Alzheimer's Insights AI Prize Application - Internal Review

1. Project Hypothesis, Methods, and Validation (4,961/4,000)

Goal. Currently, no comprehensive multimodal dataset exists for training AI systems to manage dementia-related agitation. While resources like DementiaBank provide structured clinical interviews, they lack naturalistic caregiver-patient interactions during actual agitation episodes. Without such data, developing agentic AI for dementia care remains impossible. Our goal is to create the world's first privacy-preserving, clinically-validated multimodal dataset that captures the communicative dynamics of agitation, enabling the global research community to finally develop agentic AI systems for empathetic dementia care.

→ My note: Complete strategic reframe. Instead of promising to build an agent (unrealistic in 1 year), I'm positioning us as solving THE fundamental bottleneck. This makes our contribution undeniably essential. By stating "no dataset exists," I'm creating urgency and showing judges that without us, nobody can succeed. This directly hits 'Acceleration & Transformation Potential' by removing the most critical obstacle. The comparison to DementiaBank preempts the obvious question "what about existing datasets?" and shows we've done our homework.

Project Hypothesis & Data Support. We hypothesize that the absence of shareable, ecologically valid dementia interaction data is the primary bottleneck preventing agentic AI development in this domain. Synthetic, harmonized multimodal datasets that approximate real agitation dynamics can provide the training foundation for future agentic systems capable of reasoning and acting autonomously. By creating privacy-preserving resources aligned with distributions observed in real patient data, we accelerate research that would otherwise require years of costly data collection and complex ethical approvals.

→ My note: This paragraph reframes our entire value proposition. By calling data absence "THE primary bottleneck," I'm making our work mission critical rather than just helpful. The phrase "future agentic systems" honestly acknowledges we're enabling others, not building the agent ourselves. "Years of costly data collection" quantifies our acceleration impact. This addresses multiple criteria: 'Acceleration' (removing bottleneck), 'Innovation' (synthetic data approach), and 'Ethical AI' (privacy-preserving). The judges will understand that every other team needs us to succeed.

Data Support. Since July 2025, our actively collaborating UCI-Xavor team has collected real Alzheimer's Disease and Related Dementias (ADRD) clinic and simulation data streams (audio, video), automatically transcribed and processed into valence and arousal values. These remain private under HIPAA and GDPR but serve as our ground truth for calibration. Unlike existing resources that capture diagnostic assessments, we focus on authentic caregiving moments

when agitation naturally emerges and requires intervention. In parallel, we have curated a comprehensive library of clinically validated personas and agitation scenarios (e.g., sundowning, misplacement), from which multi-turn dialogues are being generated for expert validation.

→ My note: Three strategic moves here. First, "actively collaborating UCI-Xavor team" addresses any concerns about team cohesion. Second, the contrast with "diagnostic assessments" positions us as filling a different, more practical niche than DementiaBank. Third, maintaining the HIPAA/GDPR mention shows we're already operating at regulatory standards, hitting the 'Ethical/Responsible AI' criterion. The specific timeline "Since July 2025" proves we're not starting from scratch, crucial for 'Feasibility.'

Methods. Our analytical framework uniquely integrates two complementary linguistic approaches to deconstruct agitation. First, drawing from the sociolinguistic work of Heidi Hamilton, we analyze real-world conversations at the turn-level to model agitation as a dynamic, co-constructed process. Concurrently, we apply the principles of clinical pragmatics, following Louise Cummings, to identify and quantify specific linguistic markers like topic deviation and discourse repair failures. Crucially, these linguistic markers are correlated with objective agitation scores derived directly from our video data. Using computer vision models, we quantify specific behaviors such as pacing, restlessness, and repetitive motions. These automatically detected behaviors directly map to items on the Cohen-Mansfield Agitation Inventory (CMAI) and Neuropsychiatric Inventory (NPI), providing a data-driven ground truth that removes the subjectivity of caregiver recall.

The insights from this dual analysis inform the generation of our synthetic dialogues. These are rendered with prosody-tuned Text-to-Speech (TTS) to approximate elderly vocal patterns, systematically manipulating acoustic features to convey authentic emotion. Audio features and affective curves are then harmonized with optional movement streams via Dynamic Time Warping (DTW). Fidelity is assessed through Maximum Mean Discrepancy (MMD), Fréchet Audio Distance (FAD), and our expert validation panel. This multimodal approach captures nuances that text-only or audio-only datasets miss, providing the rich training signal necessary for empathetic AI.

→ My note: This two-paragraph methods section is our 'Technical Rigor' showpiece. Citing Hamilton and Cummings establishes academic credibility immediately. The technical details (DTW, MMD, FAD) show we're not hand-waving but have concrete implementation plans. Most importantly, the final sentence explains WHY multimodal matters - "captures nuances that text-only or audio-only datasets miss." This subtly criticizes any competitor taking shortcuts with simpler data. The CMAI/NPI mapping shows clinical validity, appealing to both technical and clinical reviewers on the panel.

Validation. Our validation is conducted by a multidisciplinary panel of clinical experts and linguists. To ensure both rigor and scalability, we employ a human-in-the-loop, LLM-assisted methodology. First, our expert panel collaborates to design a sophisticated, custom rubric assessing sociolinguistic authenticity and clinical fidelity. This rubric then serves as a detailed

guideline for a fine-tuned LLM, which performs the initial, large-scale annotation of our synthetic dialogues. Finally, our human experts audit and validate a statistically significant sample (10-15%) of the LLM's output to ensure accuracy and consistency. Inter-rater reliability for this final validation is established using metrics like Fleiss' κ and Intraclass Correlation (ICC), ensuring our data is not only technically accurate but also contextually and clinically valid.

→ My note: This validation approach is strategically designed to impress both camps of reviewers. For AI folks, the "LLM-assisted" approach shows we're modern and scalable. For clinical folks, the human expert oversight and statistical measures (Fleiss' κ, ICC) show rigor. The specific "10-15%" gives concrete detail that makes it believable. This directly addresses potential concerns about "how do you know your synthetic data is good?" before they're even raised.

Risks. If synthetic audio fails to capture aging timbre, we will refine SSML parameters or train on non-patient elderly corpora. If multimodal fusion introduces bias, we will employ late-fusion architectures and modality ablations. All artifacts including dataset specs, code, model cards, and datasheets will be openly shared via AD Workbench. This foundational dataset will include annotations suitable for behavioral cloning and inverse reinforcement learning, enabling diverse approaches to agent development.

→ My note: Risk section serves three purposes. First, it shows we're realistic (addressing 'Feasibility'). Second, mentioning "model cards" and bias mitigation directly hits 'Ethical/Responsible AI.' Third, the final sentence about "behavioral cloning and inverse RL" shows we understand how others will use our data, demonstrating technical sophistication without overpromising that we'll do the training ourselves. AD Workbench mention ensures 'Relevance & Impact.'

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Reference List

Cummings, L. (2009). *Clinical pragmatics*. Cambridge University Press.

Cummings, L. (2014). Pragmatic disorders across the life span. In *Pragmatic Disorders* (pp. 31-65). Dordrecht: Springer Netherlands.

Cummings, L. (2015). Theory of mind in utterance interpretation: The case from clinical pragmatics. *Frontiers in Psychology*, *6*, 1286.

Cummings, L. (Ed.). (2017). *Research in clinical pragmatics* (Vol. 11). Springer.

Frick, R. W. (1985). Communicating emotion: The role of prosodic features. *Psychological bulletin*, *97*(3), 412.

Hamilton, H. E. (2008). LANGUAGE AND DEMENTIA: SOCIOLINGUISTIC ASPECTS. *Annual Review of Applied Linguistics*, *28*, 91-110.

Hamilton, H. E. (2019). *Language, dementia and meaning making: Navigating challenges of cognition and face in everyday life*. Palgrave Macmillan.

Kehrein, R. (2002, April). The prosody of authentic emotions. In *Speech Prosody 2002, International Conference*.

Pereira, C., & Watson, C. I. (1998, November). Some acoustic characteristics of emotion. In *ICSLP*.

Schiffrin, D., Tannen, D., & Hamilton, H. E. (Eds.). (2008). *The handbook of discourse analysis*. John Wiley & Sons.

2. Project Milestones (2,605/2,000)

Our project delivers the essential missing piece for agentic AI in dementia care: training data that captures real agitation dynamics. We structure delivery in two releases aligned with major ADRD conferences.

Dataset v1.0: Text Dialogues (Milestone: CTAD 2025) By CTAD 2025 (December 1, 2025), we will release a validated synthetic dataset of 1,000+ multi-turn dialogues grounded in clinical personas and scenarios. This initial release provides immediate value to researchers developing conversational AI for ADRD, offering the first corpus specifically designed for agitation management rather than diagnostic assessment. Each dialogue includes annotations for emotional valence, agitation triggers, and successful de-escalation strategies, enabling supervised learning approaches.

Dataset v2.0: Full Multimodal (Final Milestone: AD/PD 2026) By AD/PD 2026 (March 17-21, 2026), we will release the complete multimodal dataset, adding prosody-tuned audio with elderly vocal characteristics and synchronized behavioral annotations. This comprehensive resource will be the first to capture the full communicative spectrum of agitation episodes. The dataset will include metadata enabling researchers to train agents using behavioral cloning, inverse RL, or other approaches, dramatically accelerating development compared to collecting real patient data.

Utilization of AlzInsights AI Prize Support The $10,000 prize will be strategically allocated to ensure scientific rigor and community impact:

Expert Validation ($6,500): Critical for dataset quality and clinical validity. Funds provide honoraria to 13 experts on our clinical and linguistics panels for developing validation rubrics, reviewing synthetic dialogues, and ensuring our data truly represents dementia communication patterns. Without expert validation, the dataset would lack the clinical grounding necessary for real-world application.

Dissemination & Computation ($3,500): Conference registration for CTAD 2025 and AD/PD 2026 presentations ($2,500) ensures immediate community awareness and feedback. API costs for large-scale generation and LLM-assisted validation ($1,000) enable us to reach the scale necessary for meaningful AI training.

Efficient Use of Resources & Further Support UC Irvine provides all infrastructure including GPU computing, clinical partnerships, and research staff time as in-kind support. The prize funding directly targets activities that accelerate community impact. Post-release, we will pursue NIH funding to expand the dataset and develop reference implementations of agentic systems trained on our data.

3. Team Expertise (3,060/3,000)

Our actively collaborating UCI-Xavor team integrates complementary expertise across AI/ML, clinical nursing, linguistics, engineering, and robotics. Together, we are positioned to design, validate, and deploy agentic AI systems that address the communication challenges of ADRD.

Clinical & Domain Leadership Adeline Nyamathi, Ph.D.: As founding Dean of the School of Nursing and a world-renowned expert in ADRD populations, Dr. Nyamathi provides overarching clinical leadership. Her extensive experience in NIH-funded research, including projects on empathetic patient-robot interaction, ensures our work is grounded in real-world clinical needs. Her role as corresponding author on our team's JMIR publication on this topic demonstrates her direct involvement and expertise.

AI & Computational Leads Cheonkam Jeong, Ph.D. (Agentic AI Lead): Dr. Jeong, a Postdoctoral Scholar at UCI's School of Nursing, leads the agentic AI pipeline design. Her expertise in computational linguistics, specifically at the phonetics-discourse interface, and her direct application of LLMs to create conversational AI for dementia care are central to the project's core methodology. Her current research project focuses on developing multimodal models for empathetic patient-robot interaction, directly informing our approach.

Mahyar Abbasian, M.S. (Generative AI Lead): Mahyar Abbasian, a Computer Science Ph.D. candidate at UC Irvine, leads our generative AI and reasoning architecture. He is a specialist in applying LLMs to healthcare, having published in Nature npj Digital Medicine and developed 'openCHA,' an open-source framework for personalized Conversational Health Agents with multi-step problem-solving capabilities, which is the core of agentic reasoning.

Fatemeh (Saba) Azizabadi Farahani, M.Sc. (Multimodal AI Lead): Saba Farahani, a Ph.D. student in EECS at UC Irvine, leads our multimodal AI fusion. Her doctoral research is focused on developing algorithms that integrate heterogeneous data streams including bio-signals, clinical text, and sensor data for personalized health reasoning. Her expertise is critical for our pipeline's ability to harmonize audio, video, and movement data.

Technical Implementation & Specialization Ali Ahmad, M.S. (Robotics Lead): Ali Ahmad, a robotics engineer with over 12 years of experience, leads the physical robot integration. As Team Lead for Robotics at Xavor, he oversees the end-to-end development of the ROS-based Care Robot platform that will house our agentic AI, managing everything from hardware and software integration to autonomous navigation.

Farhan Azhar, B.S. (Synthetic Speech & AI Lead): Farhan Azhar, a Senior AI Consultant at Xavor, leads the development of our prosody-tuned synthetic speech pipeline. He has direct, hands-on experience developing emotional intelligence for care robots in a prior collaboration with UCI and has co-authored publications on the topic, ensuring our synthetic speech is not just technically sound but emotionally and clinically resonant.

Muhammad Rafay Shafqat, B.S. (Computer Vision Lead): Muhammad Rafay Shafqat, a Machine Learning Engineer at Xavor, specializes in the computer vision pipeline for the Care Companion Robot. His expertise is foundational to our project's objectivity, as he manages the workflow from dataset collection to model deployment on edge AI devices, enabling the direct, data-driven scoring of clinical instruments like the CMAI from video analysis.

Project Hypothesis, Methods, and Validation (4,961/4,000) - without my note

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