept the intention with the cat. So,
414 even if social interactions depend on the cat, they would also be based on a reciprocal
415 attachment between owner and cat (Turner, 2021). These different hypotheses underline that
416 human-cat interactions depend on a balance between the (resident) human's affection for the
417 cat and the cat's willingness to respond.

418 As far as caregivers are concerned, the situation is different. Indeed, our results show
419 that caregivers who have a strong contact with the cat have a greater number of social ties in
420 their unit. One of our hypotheses is that the cat acts as a social 'lubricant' for all caregivers in
421 units with cats (McNicholas & Collis, 2000). Indeed, the presence of the animal can be a vector
422 of social stimuli and foster communication between caregivers and residents (Forget, 2021).
423 Repeated contact with the animal seems to foster confidence and reduce anxiety among
424 caregivers at work, facilitating exchanges and openness to others (Forget, 2021) and promoting
425 better psychological health among caregivers (Fritz et al., 1996).

426 Our study highlighted that the general activity of the four cats was similar, with the cats
427 spending over 70% of the time being inactive whatever the unit, which is consistent with the
428 literature (Baguet, 2012). On the other hand, space occupation differed between the cats. The
429 cats in the ADU spend 64% of their time in the residents' bedrooms, while the two cats in the

430 DISU spend 60% of their time in the living room. This initial result could be explained by the
431 pathological context. Indeed, 85% of residents in the two cat-operated ADU are able to walk,
432 and therefore to move around. In these units, resident wandering is quite frequent. This
433 agitation can lead the cats to occupy less frequented areas of the unit, namely the bedrooms. At
434 the DISU, only four residents were able to walk or move around on their own. Consequently,
435 less agitation was observed in the living room of this unit, which could facilitate the cats'
436 occupation of the space. It is possible that the cats, confronted with the pathological context of
437 the residents in their unit, demonstrated adaptation (Lowe & Bradshaw, 2001) to the agitation
438 and rhythm of life of the residents (Adamelli et al., 2005).

439 The major limit of this study is the pathological context of the living units. It would be
440 interesting to study the impact of cats in conventional units where residents still have a degree
441 of physical and verbal autonomy without associated troubles. However, this study makes a
442 significant scientific contribution in several areas. It explores the impact of animals in nursing
443 homes on the health and well-being of older residents, enriching research in geriatrics and
444 gerontology. In addition, it enables us to study the impact of cats, a species which, previously,
445 had been little studied in the context of AAI (compared with dogs), and above all to understand
446 the effects of 'resident' animals on the older adults.

447 Finally, it also analyzes social networks within nursing homes, offering insights into
448 relational dynamics, with potential implications for quality of care. Another perspective of this
449 work would be to study the effect of cats' personality on social bonding with residents and
450 caregivers, or to go even further the effect of animals versus gerontechnology (animal robots).

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Table 1: Information collected during the habituation phase on the cats, caregivers/nurses and residents of each unit observed.

		“E” ADU with cat	“M” ADU with cat	“N” ADU without cat	DISU with two cats
Identity of European cats (Castrated male)	Name	Gizmo ¹	Mitsy	No cat	Gizmo ¹ and Felix
	Age	7 years	5 years		2 years
	Origin	Adopted by the nursing home	Arrived with a resident of (CU) ²		Adopted by the nursing home
	Training	NO	NO	/	NO
Number of caregivers + nurses and gender	Male	1	2	1	2
	Female	11	11	13	7
Number of residents and gender	Male	3	5	3	4
	Female	11	8	11	8
Average age of residents (mean ± standard deviation)		86.9 ± 6.04 years	81.5 ± 8.3 years	80.9 ± 7.68 years	67.3 ± 5.2 years
Pathologies (in % of residents)	Alzheimer + Korsakoff syndrome	21.43	15.38	14.29	----
	Alzheimer's	78.57	84.62	87.71	----
	Intellectual disability	----	----	----	66.67
	Intellectual disability + ASD ³	----	----	----	8.33
	Down syndrome + ASD	----	----	----	8.33
	Down syndrome	----	----	----	8.33
	Turner syndrome	----	----	----	8.33

Residents with sight problems (%)	Severe	7.7	7.69	----	8.33
	Moderate	30.8	23.08	53.85	8.33
	Light	15.4	23.08	23.08	----
	None	46.2	46.15	23.08	83.33
Residents with hearing problems (%)	Severe	----	15.38	----	----
	Moderate	23.1	15.38	53.85	----
	Light	46.2	46.15	30.77	----
	None	30.8	23.08	15.38	100
Ability to communicate verbally (V), physically (P) with others (Average score out of 10 ± standard deviation)		(V) 5.23 ± 1.58 (P) 4.61 ± 1.55	(V) 4.31 ± 1.89 (P) 4.15 ± 1.45	(V) 4.69 ± 2.58 (P) 4.61 ± 1.07	(V) 2.33 ± 2.42 (P) 3.33 ± 2.28
Autonomy (%)	In a wheelchair	7.1	23.1	----	58.3
	Walking with medical walker	35.7	15.4	7.1	16.7
	Walking alone with difficulty	7.1	23.1	35.7	8.3
	Walking alone easily	50.0	38.5	57.1	16.7
% of residents under treatment influencing their social interaction(s) ⁴		64.3	76.9	57.1	83.3
Seniority of the resident in the unit (mean number of months ± standard deviation [min/max])		20.5 ± 18.4 [1/65]	13.8 ± 5.1 [5/21]	24.9 ± 32.5 [1/134]	47.3 ± 21.5 [1/64]

ADU refers Alzheimer's living unit and DISU refers Disability living unit. ¹Two cats have the same name, subsequently they will be called ADU Gizmo and DISU Gizmo. ²Conventional Unit. ³ASD: Autism Spectrum Disorders. ⁴e.g. antipsychotic.

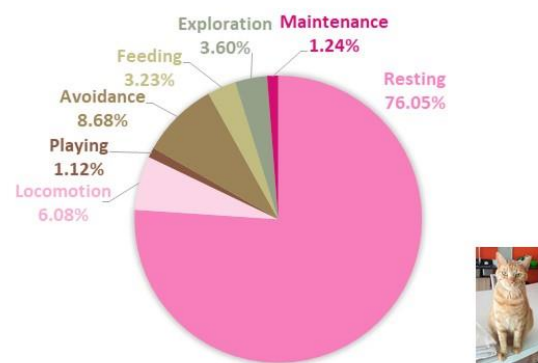
Table 2: Definition of descriptive measures of a social network (based on the work of Croft et al., 2008; Wasserman & Faust, 1994).

Descriptive social network measures	Definition
Density	It represents the proportion of ties present in the network compared to the total number of possible ties. Its values vary from zero to one, with the value one indicating a fully connected network, that is, all individuals interact with each other.
Modularity	It represents the level of division of a network into clusters (subgroups of strongly connected nodes), its high coefficient (ranging from zero to one) indicates a greater number of contacts inside the clusters and a lower number of contacts outside the clusters.
Node degree	It represents the number of nodes connected to it. Here the node is synonymous with individual (resident, caregiver, nurse or cat).
Weighted degree	This is the number of ties linked to this node. The more ties a node has, the more connected it is and the more central it is.
Eigenvector centrality	It is a measure of the number and quality of a subject's social partners. People with high eigenvector centrality have a large number of partners, who themselves have a large number of partners.

a) « E » Alzheimer's living unit (ADU) with Gizmo



c) Disability living unit (DISU) with Gizmo and Felix



b) « M » Alzheimer's living unit (ADU) with Mitsy

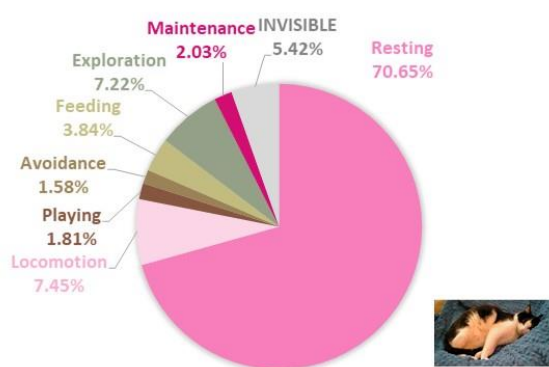
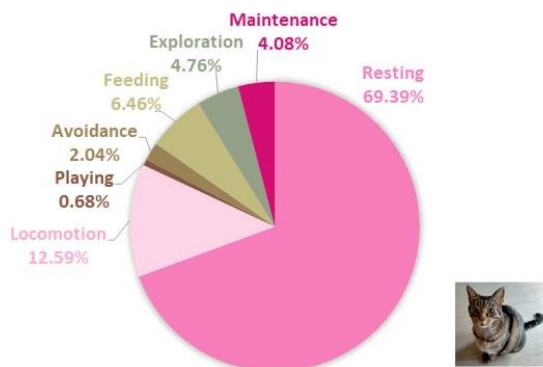


Figure 1: Time budget for the general activity of the four cats from a) “E” Alzheimer’s living unit (ADU) with Gizmo, b) “M” Alzheimer’s living unit (ADU) with Mitsy and c) Disability living unit (DISU) with Gizmo and Felix expressed as an average % of the total time spent performing these behaviors.

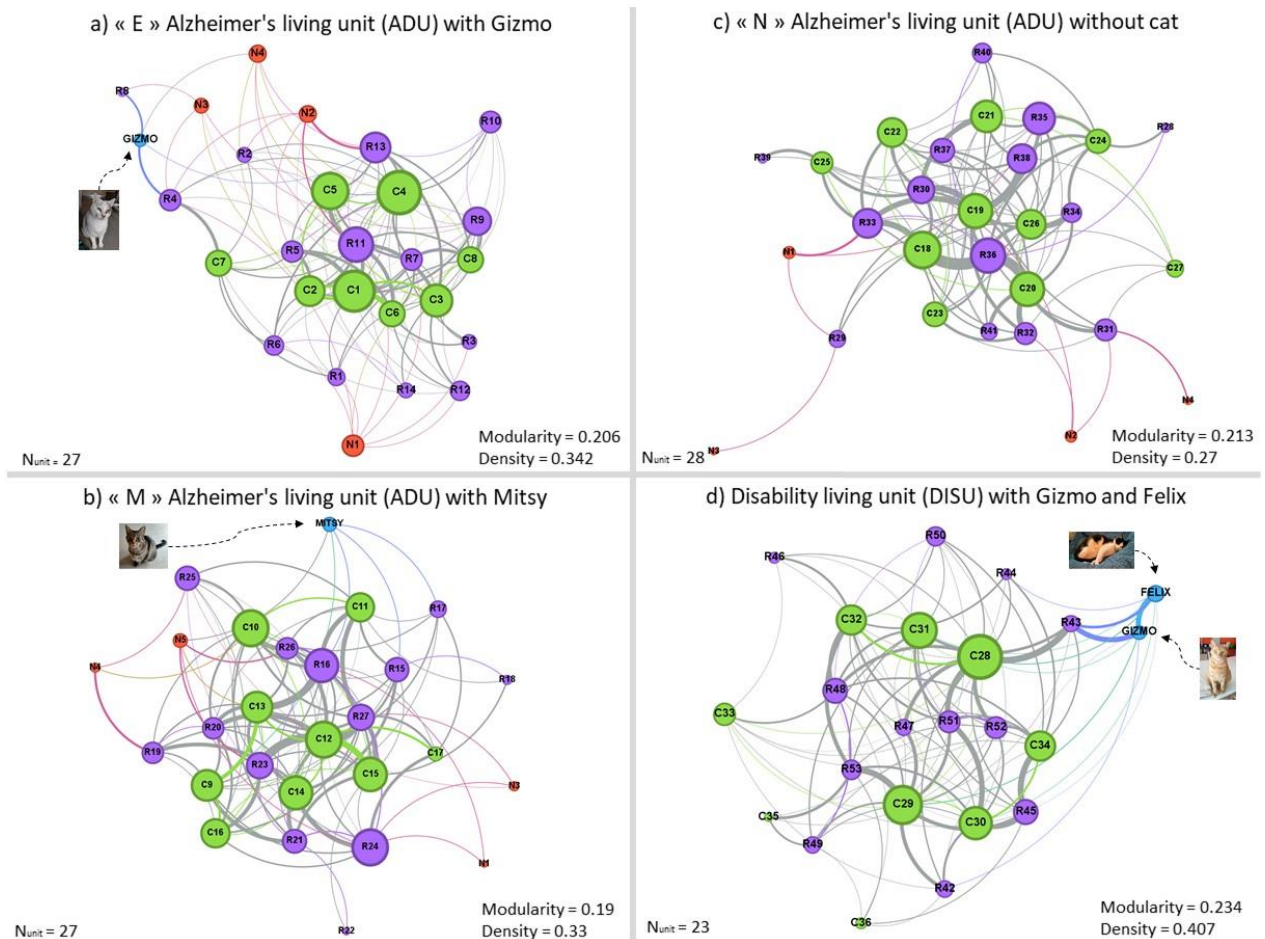


Figure 2: Visualization of “in contact” social networks for the four units observed. Residents are indicated by **purple nodes (R_n)**, caregivers by **green nodes (C_n)**, the **nurses by orange nodes (N_n)** and **cats with blue nodes**. The numbers within each unit are indicated at the bottom left of the SN, the modularity and density at the bottom right of the SN.

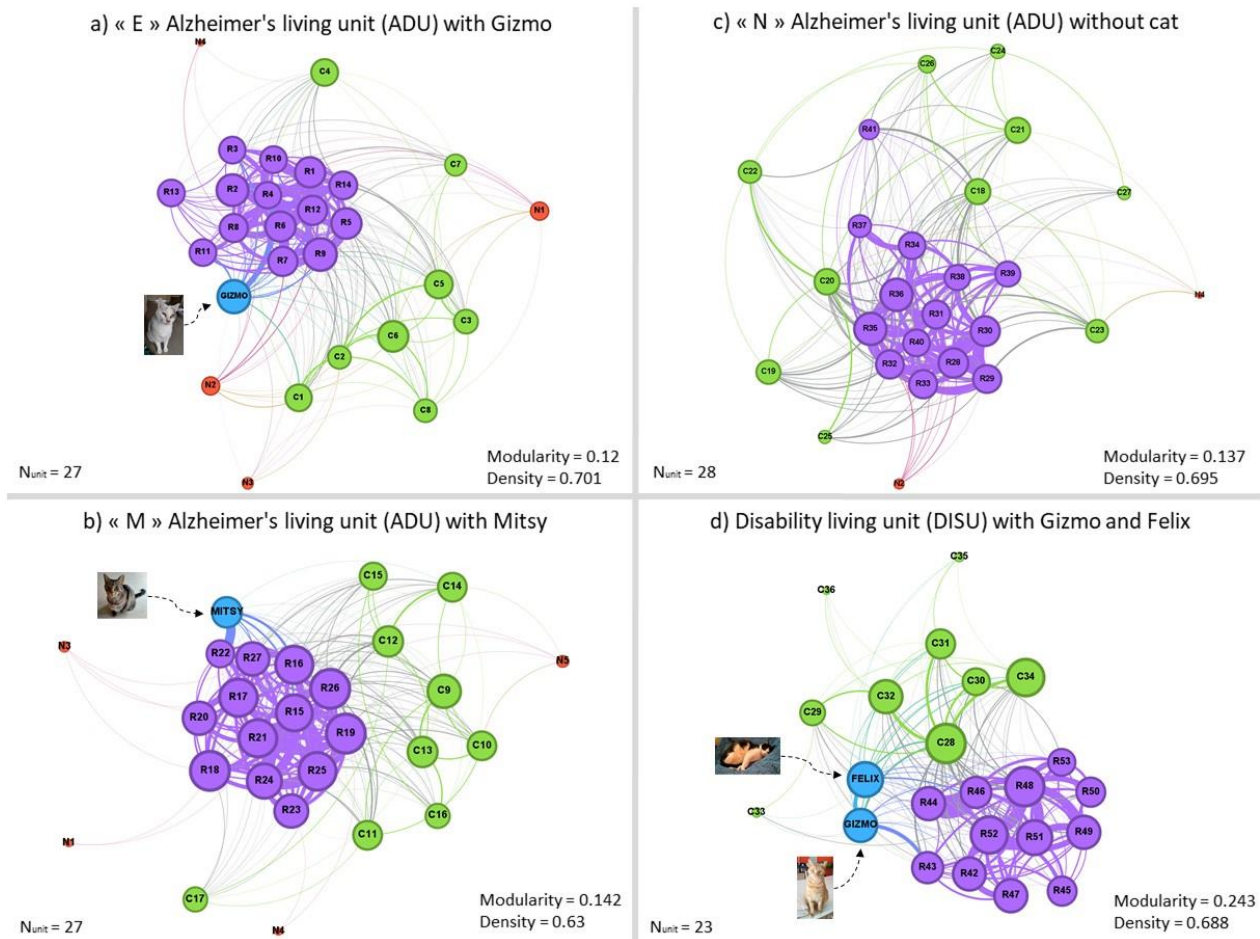


Figure 3: Visualization of “nearby” social networks for the four units observed. Residents are indicated by **purple nodes (R_n)**, caregivers by **green nodes (C_n)**, the **nurses by orange nodes (N_n)** and **cats with blue nodes**. The numbers within each unit are indicated at the bottom left of the SN, the modularity and density at the bottom right of the SN.

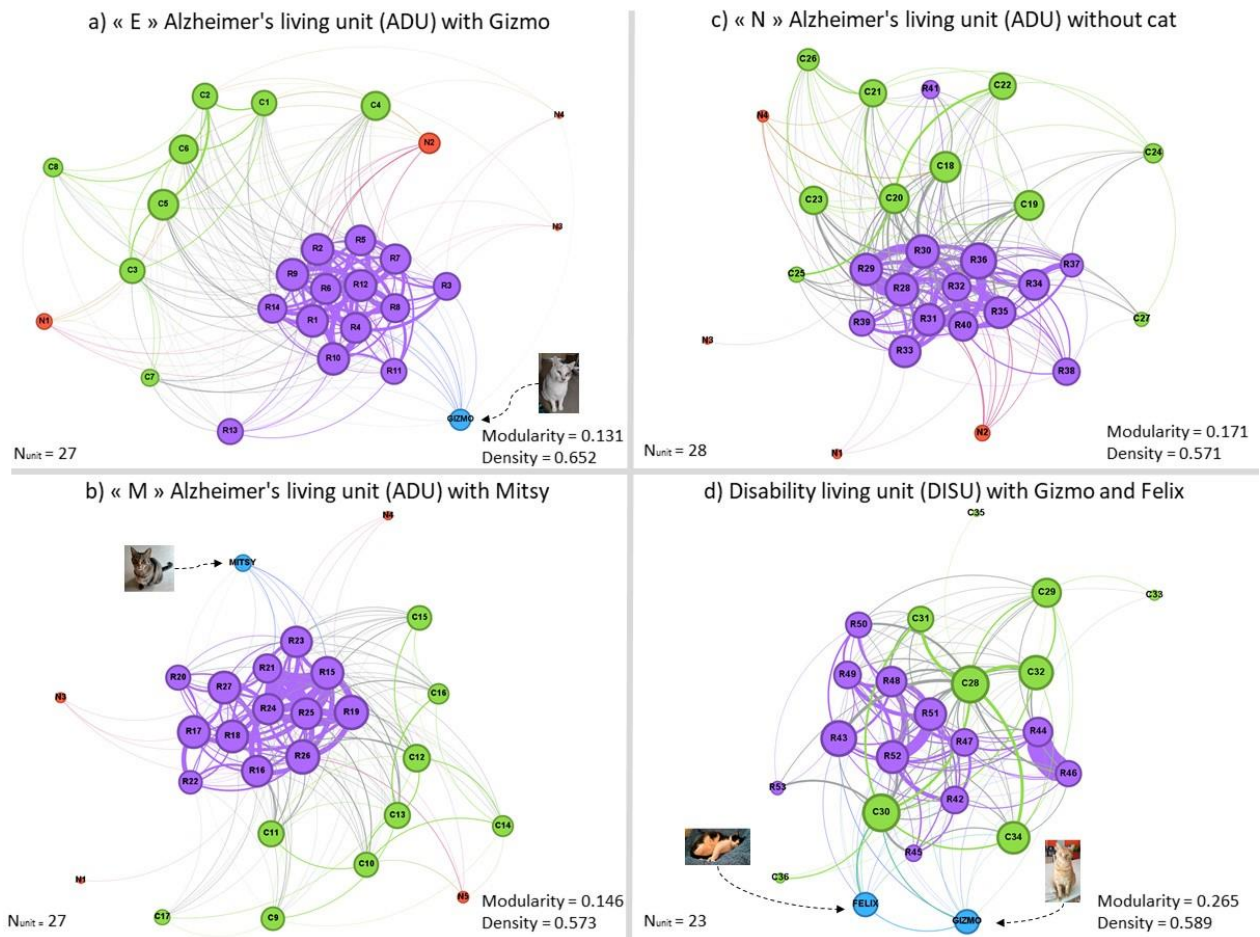


Figure 4: Visualization of social networks “talking to/looking at each other” for the four units observed. Residents are indicated by **purple nodes (R_n)**, caregivers by **green nodes (C_n)**, the **nurses** by **orange nodes (N_n)** and **cats** with **blue nodes**. The numbers within each unit are indicated at the bottom left of the SN, the modularity and density at the bottom right of the SN.