REQUILIBRIUM

An intelligent, adaptive system designed to help late stage Parkinson's patients regain equilibrium. In movement, in mind, and in daily life.

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RESEARCH AND PROBLEM DEFINITION

HYPOTHESIS

After completing some preliminary research, I developed an initial hypothesis that required validation through qualitative research. My hypothesis suggested that:

Balance impairment, resulting in falls, is one of the most significant and common symptoms experienced by individuals with mid to advanced stages of Parkinson's disease. Despite numerous interventions, falls continue to be a leading cause of injury, diminished quality of life, and heightened healthcare burden, highlighting the urgent need for more effective and personalized strategies for fall prevention.

RESEARCH PLAN

Goal

Learn what are the most impactful daily challenges for people living with mid-advanced stages of Parkinson's Disease that persist despite conventional treatment. What do they do to mitigate those challenges, and how effectively do their actions address these challenges?

Learning objectives

01

Understand the top 3 challenges of mid-advanced stage Parkinson's Disease patients and if falls or balance impairment constitutes one of them

02

Understand how those unmet needs are prioritized: What unmet need affects or impairs their quality of life the most and why

03

Understand if or how they are currently addressing or if they are actively trying to resolve this unmet need

04

Understand what difficulties if any they encounter with existing solutions and why those solutions don't fill the need gap adequately, if applicable

USER INTERVIEWS

Interview findings with 3 late-stage Parkinson's Disease patients revealed that balance impairments causing frequent falls or fear of falling, and challenges around managing daily activities around medication 'on' and 'off' periods, highlight an urgent, unmet need for innovative interventions that can improve functional mobility, enhance safety and help patients better manage medication-dependent symptom fluctuations.

Painpoints and needs

Participants were concerned about falls, mobility and transfers. Their top challenges are balance impairments causing falls and difficulties with sitting-to-standing transfers.

They plan their lives according to their physical limitations to reduce difficulty in mobility or fall risk.

They don't want solutions that are escalatory due to a fear of 'disruption', but prefer triaged solutions.

All participants mentioned having 'on' and 'off' periods and related these to the timing of their medications. They time particular tasks and functions around certain windows.

All participants mentioned a need for calm and focus when symptoms surge. 'Off' periods lead to slower thinking, missed routines and anxiety, which worsen their motor symptoms.

RESEARCH INSIGHTS

01

Falling or fall risk leads to fear and anxiety, which is a force multiplier.

Anxiety degrades both motor and cognitive function.

02

Transfers from sitting to standing severely limit independence and quality of life

They cause delays waiting for caregivers and induce a fear of falls.

03

Medication windows run their day.

Patients plan their activities around how effective their treatment is.

04

Users avoid help if it auto-escalates.

They prefer to steer clear of costly and inconvenient hospital visits, seeking triaged solutions and control.

05

Solutions must adapt to fluctuating symptoms.

Low cognitive load options and easy modes for 'off' periods need consideration.

PROBLEM DEFINITION

People with mid to advanced stage Parkinson’s Disease often face symptoms that conventional treatments can't adequately address. Key challenges include balance issues, frequent falls, and difficulties with basic mobility tasks like sitting-to-standing transfers. Despite therapies like levodopa, deep brain stimulation, and physical therapy, these mobility problems remain a major cause of injury, loss of independence, and reduced quality of life. This cycle of fear and helplessness underscores the urgent need for innovative interventions to restore mobility, enhance safety, and improve well-being for those with advanced stage Parkinson’s Disease.

CONCEPT DEVELOPMENT & USER INTERACTION

GATHERING REQUIREMENTS

After carefully analyzing and prioritizing insights, I outlined the UX requirements to tackle essential user issues, detailing how to address the data flow of AI concepts and the specific areas within the app where these would be implemented. Some key aspects included:

Predictive fall risk assessement:

Based on medication window timing, predicts when fall risk is highest and provides proactive suggestions and output regarding:
1. Gait patterns - learns these over time and improves and personalizes
2. What tasks and activities to focus on
3. What tasks to avoid doing
4. Increases awareness and provides warnings
5. Suggests how to alter movements
6. Vibrates in case of high risk situations

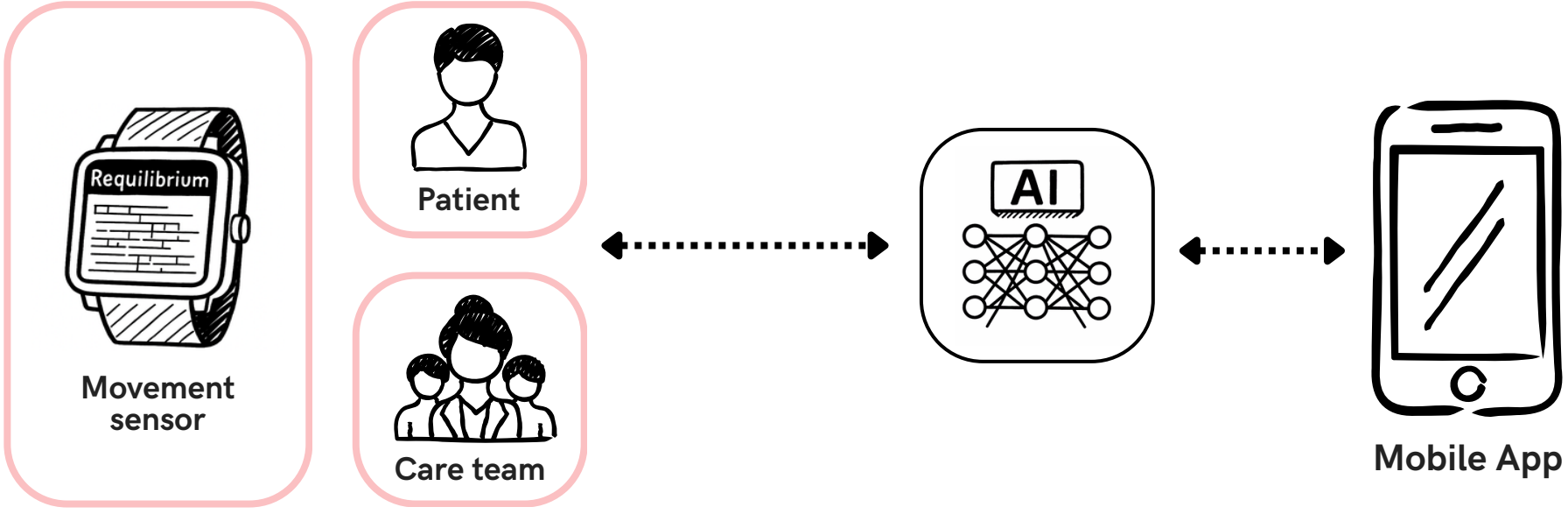
Medication window optimization:

Model learns how to optimize medication timing according to patient needs.
1. Recommends tasks to focus on - (Great time to get out of the house)
2. Recommends tasks to avoid (Risk window - focus on reading and low energy tasks)

Capturing movement data

How can the product identify gait patterns or sensory input signals related to movement and display this information on a wearable and / or mobile device?

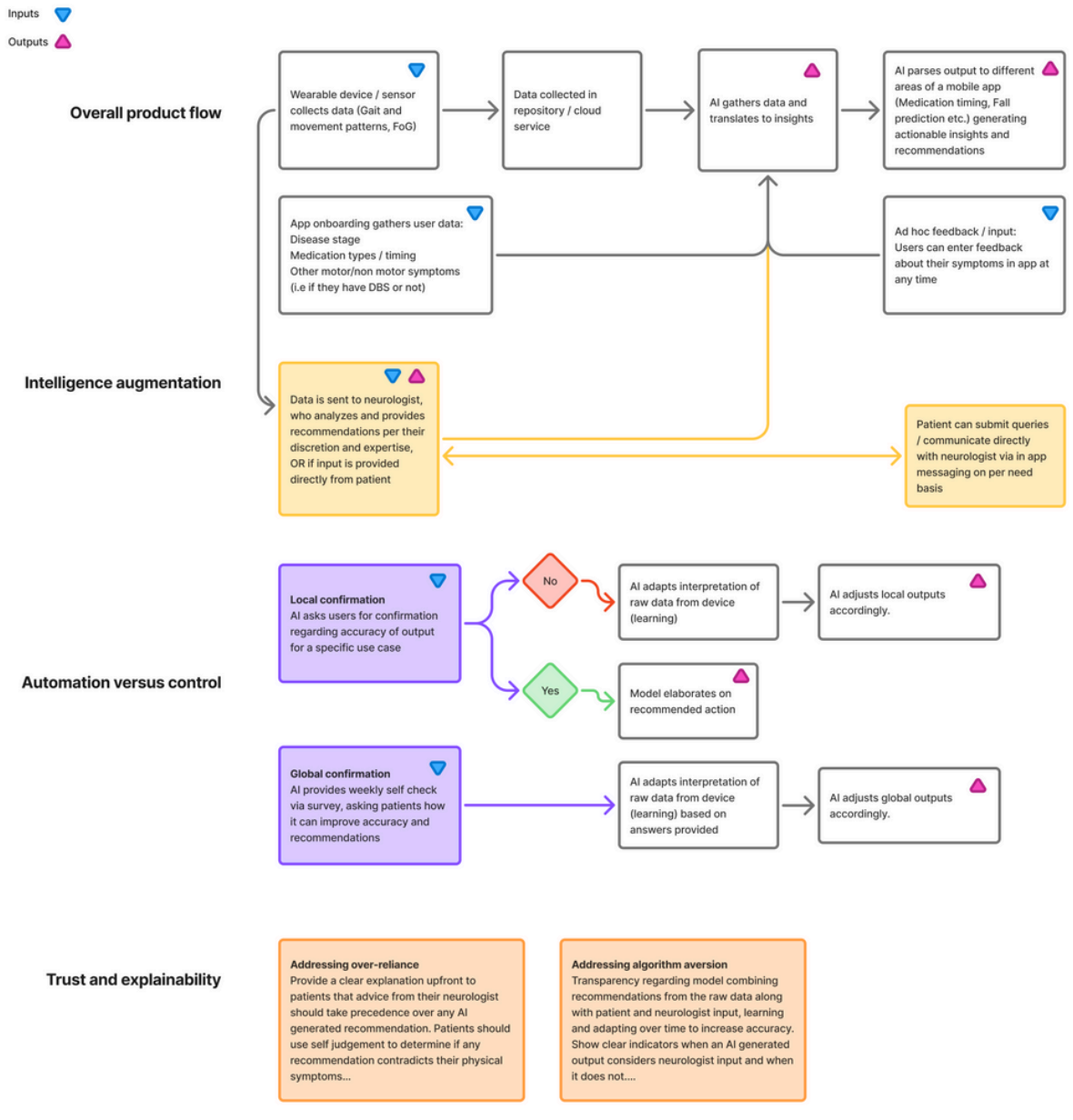
SOLUTION: A TRIAGED ECOSYSTEM



A smart, wearable app ecosystem monitors Parkinson's symptoms and medication effectiveness, offering personalized insights while preserving clinician oversight and patient autonomy. It uses wearable sensors to detect movement and gait patterns and possible freezing episodes (FoG), while the mobile app captures medication timing and real-time symptom feedback. AI analyzes combined data from wearables, patients, and clinicians to surface personalized insights - reviewed and refined through clinician oversight, to identify fall risks, predict mobility patterns, and recommend optimal activities around medication timing.

AI SYSTEM ARCHITECTURE AND DATA FLOW

This diagram illustrates the AI system architecture and data flow behind *Requillibrium*, mapping how data from wearables, users, and clinicians translates into meaningful insights and adaptive recommendations.
It highlights the balance between human and machine intelligence, ensuring transparency, user control, and trust throughout the product experience.



AI CONSIDERATIONS AND BEST PRACTICES

Balancing automation and user control

Onboarding

App onboarding requires user input regarding disease stage, medication types or clinical treatments (i.e levodopa, DBS), and other forms of disease management (i.e physical therapy). It also requires input regarding motor and non-motor symptoms, using this as part of any AI generated output.

Clinician AI collaboration

The system facilitates seamless communication between patient and neurologist, with any AI generated recommendations / feedback supporting clinical decision making. Neurologist recommendations take precedence over AI suggestions, maintaining clinical authority and augmenting care with continuous monitoring insights.

User Feedback

Users can provide in-app feedback about any of their symptoms at any given time. Any AI suggestions or recommendations adapt to this feedback in real time, considering current medication timing windows, clinician recommendations and sensor data

AI CONSIDERATIONS AND BEST PRACTICES

Balancing automation and user control

Mixed initiative interaction - Local confirmation

Any AI-generated recommendation or suggestion can be rejected by users. In case of rejection, the AI would ask for feedback for improvement. Local confirmation asks patients to validate specific AI outputs (like fall risk alerts), adapting interpretation based on accuracy.

Weekly feedback loops - Global confirmation

A short, optional weekly check-in calibrates system-level settings - medication timing windows, risk thresholds, and alert frequency - based on the patient's week and clinician input. Results adjust future recommendations (with undo and clinician review where needed), improving accuracy and trust over time.

AI CONSIDERATIONS AND BEST PRACTICES

User trust and explainability

Addressing over-reliance through app messaging and reminders

The system takes proactive measures to prevent blind adherence to AI recommendations through clear messaging and patient empowerment. Onboarding establishes upfront that neurologist advice always takes precedence over AI-generated recommendations. The app also prompts users to cross reference AI suggestions against their physical symptoms and lived experience. For instance, if the AI recommends increased activity during a period where the patient feels physically unstable, users can reject this recommendation, and clear messaging reminds them: "Your body's signals matter most -consult your neurologist if this recommendation feels inconsistent with your current symptoms". The patient's critical role in their care decisions is therefore upheld while leveraging AI-generated insights.

AI CONSIDERATIONS AND BEST PRACTICES

User trust and explainability

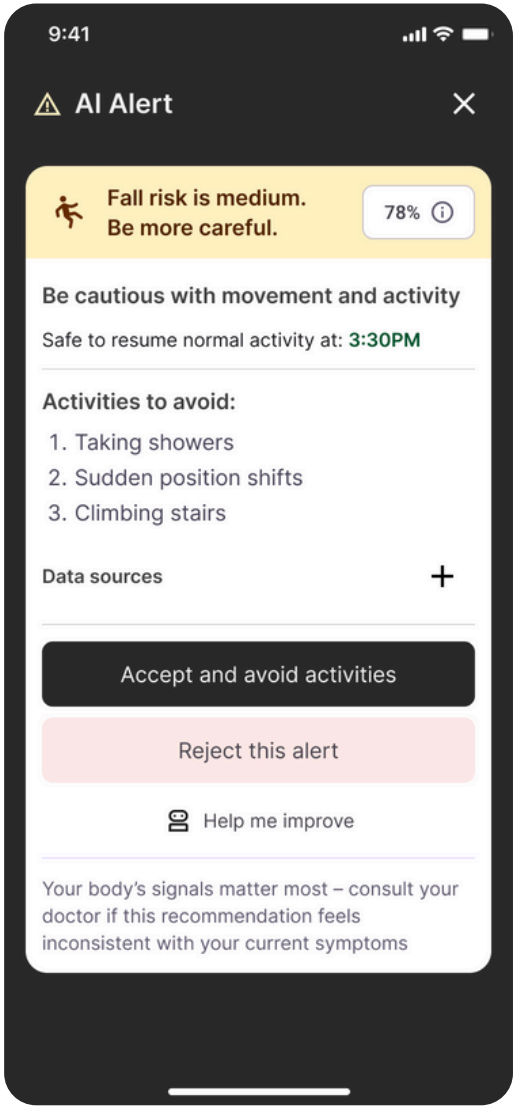
Addressing algorithm aversion

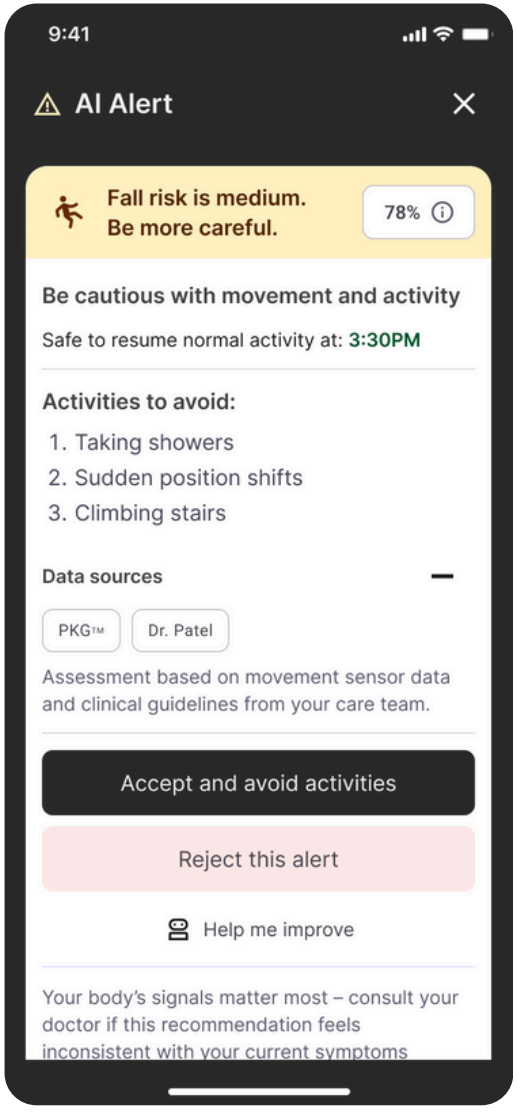
System builds user trust and confidence via:
Transparent visibility into how the AI combines multiple data sources – showing when recommendations draw from sensor data, patient input, neurologist guidance or all three.
Clear visual distinctions show whether outputs incorporate recent neurologist input versus purely sensor-based analysis, helping patients understand the clinical validation behind any recommendation.
Progress indicators demonstrate the algorithms improved accuracy over time (through feedback loops, local and global confirmation), and can display metrics like "Prediction accuracy increased by 12% after incorporating your feedback"
The system can also acknowledge uncertainty regarding outputs through confidence level indicators, and if their confidence level is below a certain threshold, can suggest human consultation is warranted.

AI FEATURE DESIGNS

AI generated alerts: Fall risk prediction

In-app AI alerts, based on sensor data and input from patients and neurologists, include a confidence score to build trust. Clicking the info icon explains the score calculation. Each recommendation lists data sources and advises consulting a doctor for inaccuracies. Users can accept, reject, or give feedback for AI improvement.

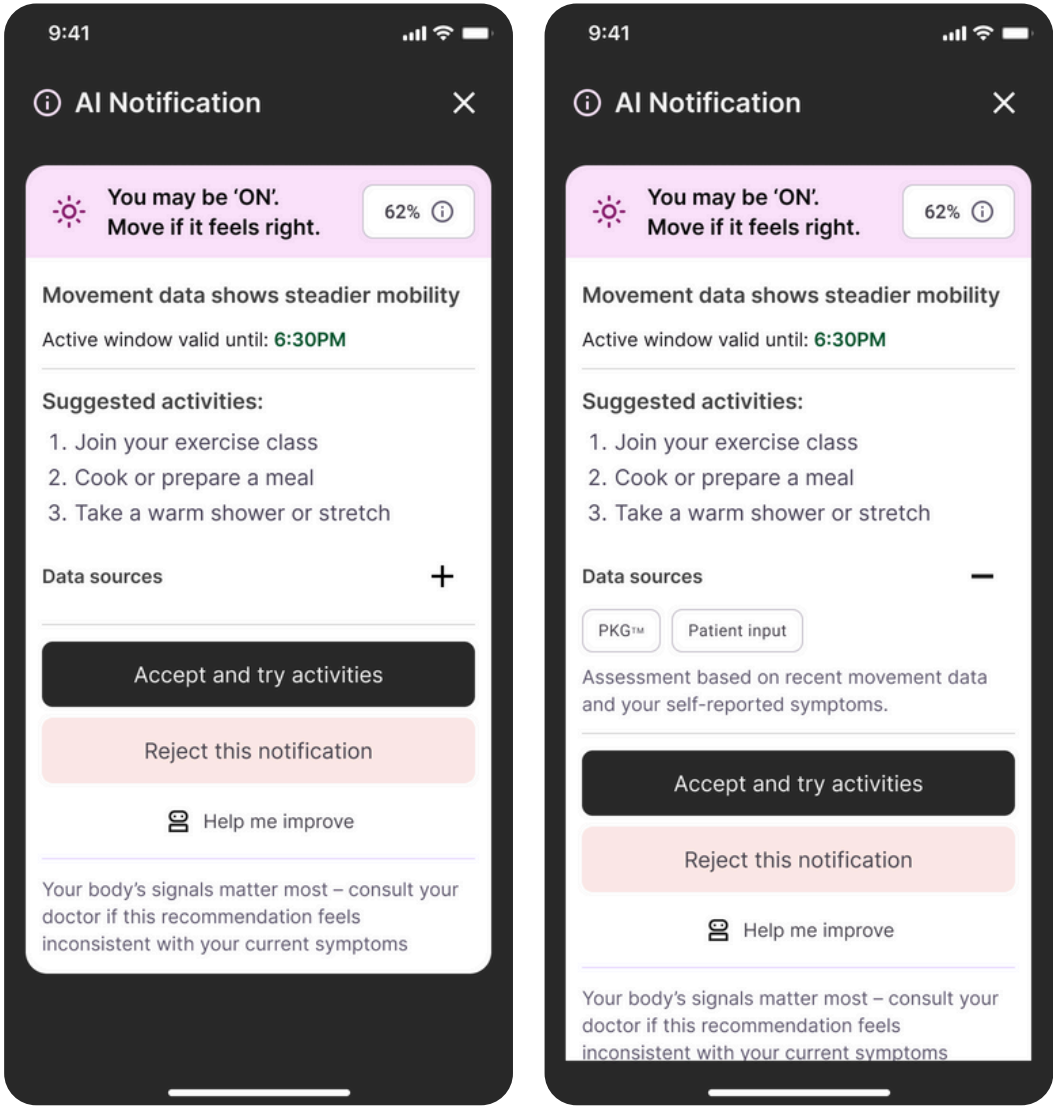




AI FEATURE DESIGNS

AI generated recommendations: ‘On’ and ‘Off’ state detection

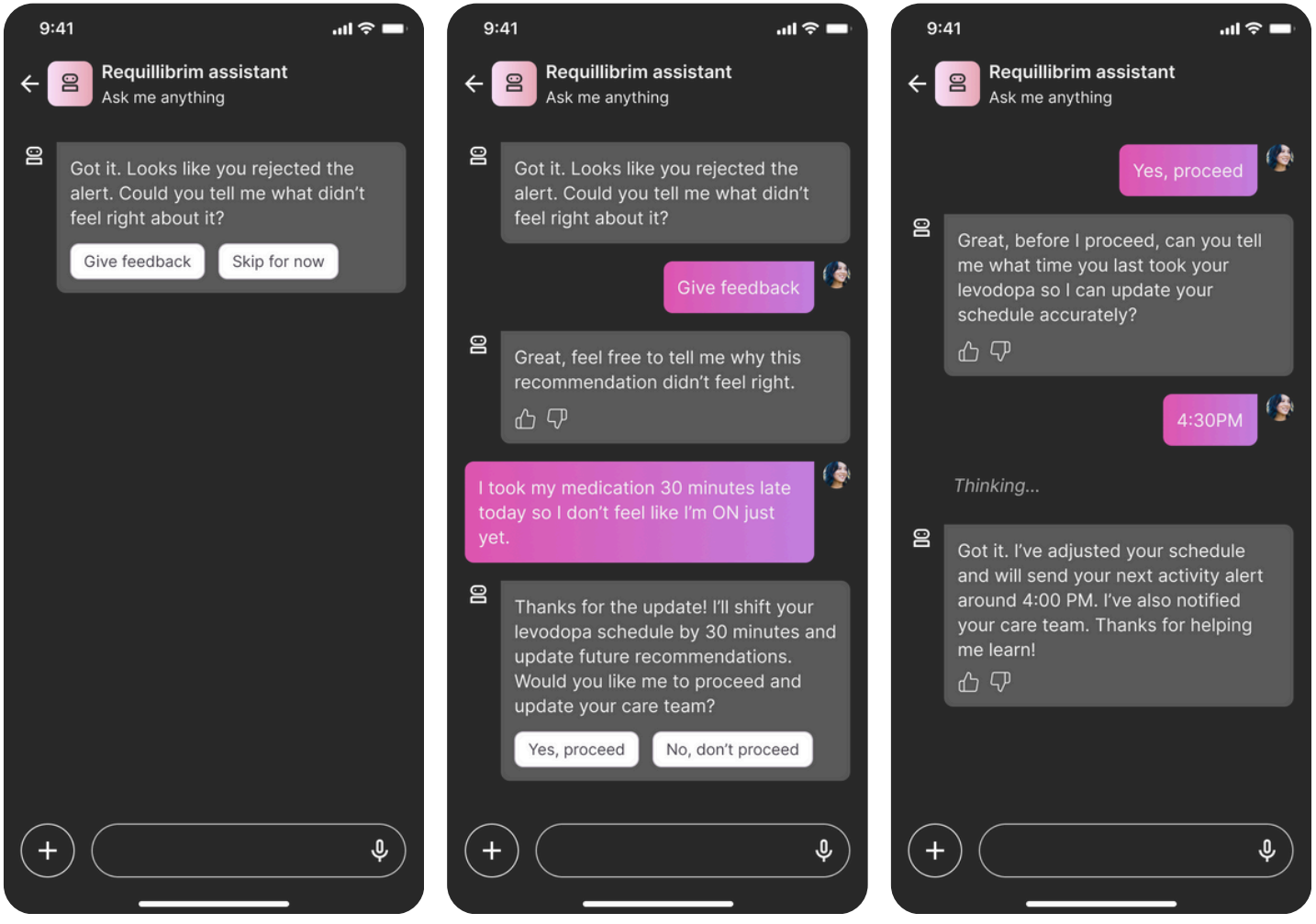
AI generated recommendations are provided according to patient input, i.e the timing of their medication intake, as well as gait patterns and data received from their sensor device. In case the user rejects the recommendation, the AI prompts them to give further elaboration and adapts its outputs accordingly.



AI FEATURE DESIGNS

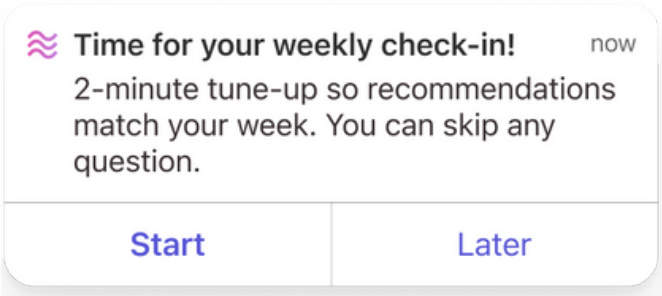
Mixed initiative interaction: Local confirmation

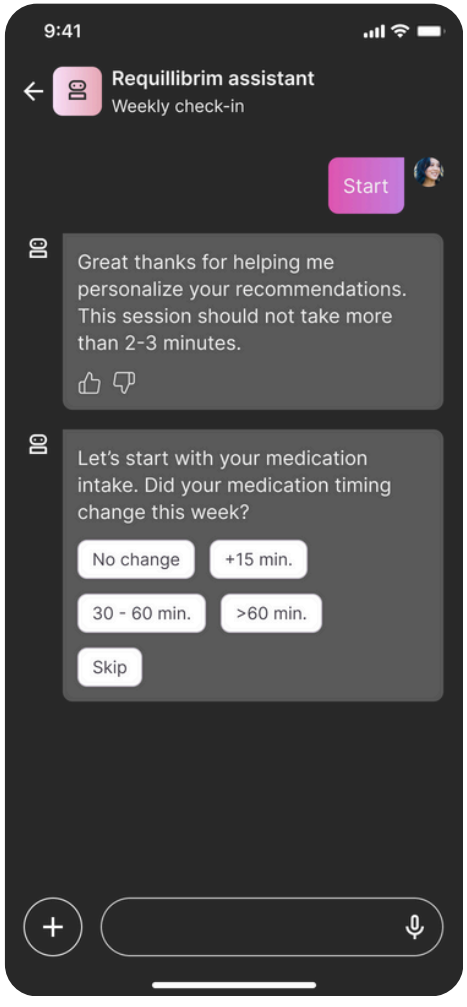
If users reject any AI generated alert or recommendation, the app AI chat prompts them with the option to provide feedback. Through local confirmation, the model can adapt its interpretations of sensor and gait data, and can adjust local outputs accordingly.

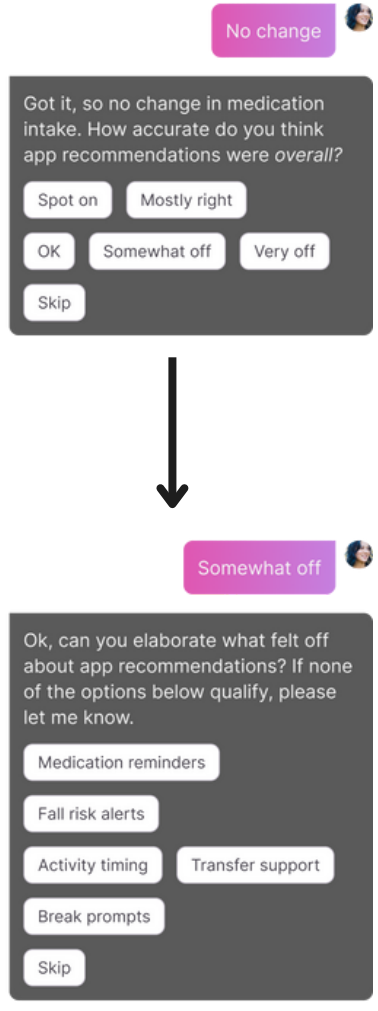


AI FEATURE DESIGNS

Weekly feedback loops: Global Confirmation







A brief weekly check-in recalibrates system level parameters: timing windows, risk thresholds, and alert cadence - so recommendations adapt to the patient's week, with clinician oversight and an end of flow apply/share control.

AI FEATURE DESIGNS

Low cognitive / simplified mode

When *Requilibrium* AI detects an ‘Off’ state with over 80% confidence, it presents a ‘Simplified Mode’ prompt, shown either as an alert or confirmation depending on context. The prompt is designed for cognitive ease featuring larger text, clear CTAs and a calming tone.
If the user confirms, the app activates ‘Simplified Mode’, adapting the interface and leveraging iOS accessibility tools like Assistive Access and VoiceOver.
Users can also toggle ‘Simplified Mode’ anytime from the top bar for flexible, on-demand control.

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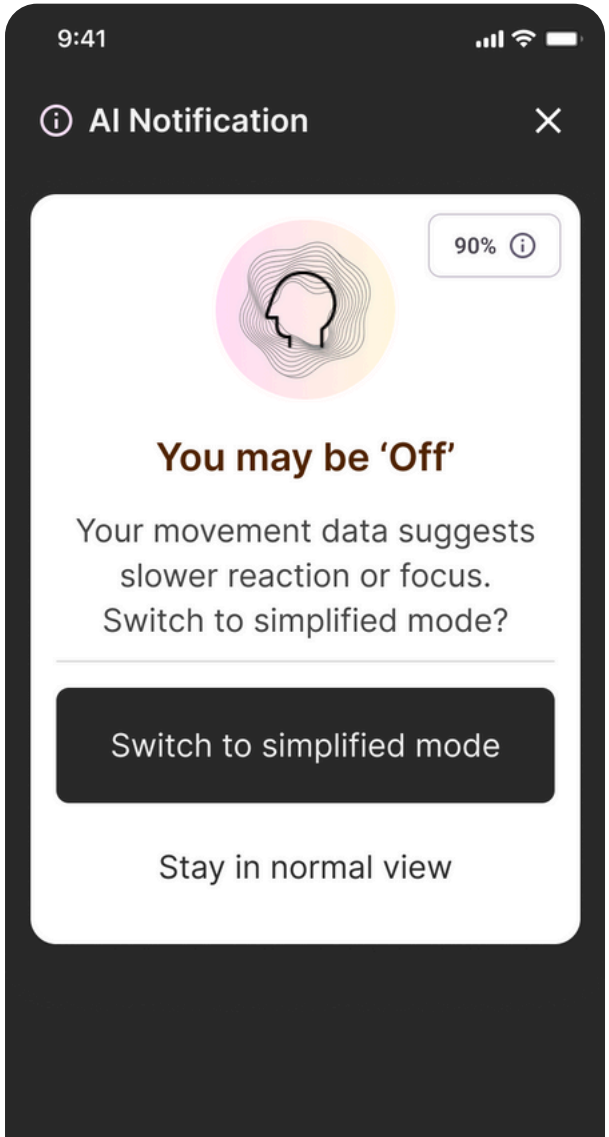
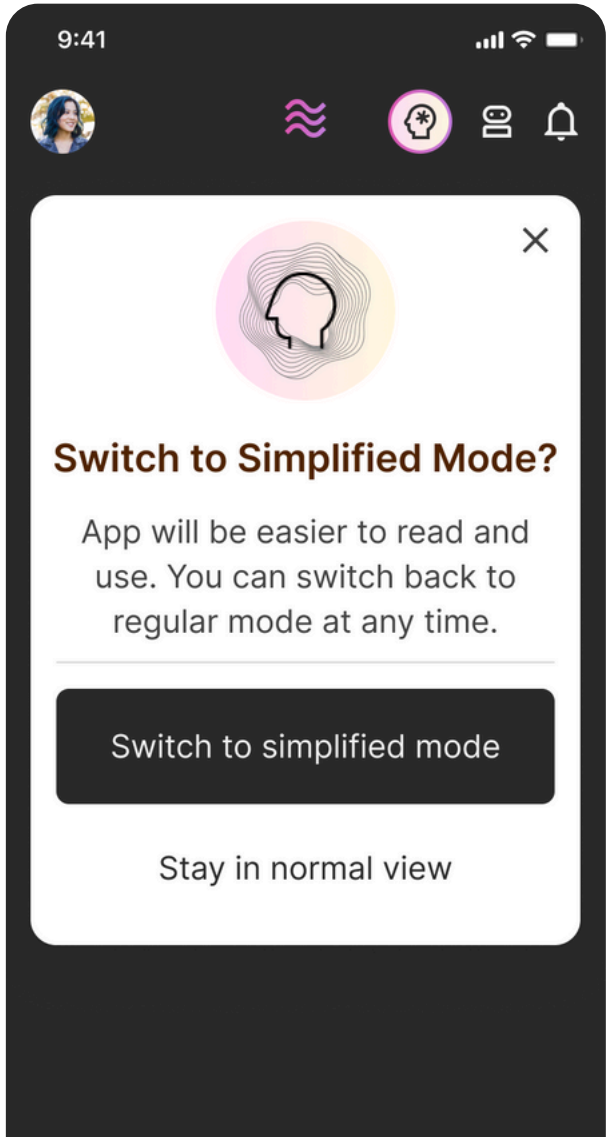
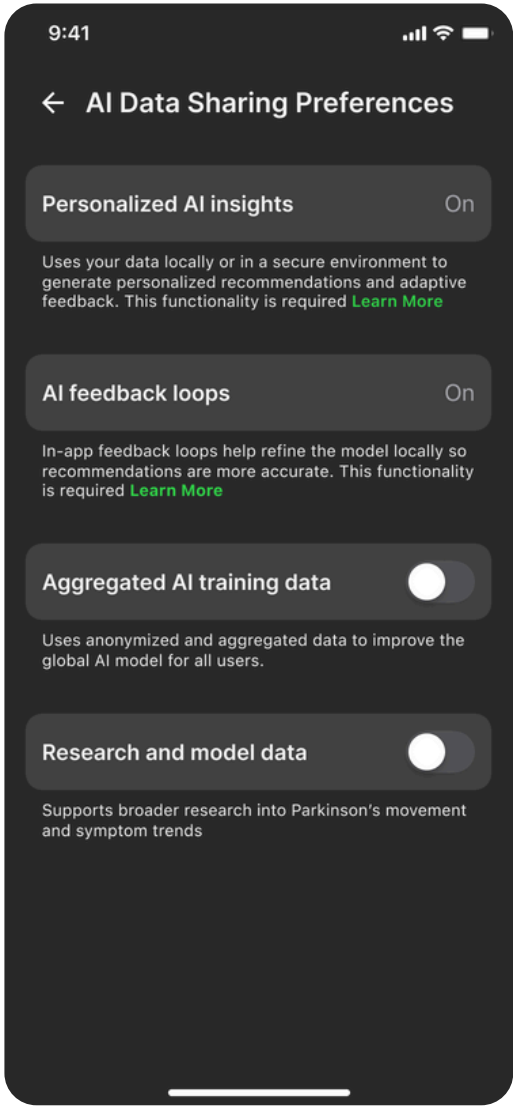




AI FEATURE DESIGNS

AI Data Sharing Preferences

Users have clear control and full transparency into how their data supports *Requilibrium* AI. Core functionality such as personalized AI insights and AI feedback loops are always active to maintain adaptive, real-time guidance. Users can choose to share aggregated and research data to help improve the model over time, ensuring transparency and user agency without compromising essential functionality.



ETHICS AND SOCIETAL IMPACT REVIEW

RISKS & MITIGATIONS

Privacy, data collection and sharing

Requilibrium continuously collects highly sensitive data, including gait patterns, medication schedules, and symptom fluctuations through both passive and manual inputs. Without clear transparency, users may not understand how or why their data is used or shared.

Mitigations

1. Provide clear, accessible privacy and data-use policies.
2. Offer granular consent options to opt in/out of specific data types.
3. Store raw data locally or on an encrypted local hub with limited retention.
4. Require clinician and patient co-approval before sharing any data externally.

RISKS & MITIGATIONS

Security and system misuse

Continuous data streams from wearables, cloud storage, clinician and patient input can increase exposure to potential data breaches or misuse. For example, bad actors could potentially manipulate the model to gain insights into training data, or external APIs can introduce weak links if not properly secured.

Mitigations

1. Apply end-to-end encryption across all data channels.
2. Use AI based anomaly detection to flag suspicious activity or spoofing.
3. Implement multi-factor authentication and role-based access.
4. Comply with HIPAA and data breach notification laws, providing transparent user alerts and mitigation instructions.

RISKS & MITIGATIONS

Algorithm bias and misinterpretation of symptoms

Requilibrium AI generated suggestions and insights may not take into account a varied enough data set to provide accurate results always. As symptom manifestation can vary widely across patients, AI trained on limited or biased datasets can misinterpret symptoms across cultural contexts, body types or ages. This can lead to false alarms or missed detections.

Mitigations

1. Train models on diverse, representative datasets.
2. Continuously audit model accuracy and false positive / negative rates across demographics.
3. Include clinician and patient feedback loops for ongoing tuning.
4. Communicate model limitations and confidence levels transparently. Clearly communicate that *Requilibrium* offers decision support rather than diagnosis.

RISKS & MITIGATIONS

Patient safety, data integrity and error handling

Errors in data capture, transmission and processing can lead to inaccurate outputs, producing unsafe recommendations affecting medication intake, physical activity and other daily routines. For late stage Parkinson's Disease patients, this poses a real safety risk.

Mitigations

1. Perform continuous data validation and third-party audits.
2. Apply multi-layer verification, including clinician review and user confirmation. For example, asking the patient to confirm they were unstable to reinforce safety and patient agency.
3. Use 'safe failure' logic: defer outputs when confidence score is low, or below a certain threshold.
4. Maintain accessible error logs for clinician oversight.

RISKS & MITIGATIONS

Accessibility, inclusivity and equity

Patients with limited means, cognitive challenges, or low digital literacy risk exclusion from benefit. Furthermore, patients who are a part of under resourced care systems may have limited access to clinician based features. This can potentially reinforce inequities, for example if only available through private clinics, advanced hospitals or expensive wearables.

Mitigations

1. Offer tiered pricing options to improve affordability. For example, a basic monitoring only version versus a premium version including clinician input and review.
2. Allow authorized caregiver access to manage the app for patients experiencing cognitive relapses or slowed thinking.
3. Include a 'low cognition' mode with simplified UI and voice guidance, including reassuring feedback to reduce anxiety and increase confidence.
4. Support offline functionality for intermittent connectivity.

RISKS & MITIGATIONS

Cognitive dependence and reduced autonomy

Overreliance on AI insights or recommendations can erode user confidence and bodily self-awareness, especially during cognitive decline. This can in turn actually amplify patient core problems, for instance, leading to a 'learned helplessness'.

Mitigations

1. Use suggestive versus directive language in recommendations. For example, phrases like 'Your movement patterns suggest you should take things easy', instead of 'You're in an 'off' period'.
2. Display confidence scores and rationale in natural language.
3. Encourage user judgment to take precedence over AI advice.
4. Always give users the option to 'reject' or 'ignore' any AI generated output, and provide prompts for self-reporting, encouraging bodily awareness.

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