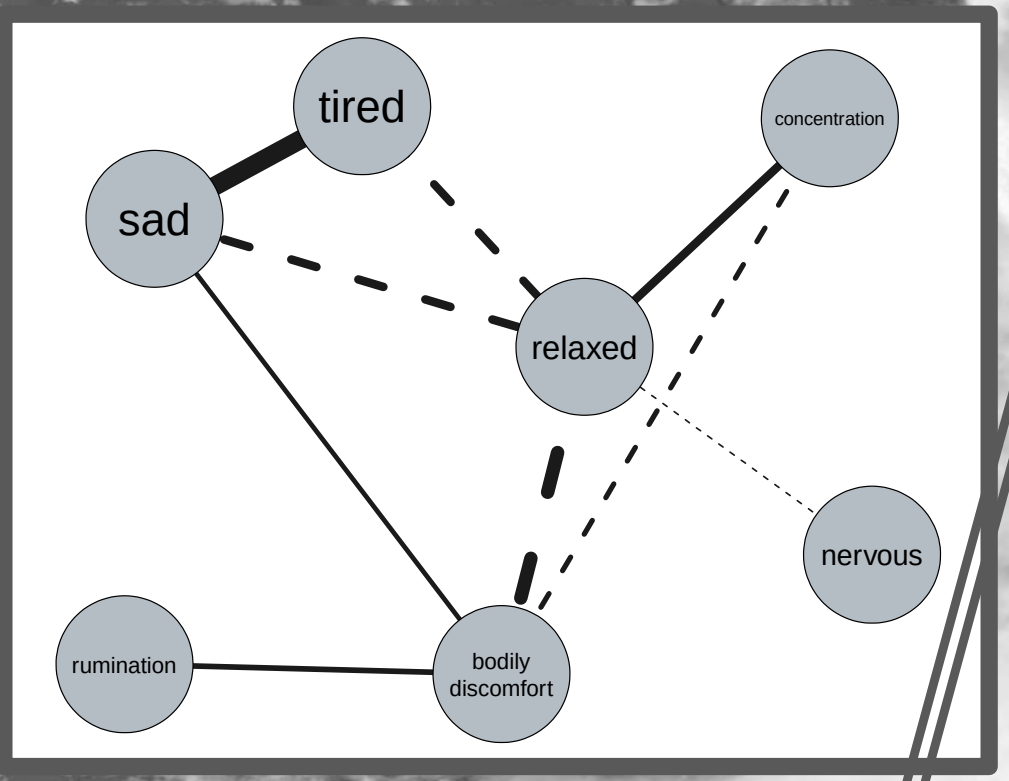
ICPS 2019

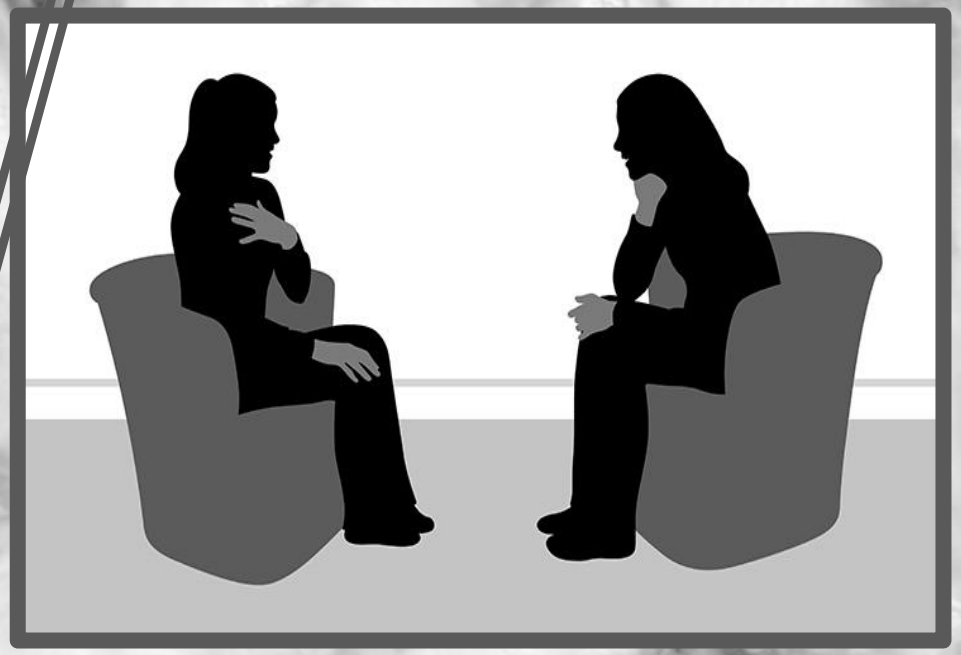
TIPS: Therapy Implications from Psychopathological Dynamical Systems

Julian Burger

University of Amsterdam, University Medical Center Groningen

Network Models and Clinical Psychology

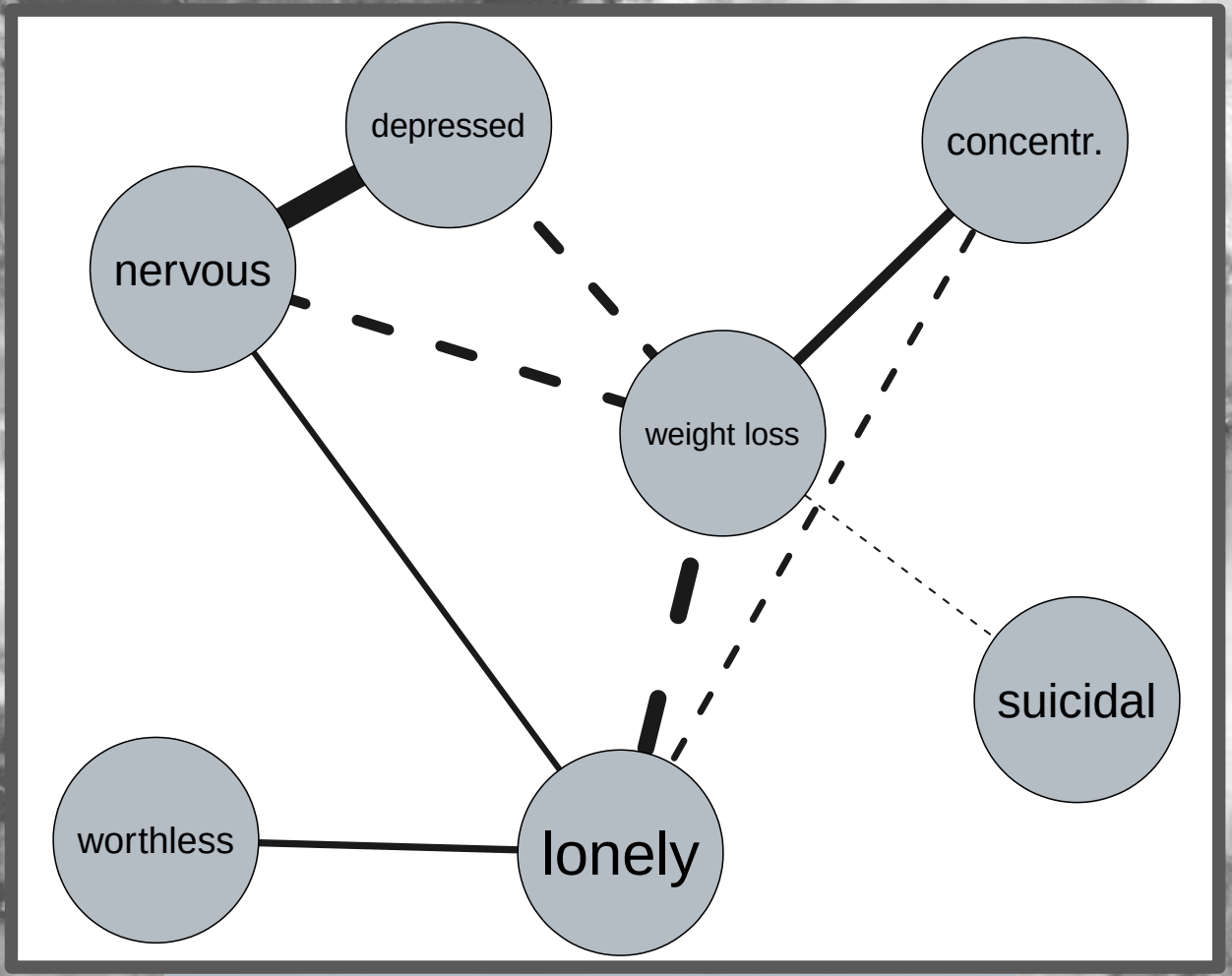




Practical and Theoretical Considerations

Consideration 1:

***Severity* of Symptoms**



Patient 1

Practical and Theoretical Considerations

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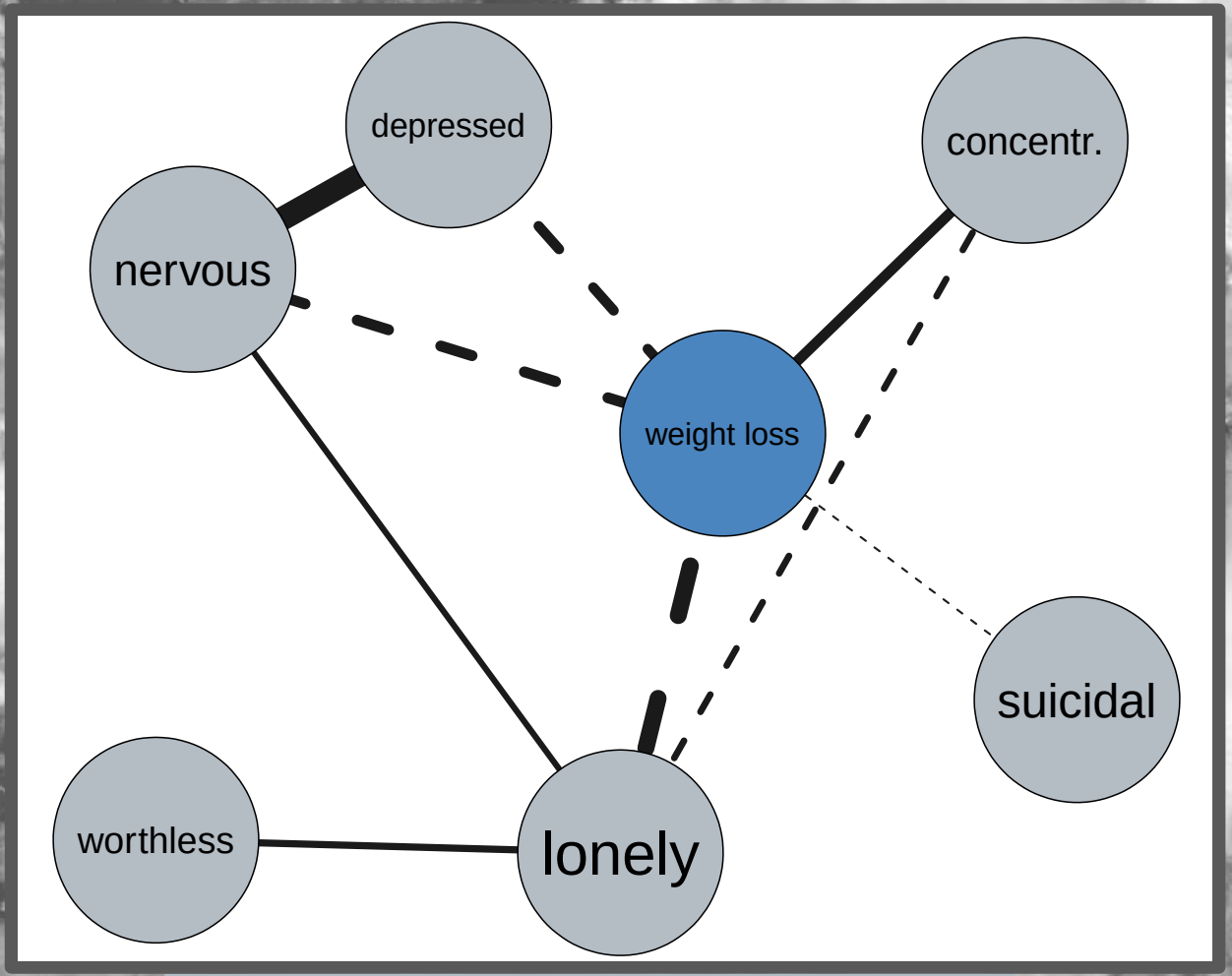

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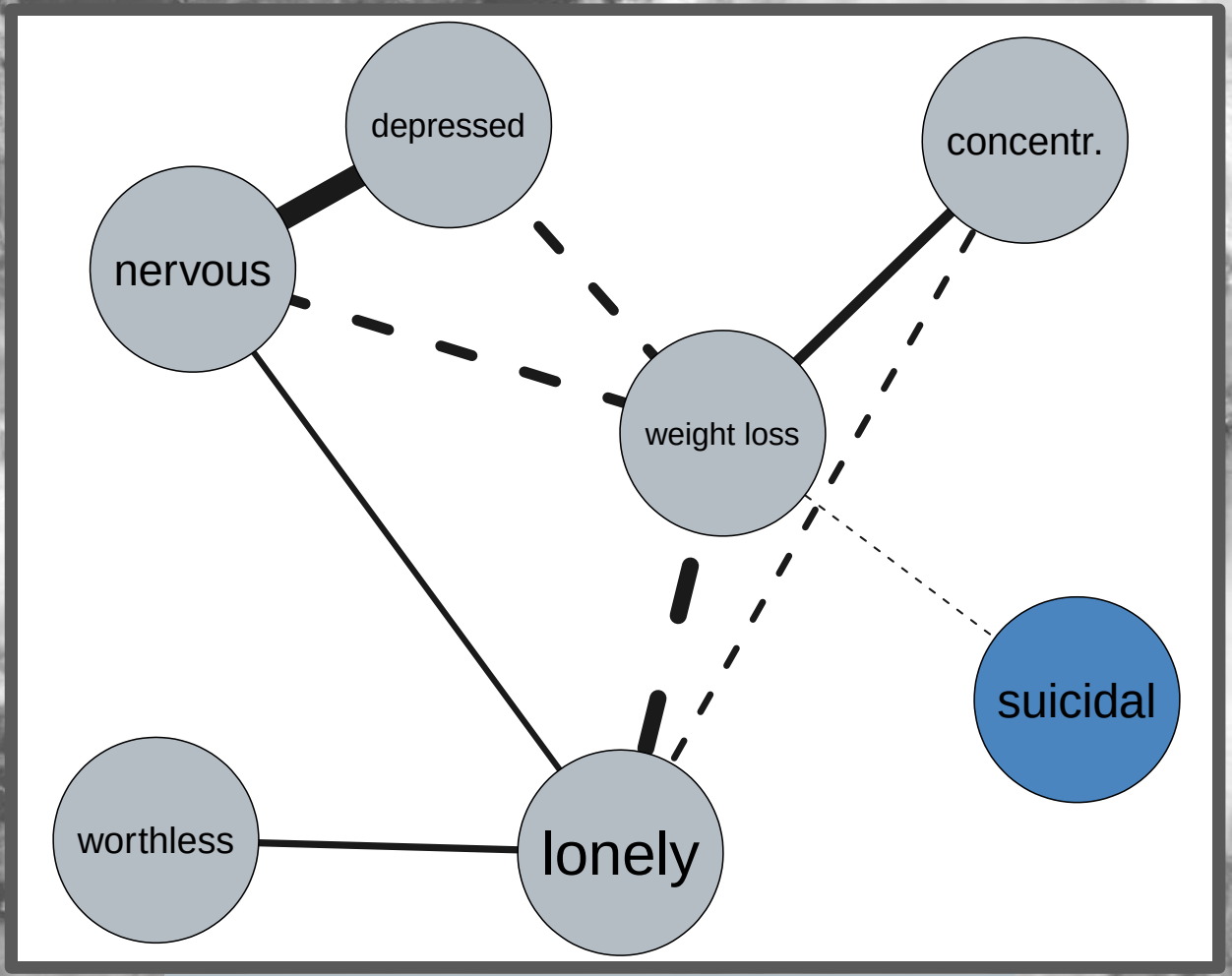
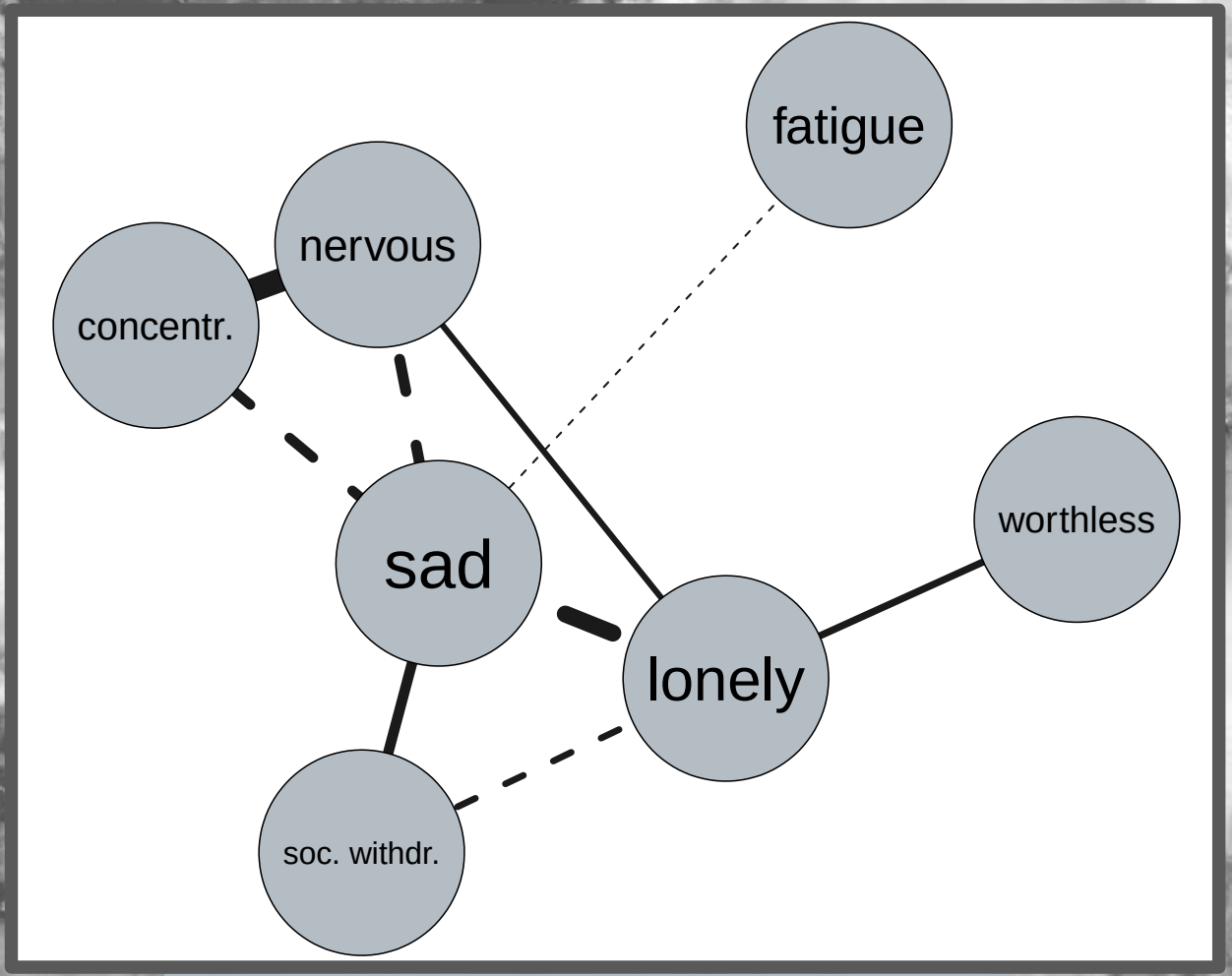


Patient 1

Practical and Theoretical Considerations

Consideration 1:
***Severity* of Symptoms**

Consideration 2:
***Accessibility* of Symptoms**



Patient 2

Practical and Theoretical Considerations

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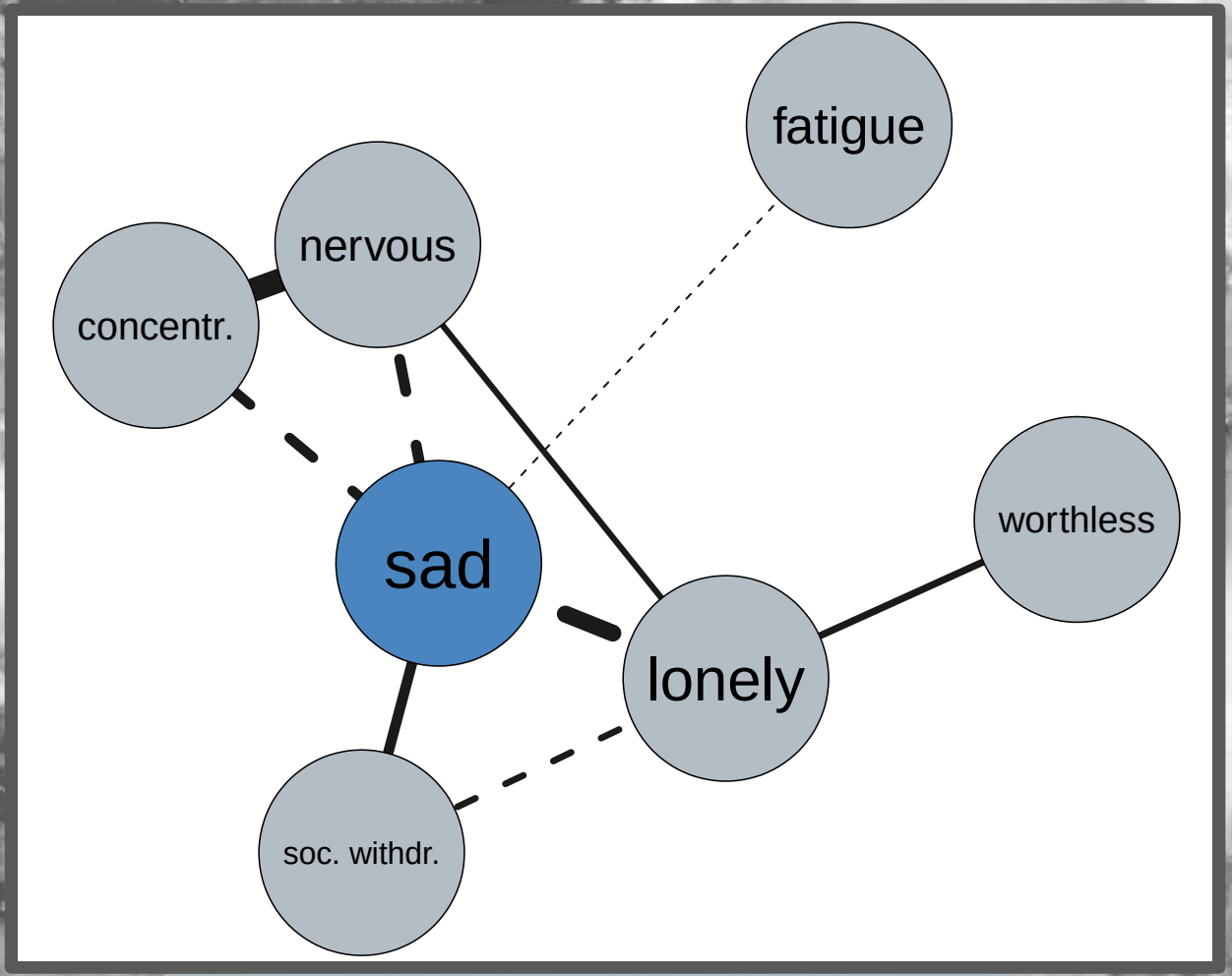

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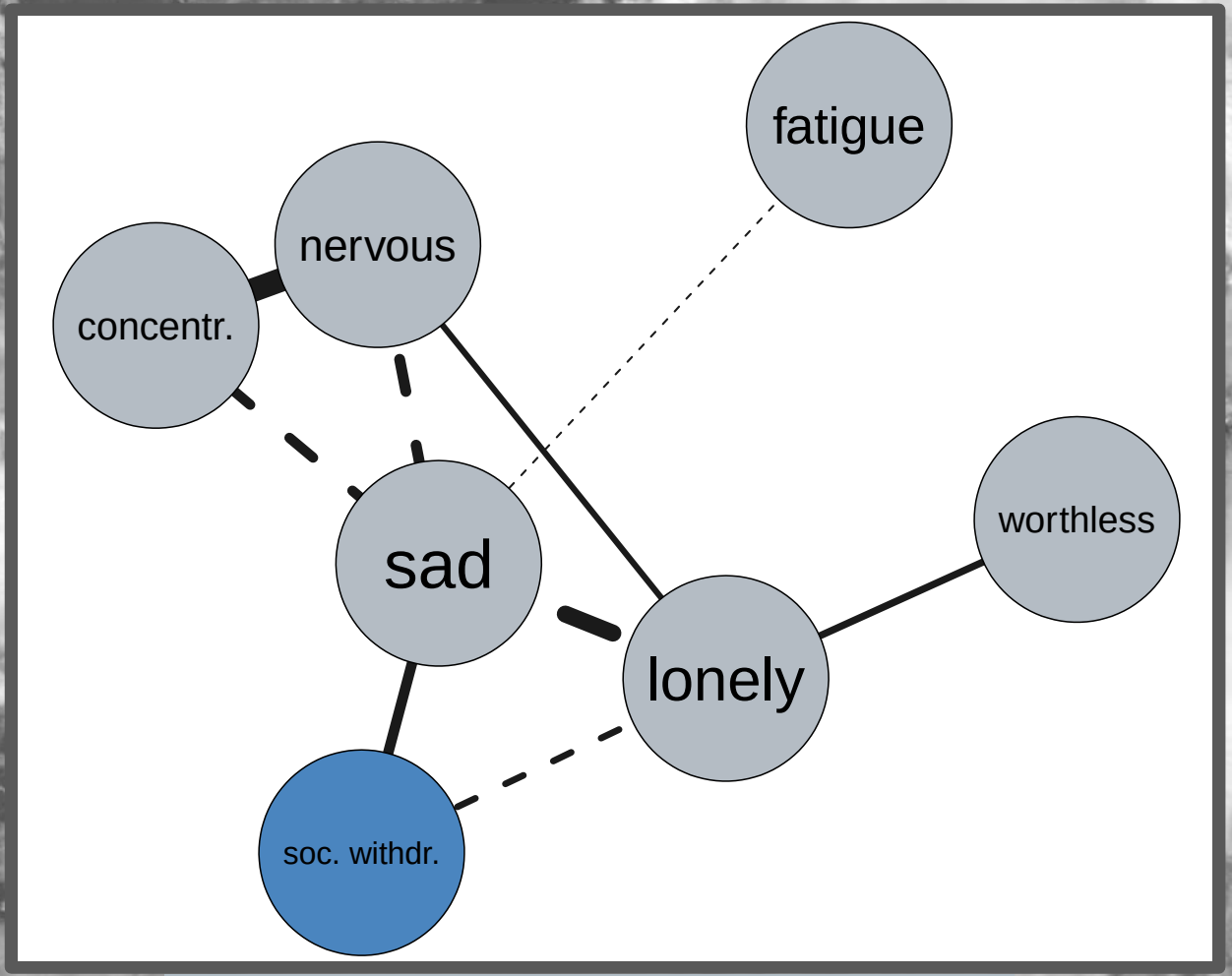


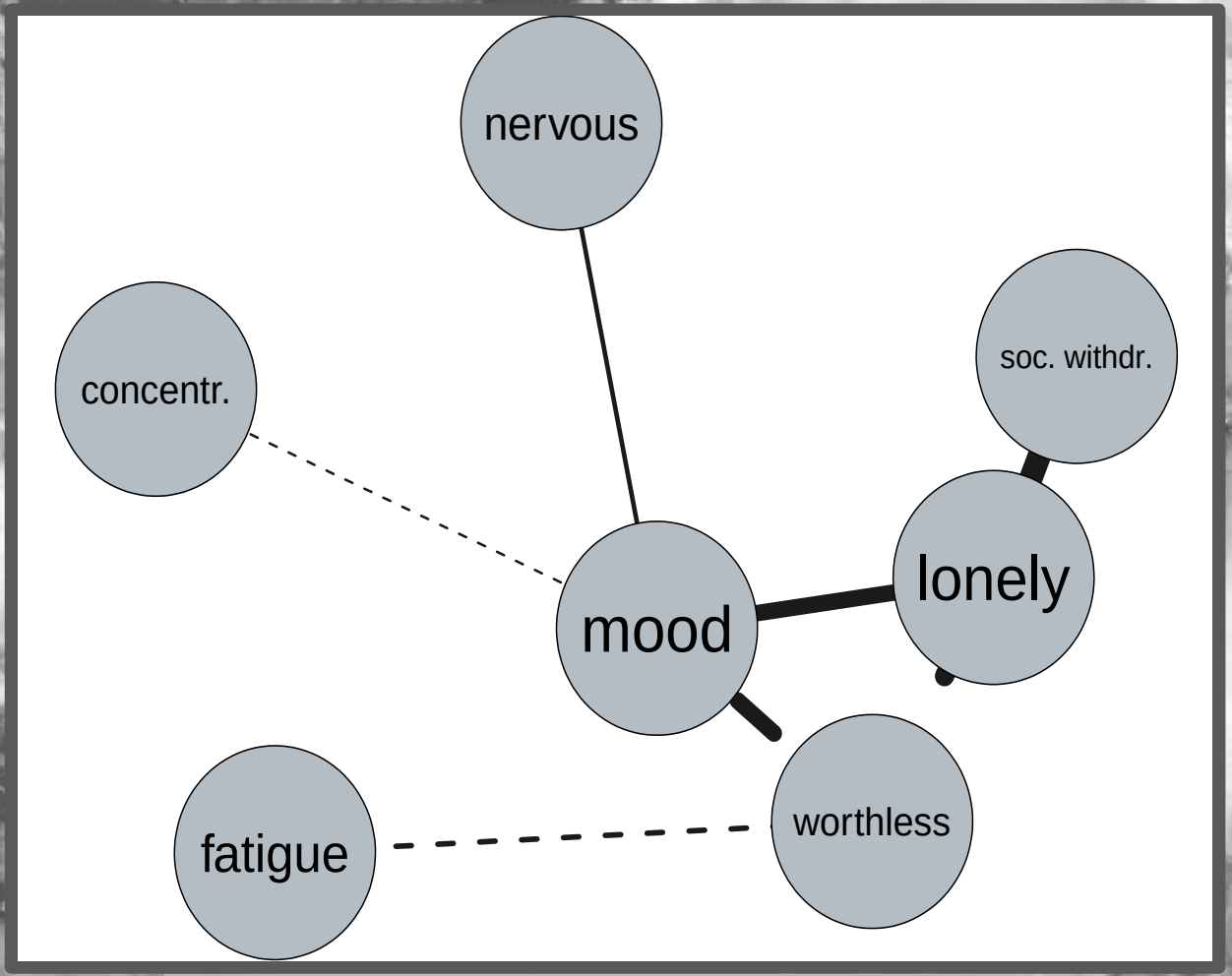
Patient 2

Practical and Theoretical Considerations

Consideration 1:
Severity of Symptoms

Consideration 2:
Accessibility of Symptoms

Consideration 3:
Clinical Theories



Patient 3

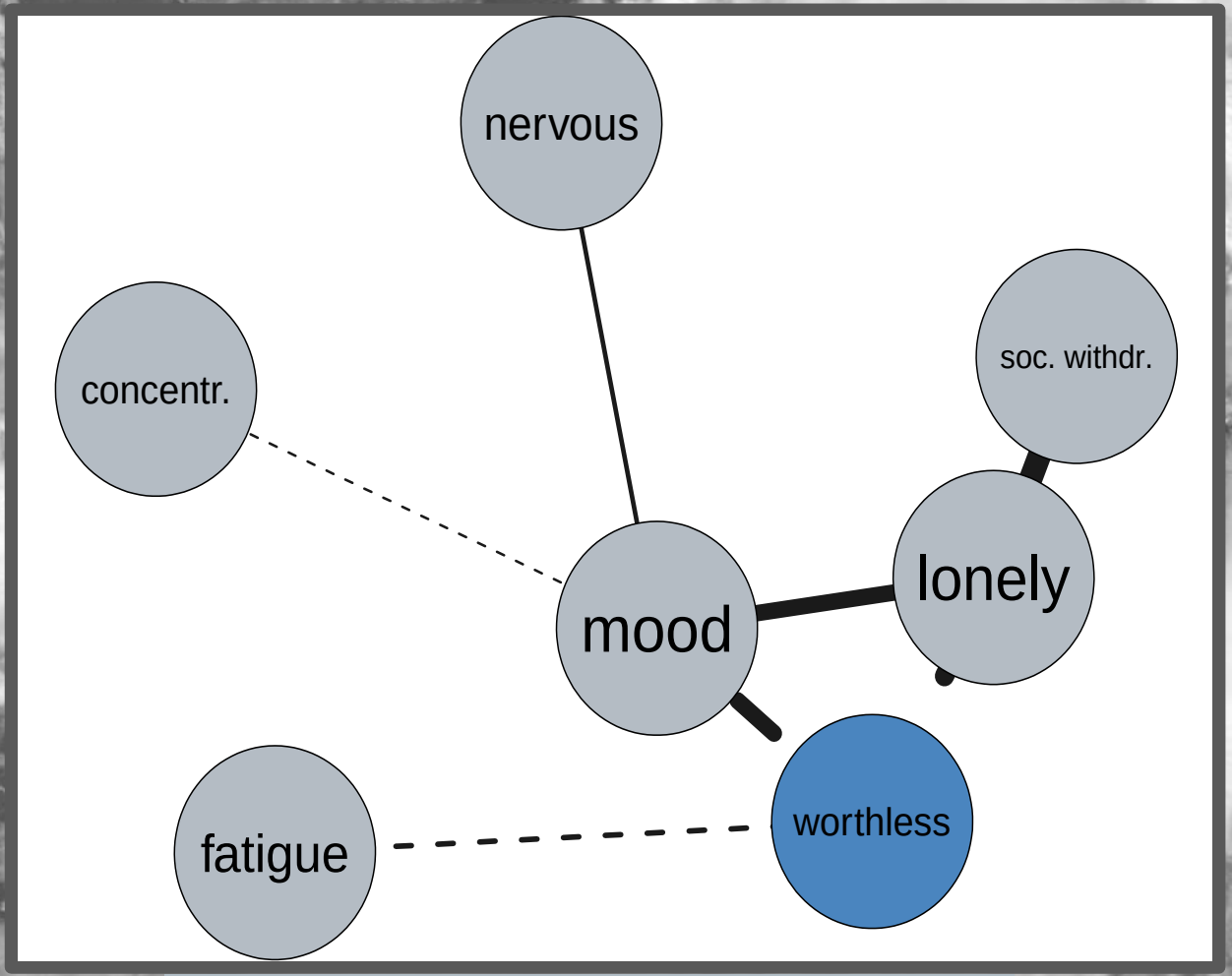
Therapist Background:
Cognitive Restructuring

Practical and Theoretical Considerations

Consideration 1:
Severity of Symptoms

Consideration 2:
Accessibility of Symptoms

Consideration 3:
Clinical Theories



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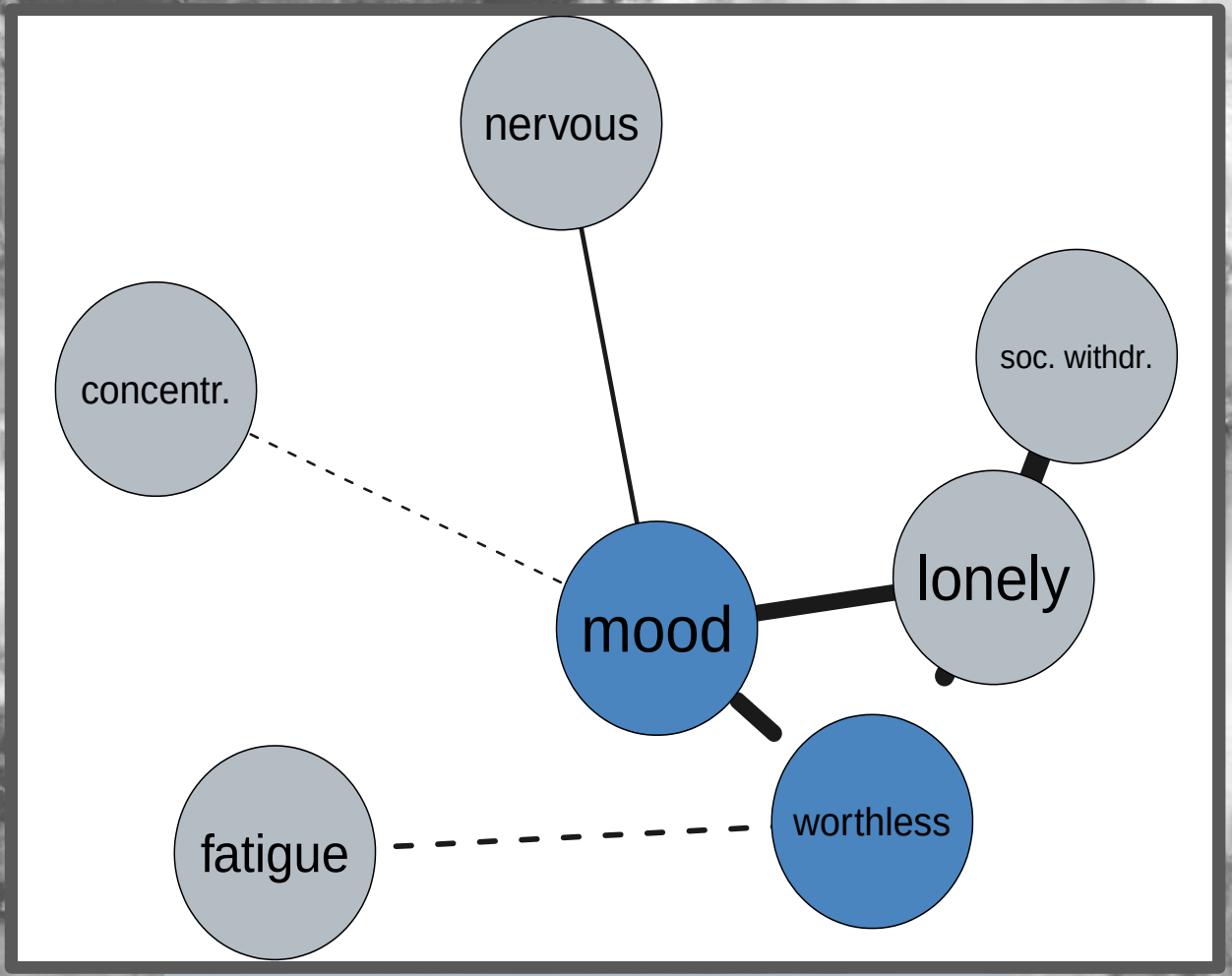

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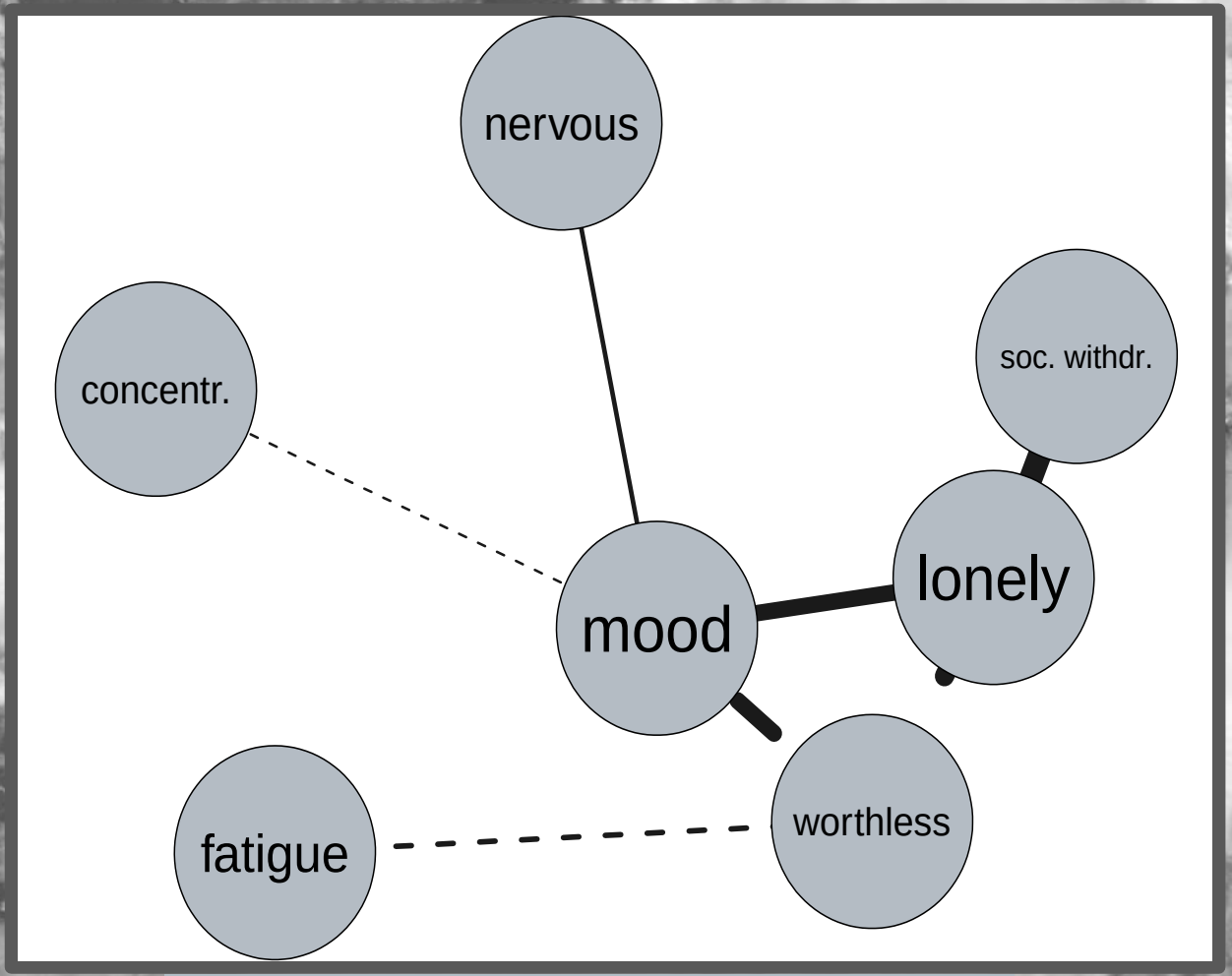

Patient 3

Therapist Background:
Behavioral Approach

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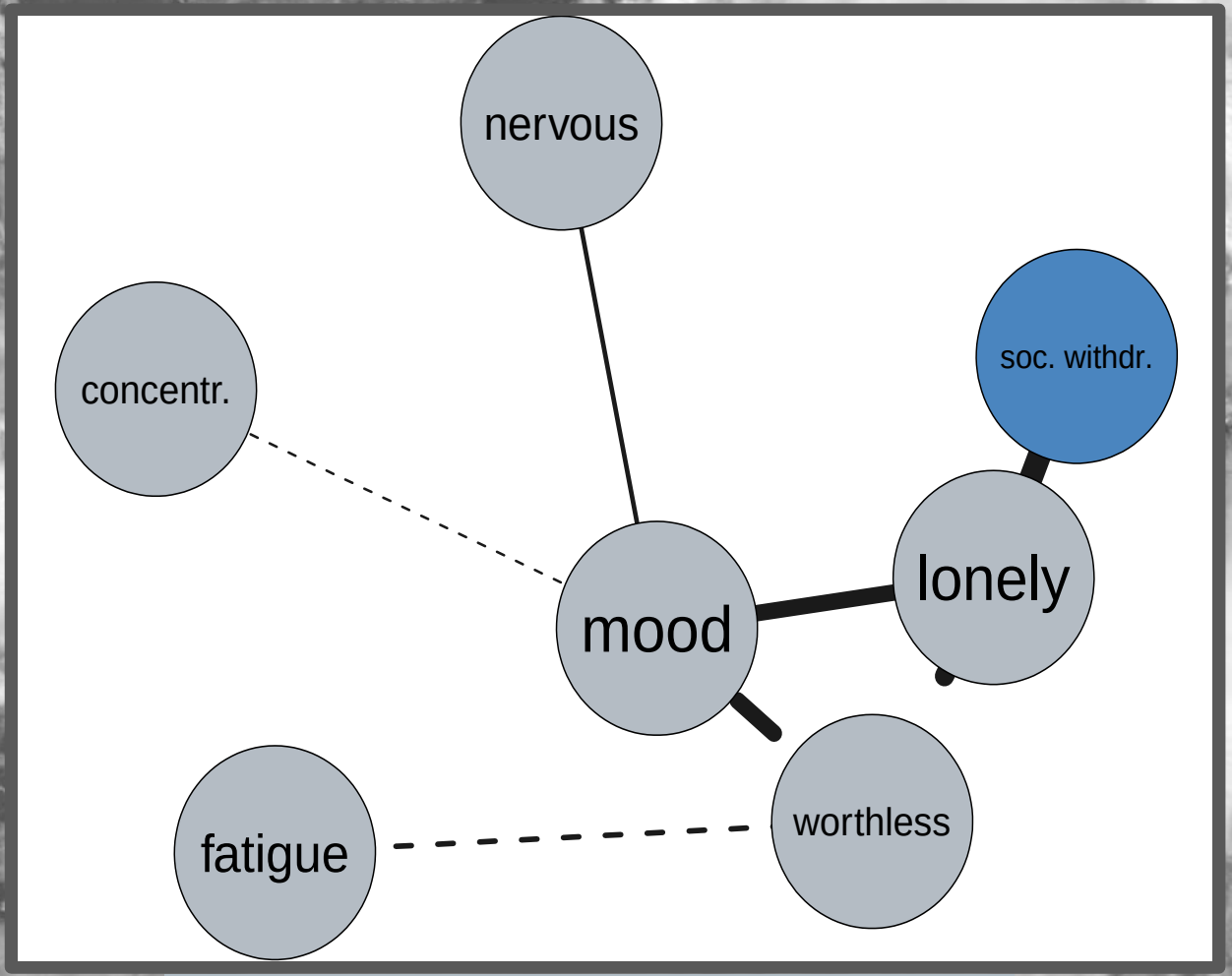

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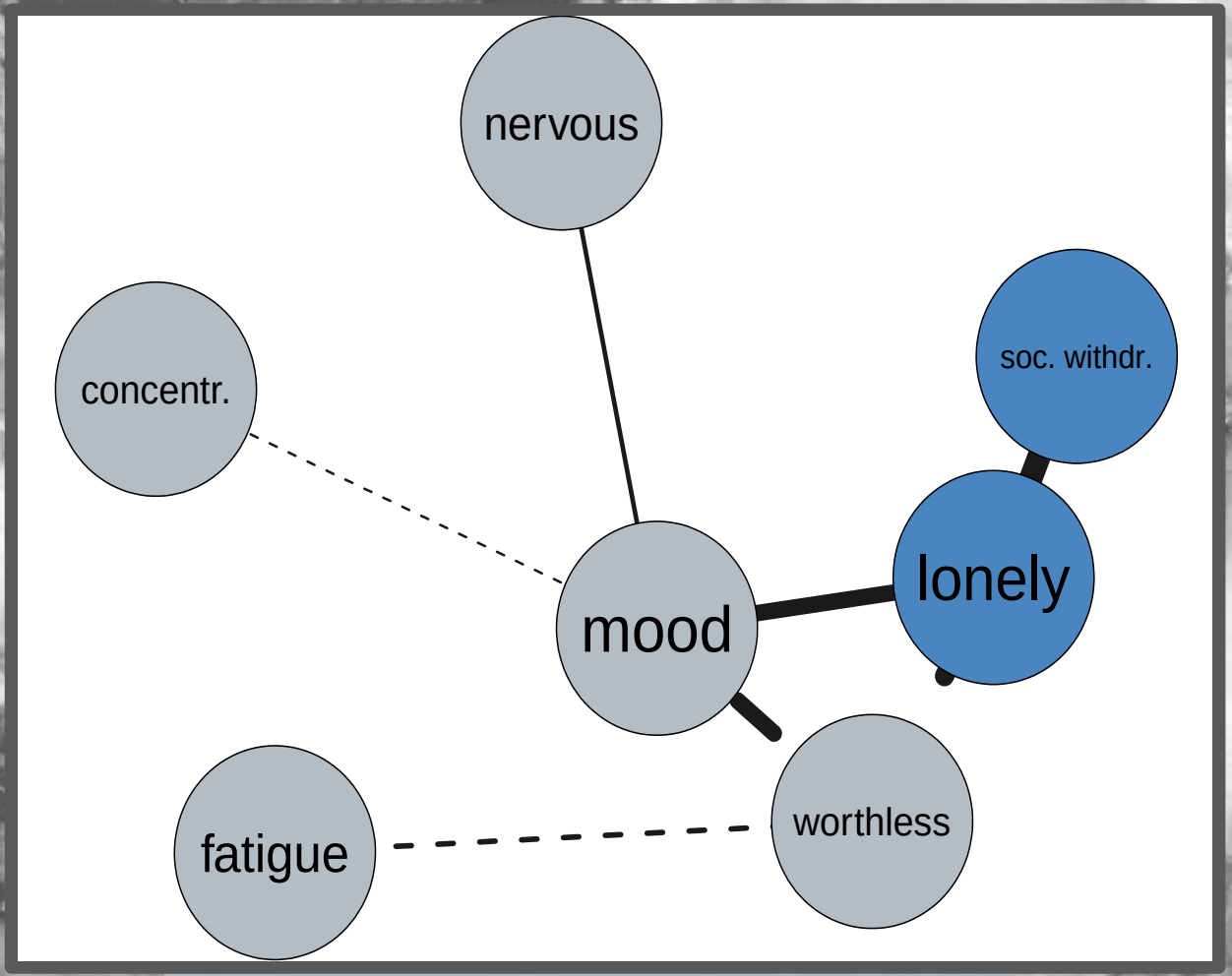

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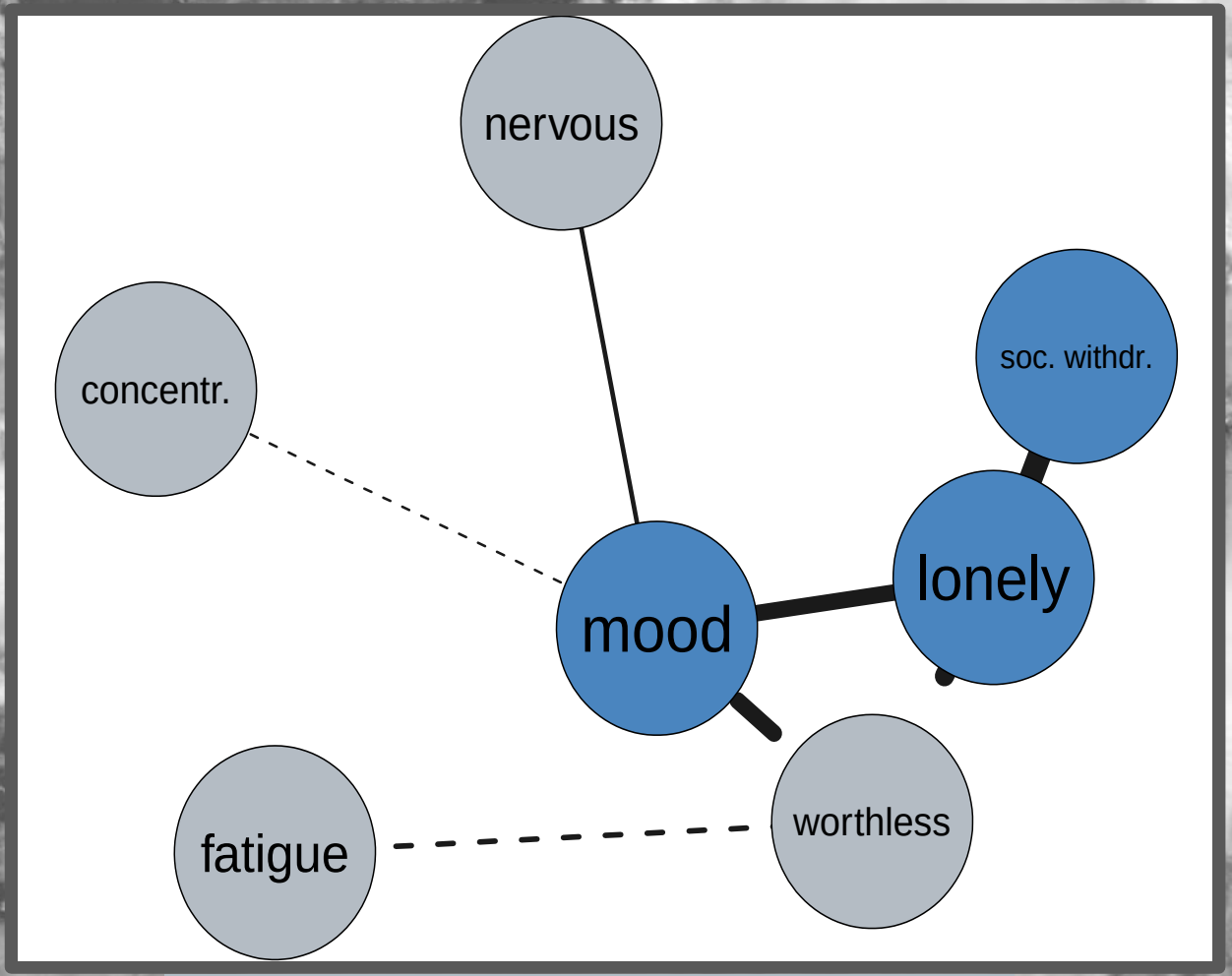

Patient 3

Therapist Background:
Behavioral Approach

A Clinician's Wish-List

Models need to …

…acknowledge the differences in ***severity*** and ***accessibility*** of symptoms.

…incorporate ***theoretical knowledge*** from clinical psychology.

…be implemented in ***accessible tools.***

Goal:

Modeling the dynamics of clinical theories, a

Dynamical Case Conceptualization

Case Conceptualization: Function Analysis

Sd:
Discriminant Stimulus

R:
Reaction

Sr:
Reinforcing Stimulus

Short-term positive consequences

Long-term negative consequences

Case Conceptualization: Function Analysis

Patient Diagnosis:

Agoraphobia with Panic Disorder (F40.01)

Sd:
Heart racing in cinema

R:
Leave the cinema

Sr:
Reinforcing Stimulus

Positive:
Relief

Negative:
No falsification,
less pleasant events

Case Conceptualization: Function Analysis

Sd:
Heart racing in cinema

+

R:
Leave the cinema

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Sr:
Reinforcing Stimulus

+

Positive:
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-

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No falsification,
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Patient Diagnosis:

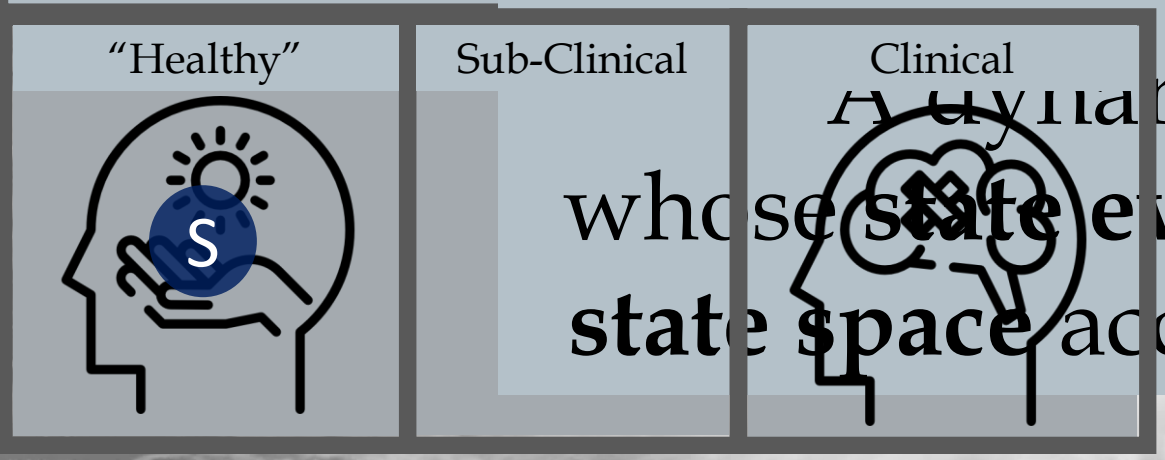
Agoraphobia with Panic Disorder (F40.01)

Dynamical Case Conceptualization?

Dynamical Systems:
"A dynamical system is a system whose **state** evolves over a **state space…**

…**with time**…

…according to a **fixed rule.**"



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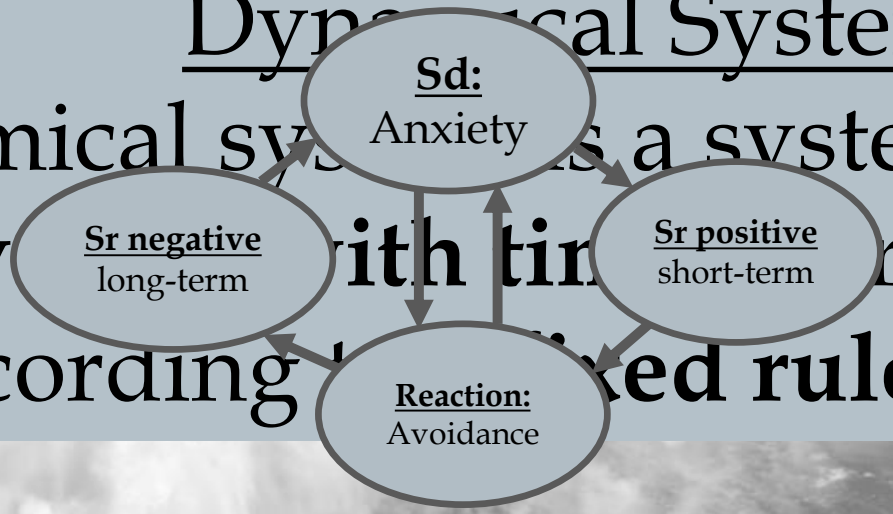


System Behavior: Alternative Stable States and Critical Transitions

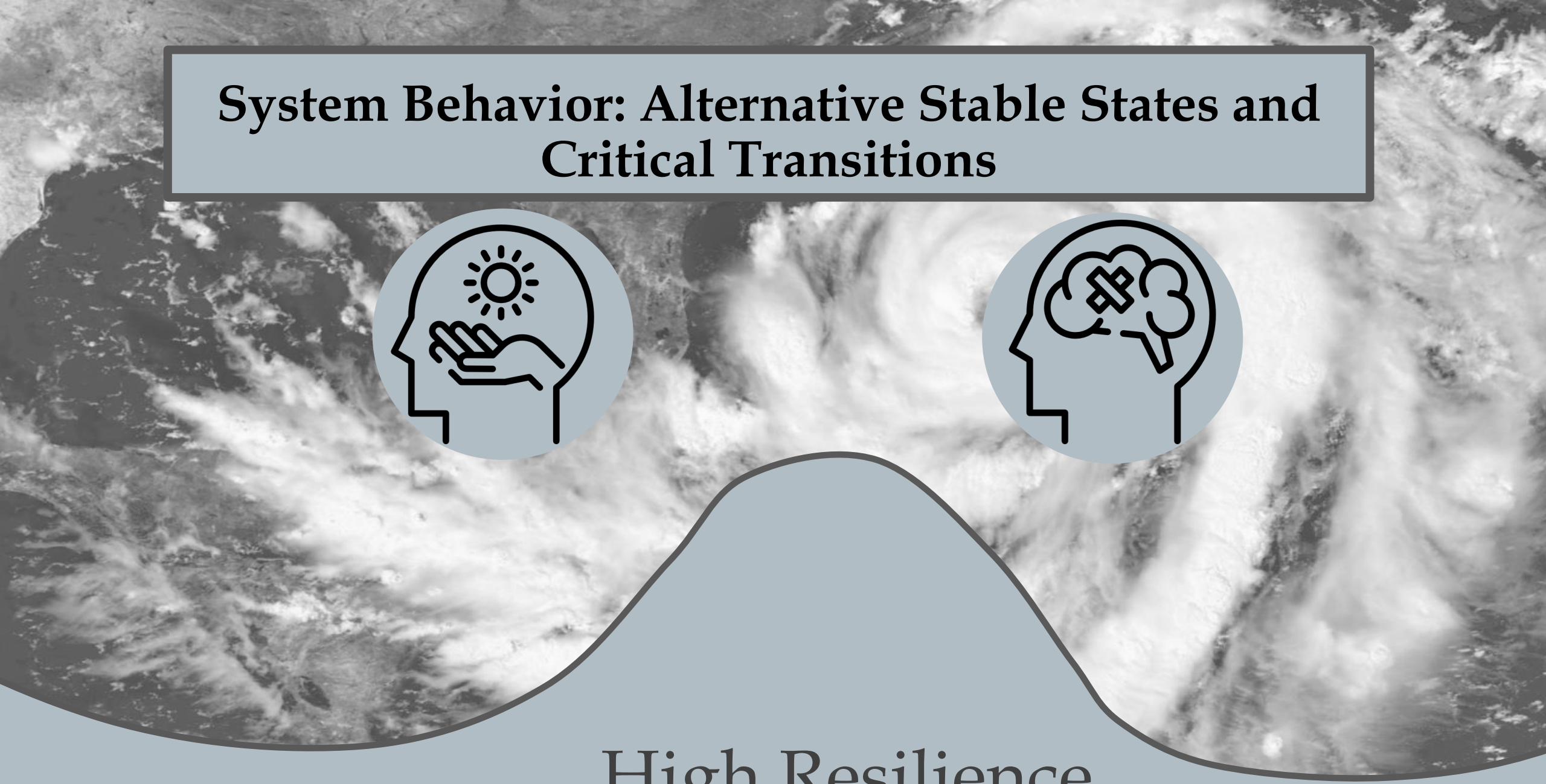
Critical Transition

System Behavior: Alternative Stable States and Critical Transitions

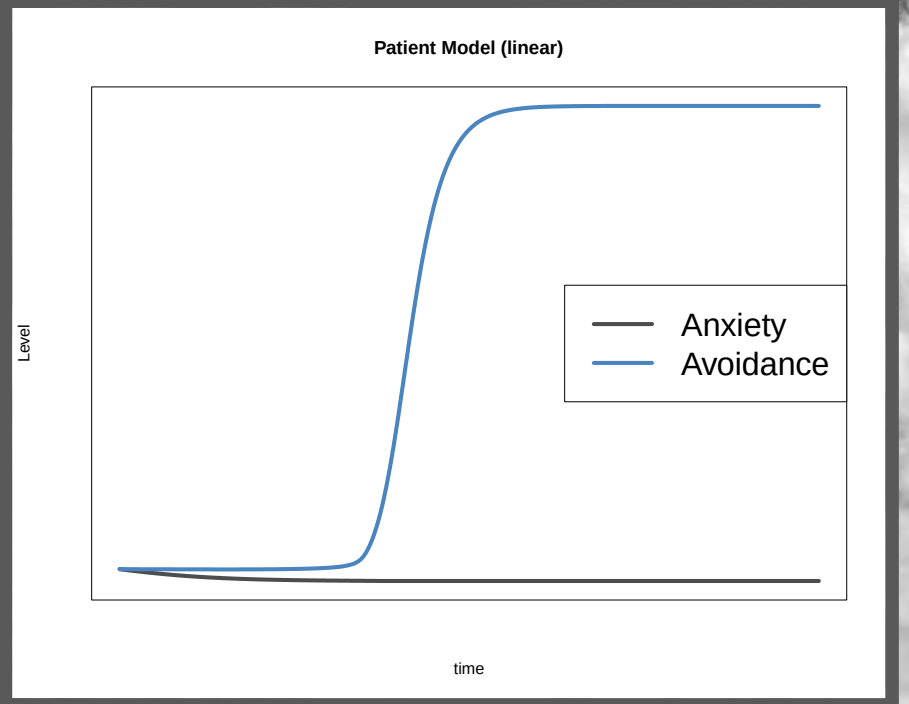
System Behavior: Alternative Stable States and Critical Transitions

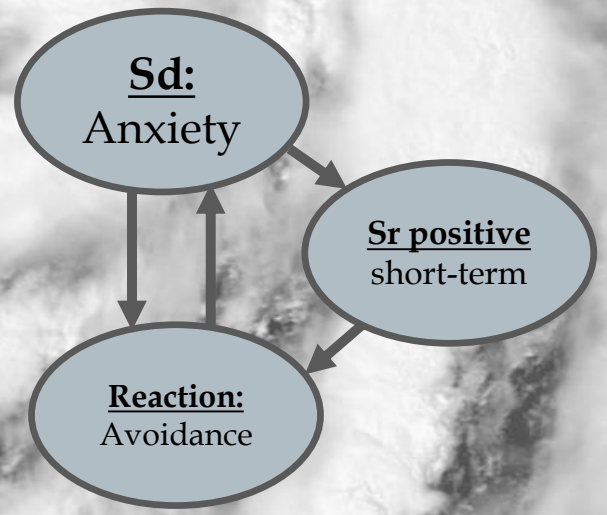
Low Resilience

System Behavior: Alternative Stable States and Critical Transitions



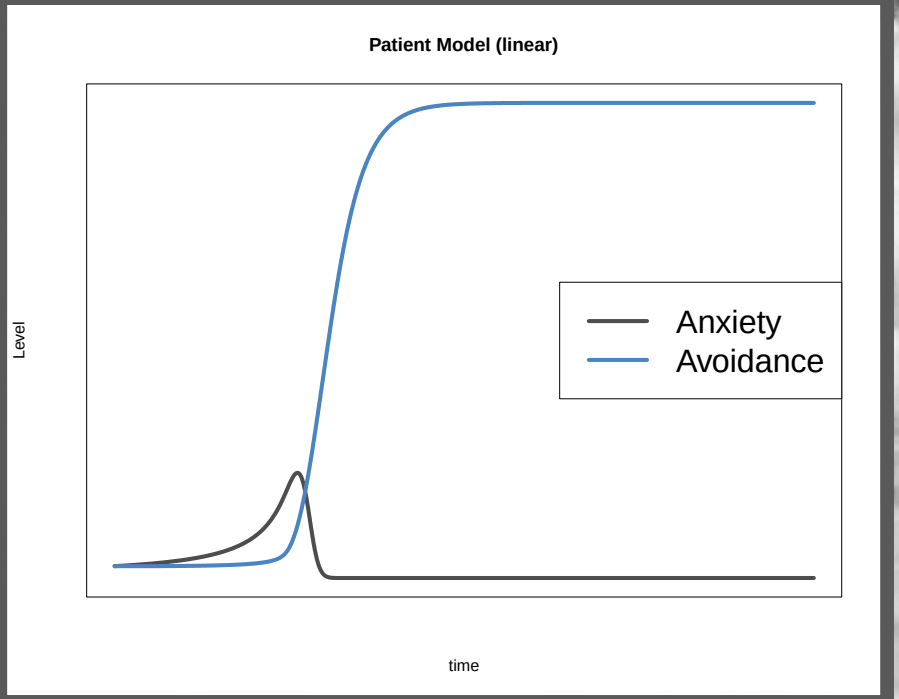
Dynamical Case Conceptualization

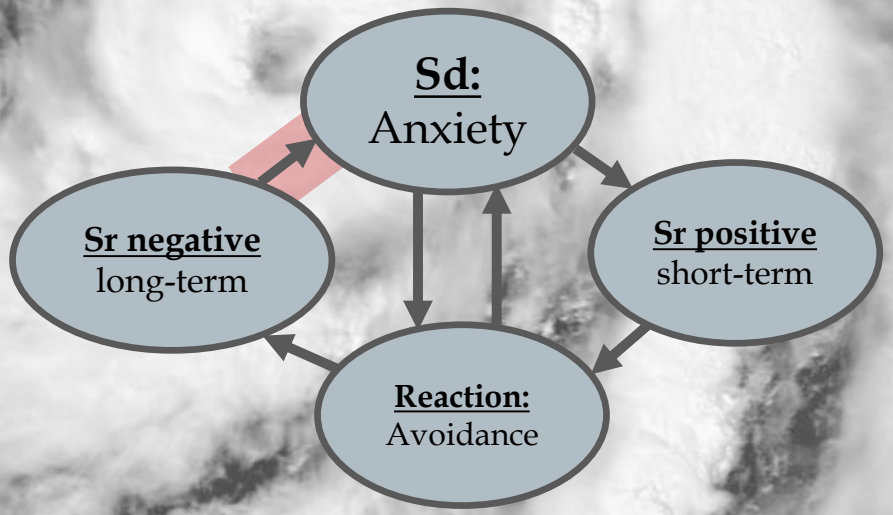




Scenario 1: *Patient Model*

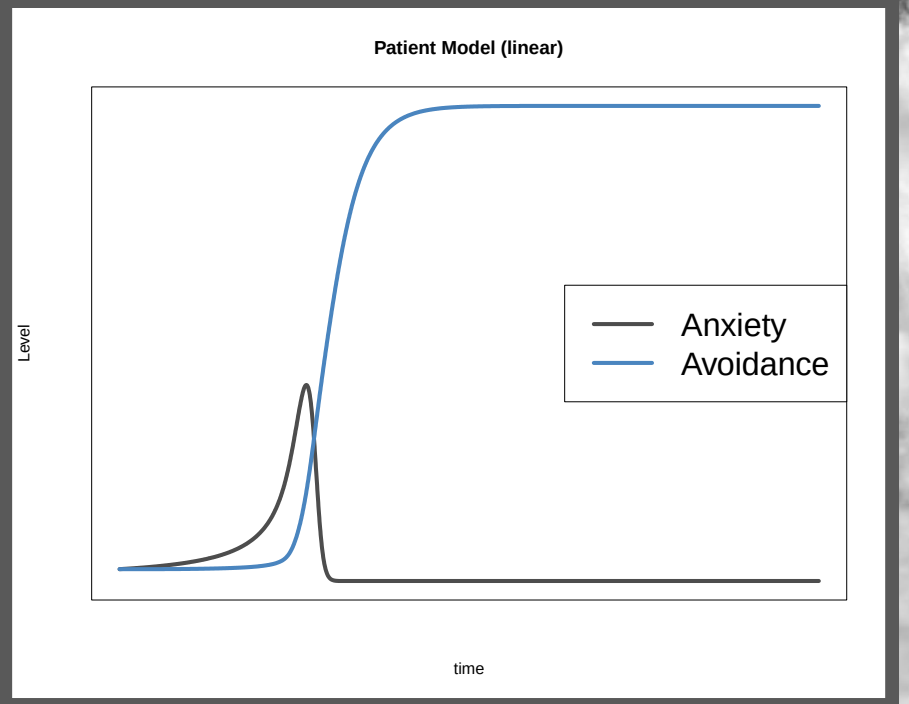
Dynamical Case Conceptualization

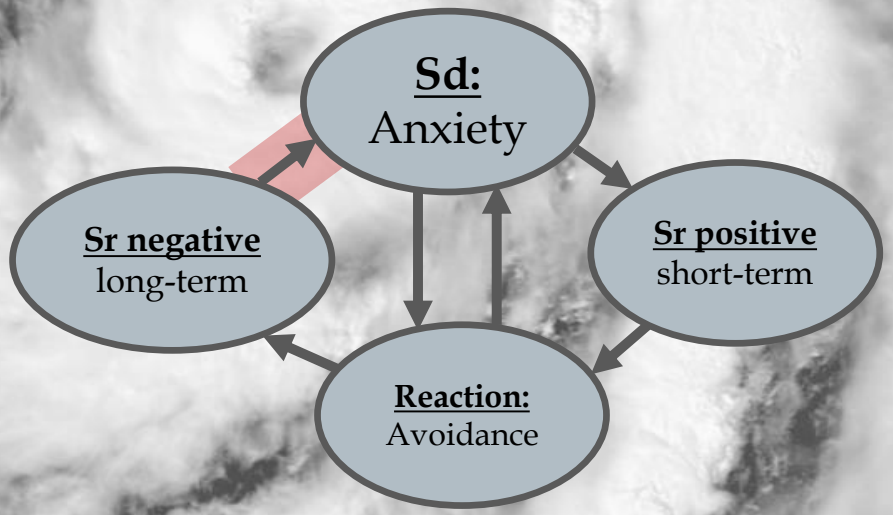




Scenario 2: from *Patient Model* to *Therapist Model*

Dynamical Case Conceptualization





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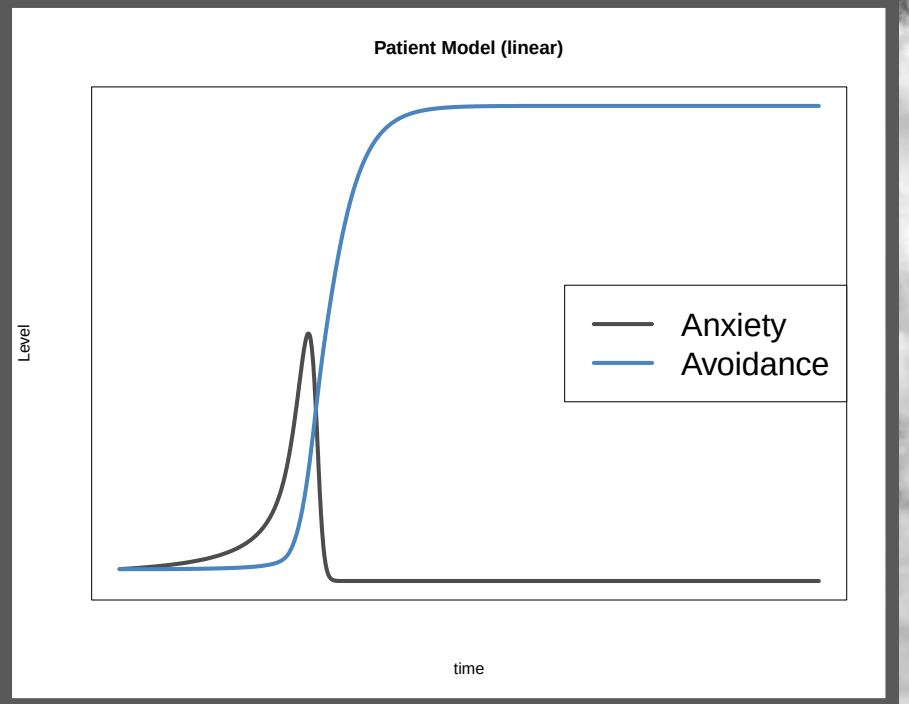

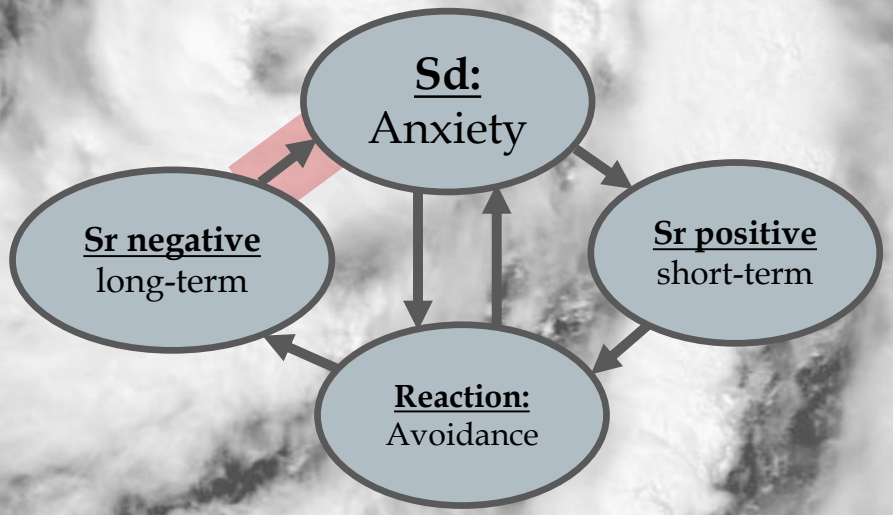

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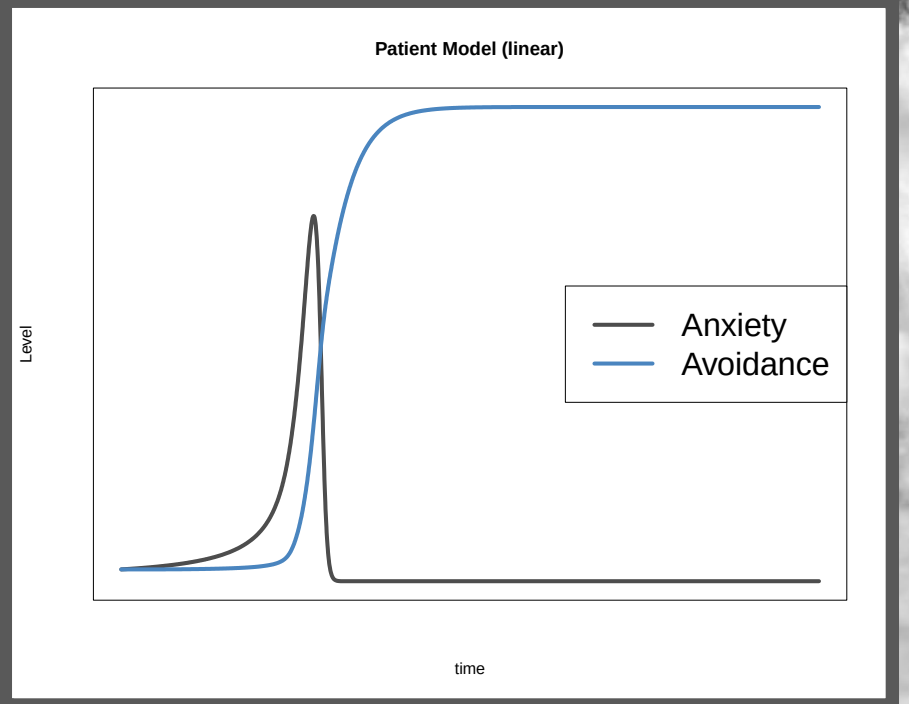

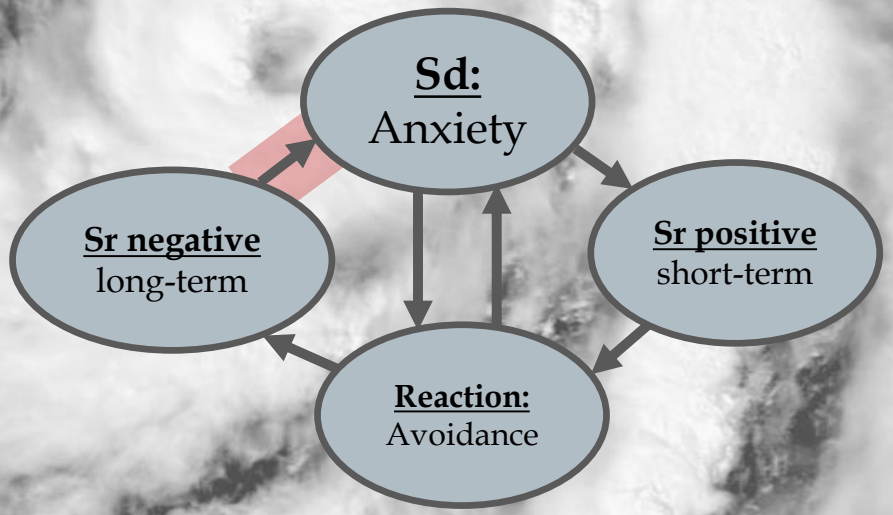

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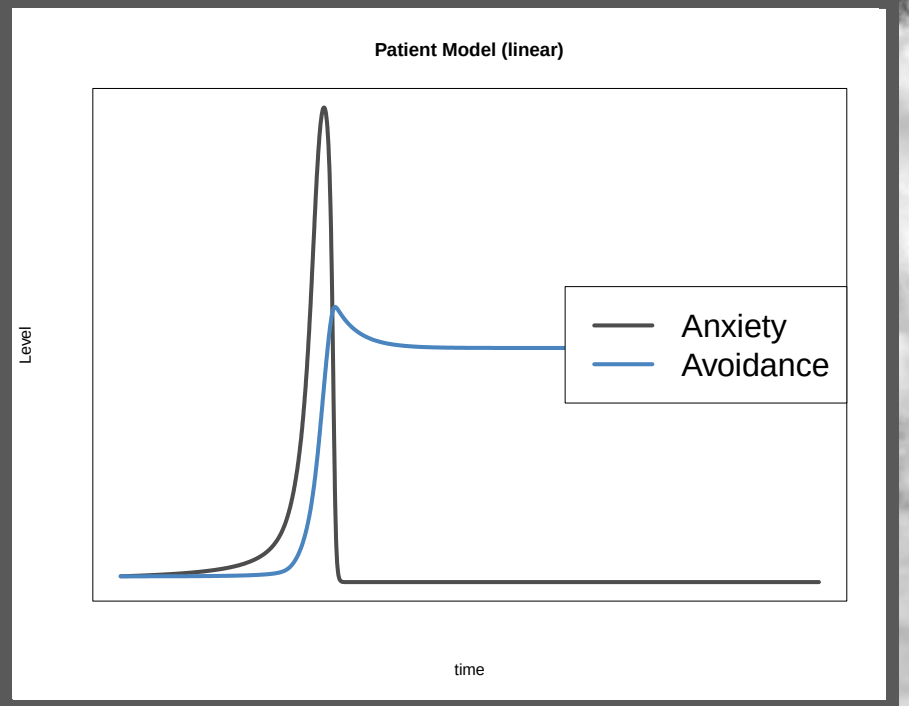

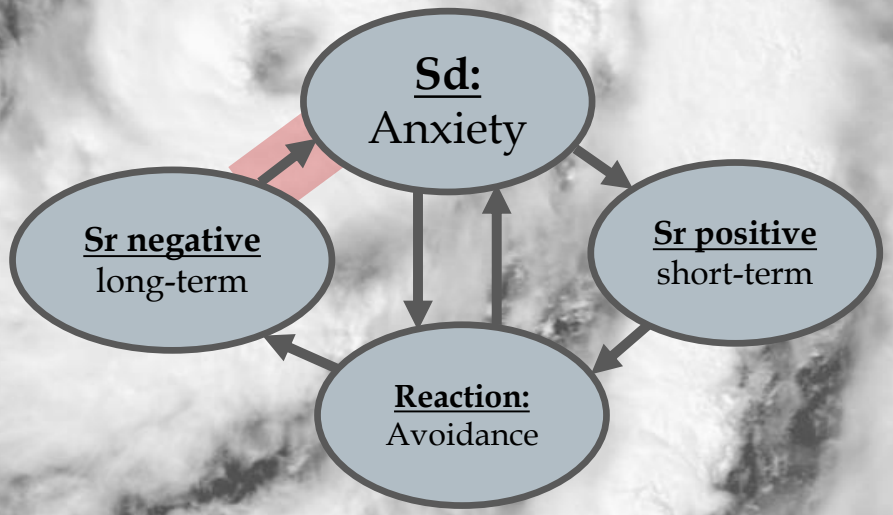

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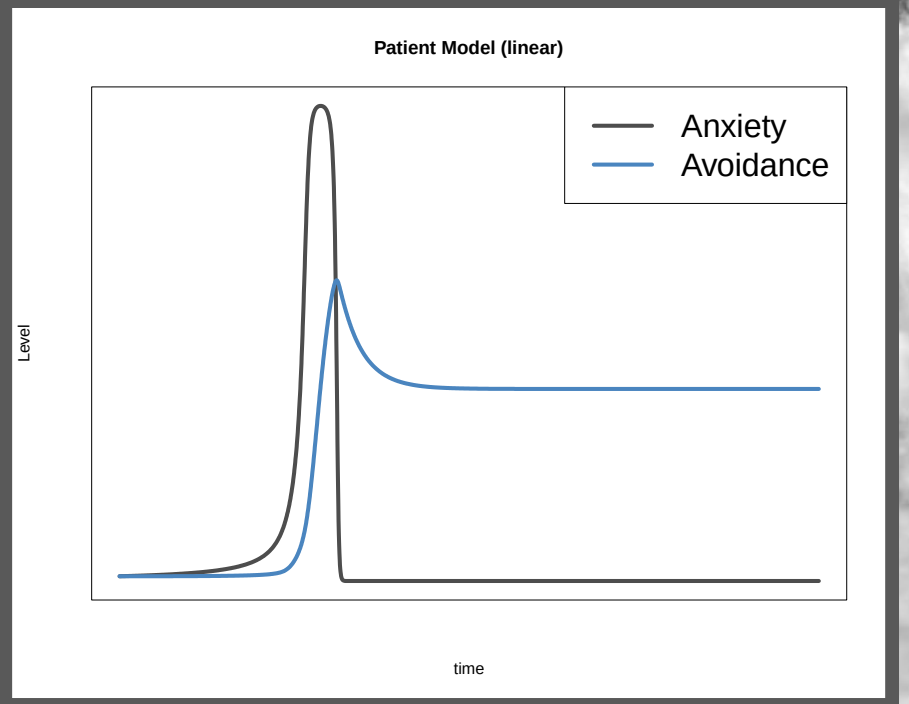

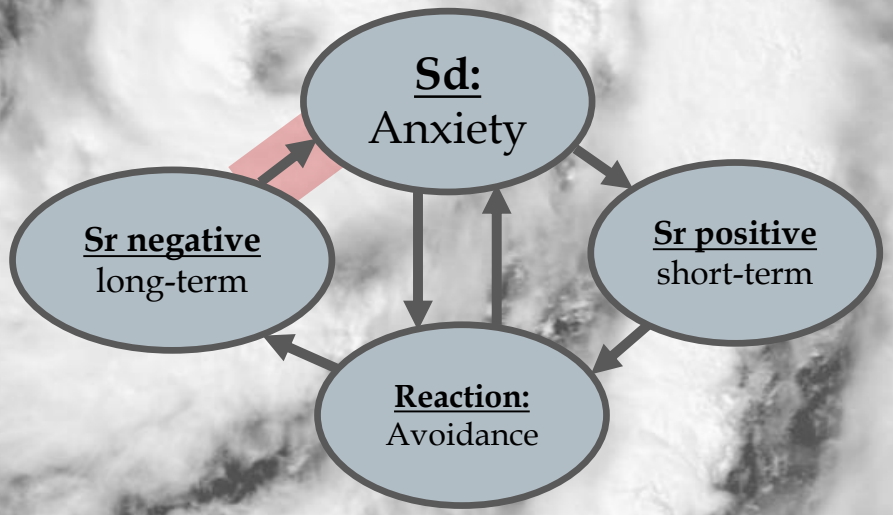

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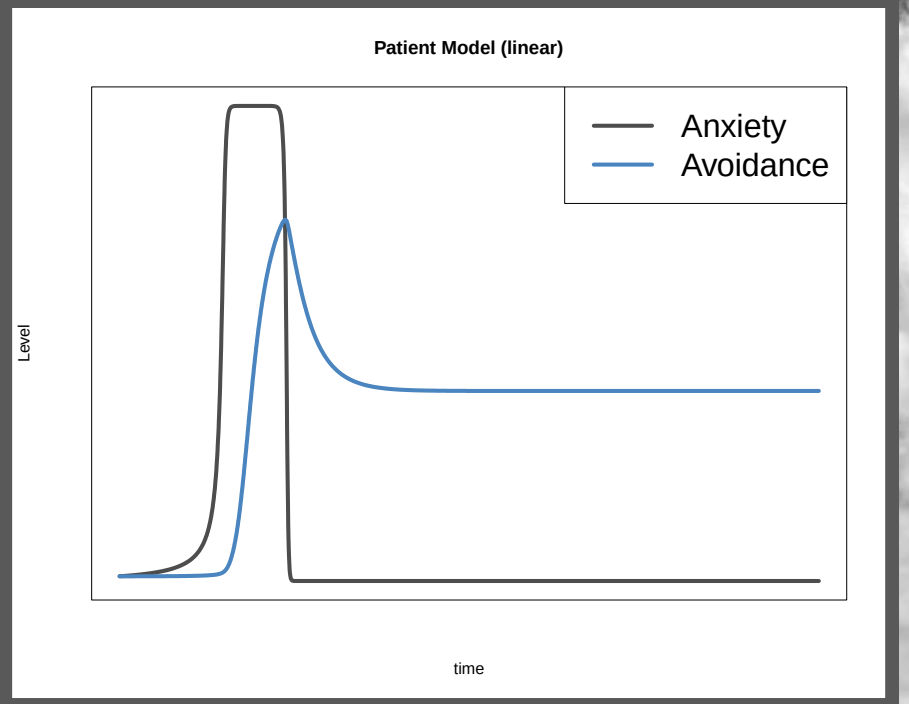

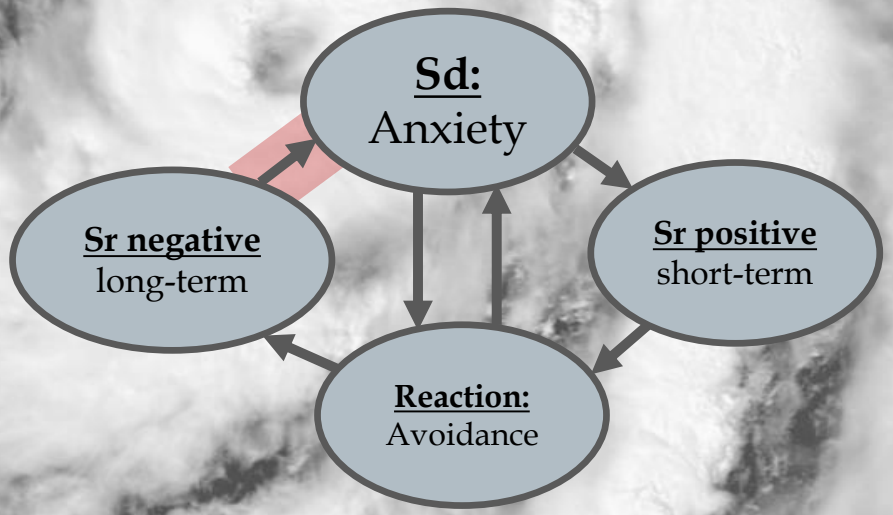

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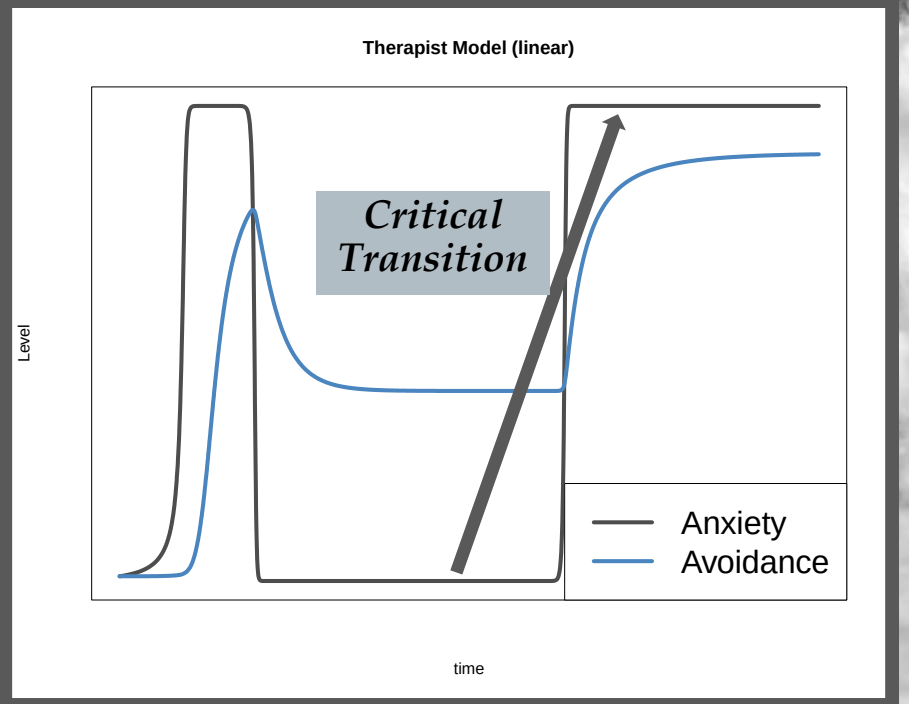
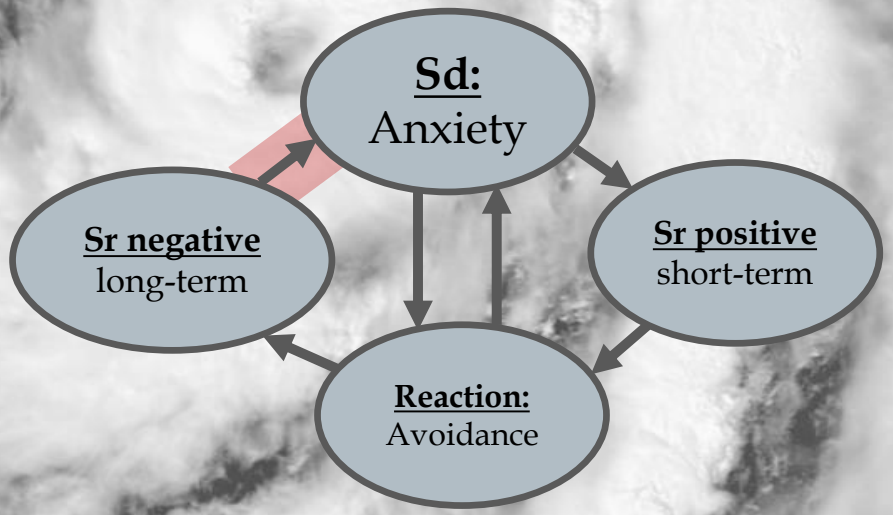
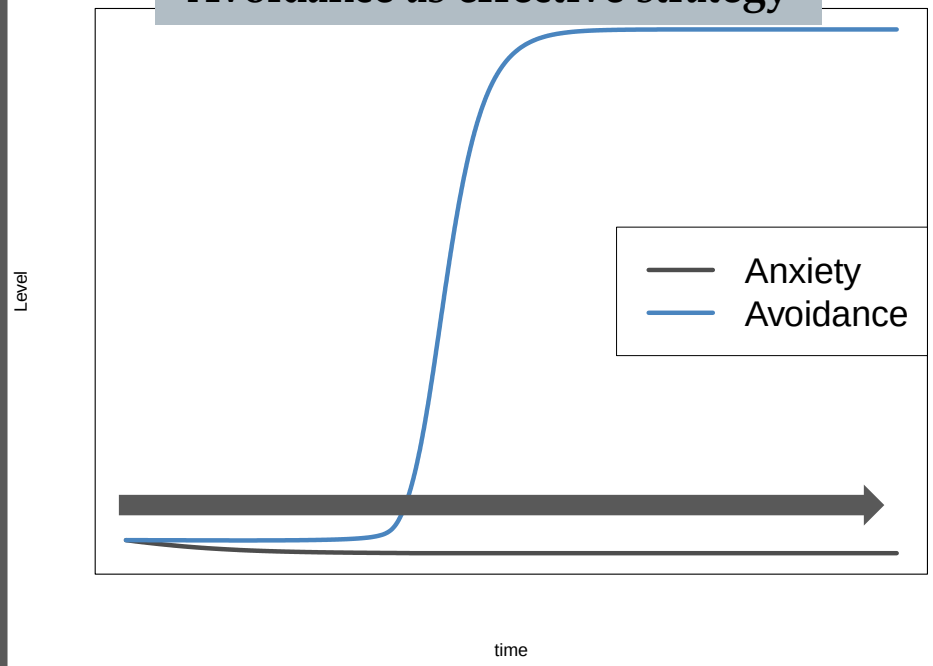




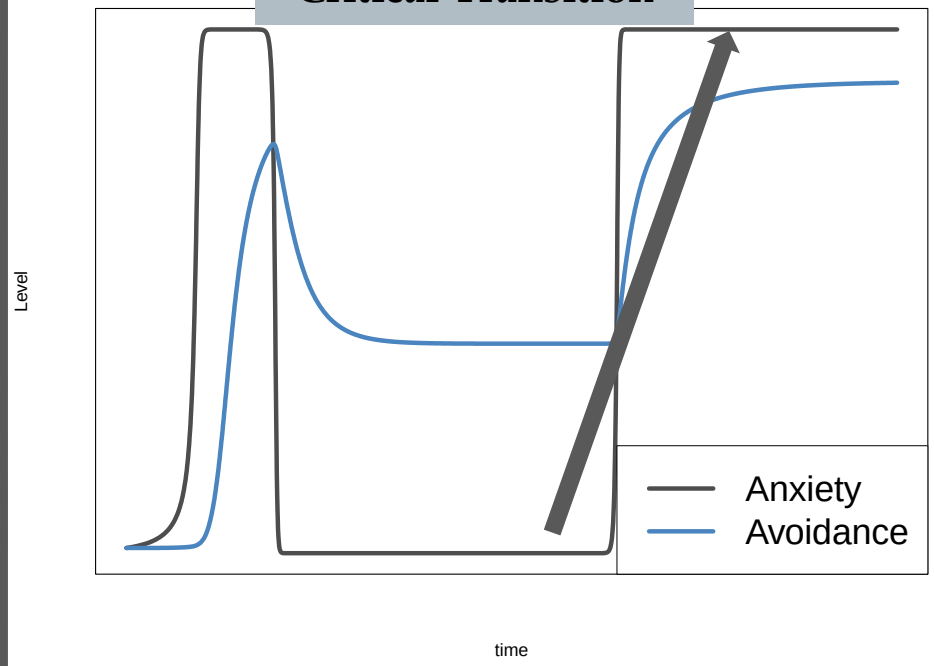
Scenario 3: *Therapist Model*

Dynamical Case Conceptualization

Patient Model:
Avoidance as effective strategy



Therapist Model:
Critical Transition



<u>Goal:</u>

Modeling the dynamics of clinical theories, a

Dynamical Case Conceptualization

Treatment Selection

A Tool for Clinical Practice:
Therapy Implications from Psychopathological-Dynamical System Modeling (TIPS)

TIPS (Therapy Implications from Psychopathological-Dynamical Systems)

Model Description and App Instructions | Symptom Level Prediction | Symptom Range Prediction | Intervention Selection

About this App

Symptom Range Prediction

For different levels of substance use and tolerance effects, what levels of your variable can you expect?

Which symptom/variable are you interested in?

Negative Emotionality

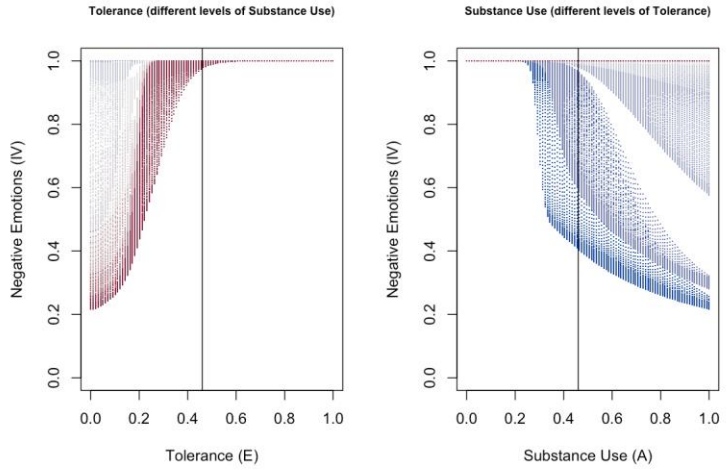
How many levels of the discrete variable do you want to plot?

9

How many levels of the continuous variable do you want to plot?

100

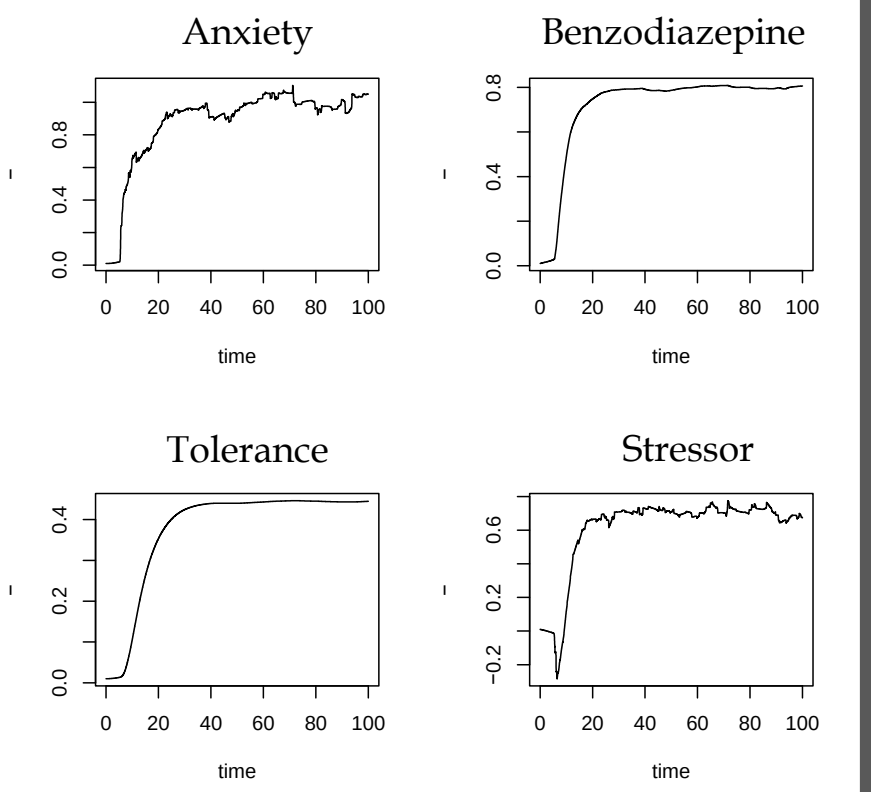
After how many days of symptom



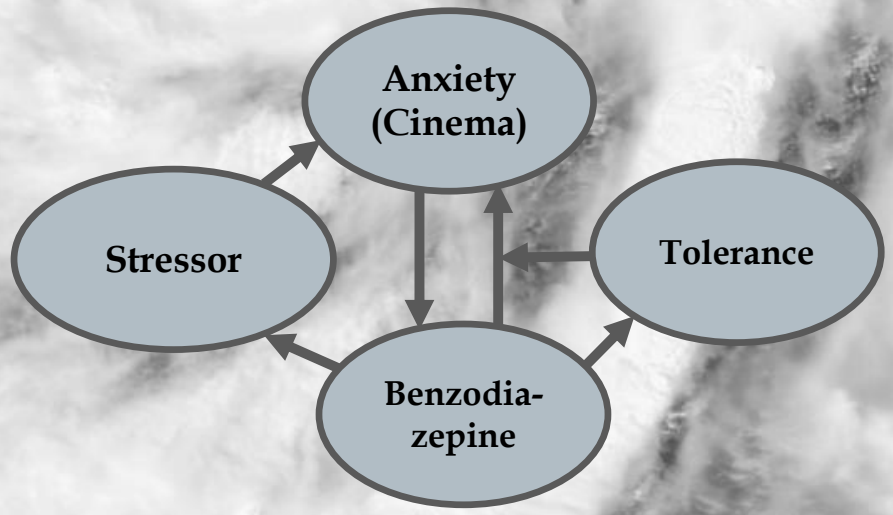
TIPS - Julian Burger

Accessibility: TIPS Application

Intervention Recommendation System



Scenario 1: **No intervention**



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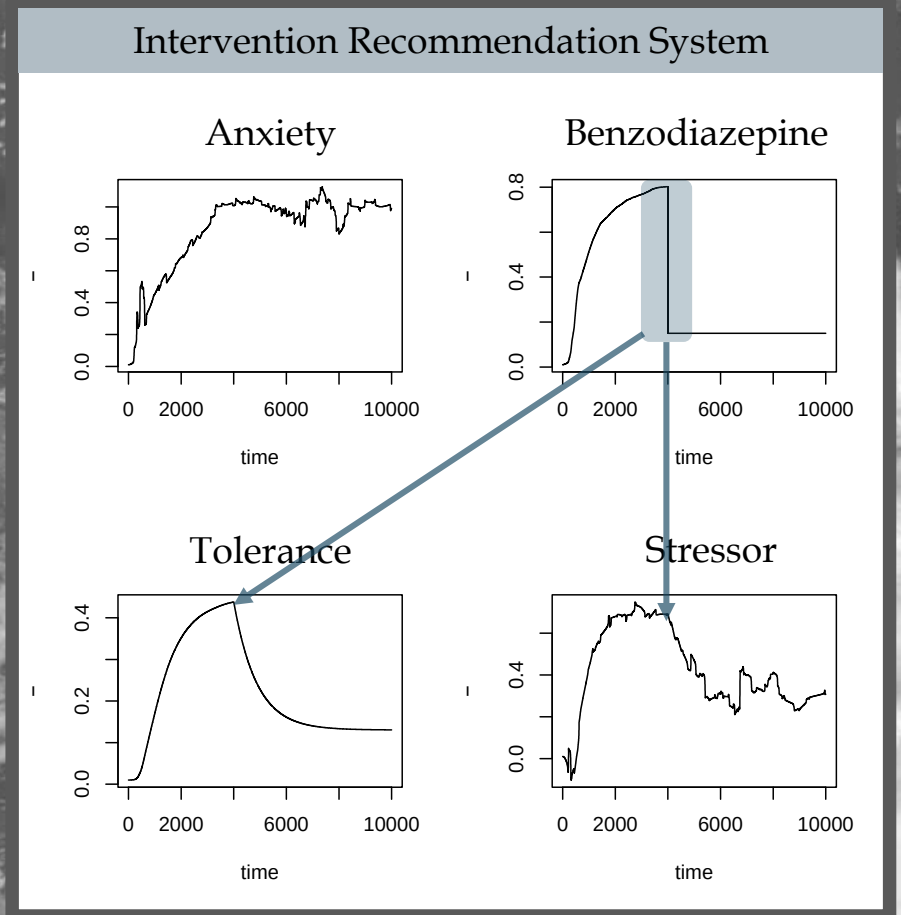
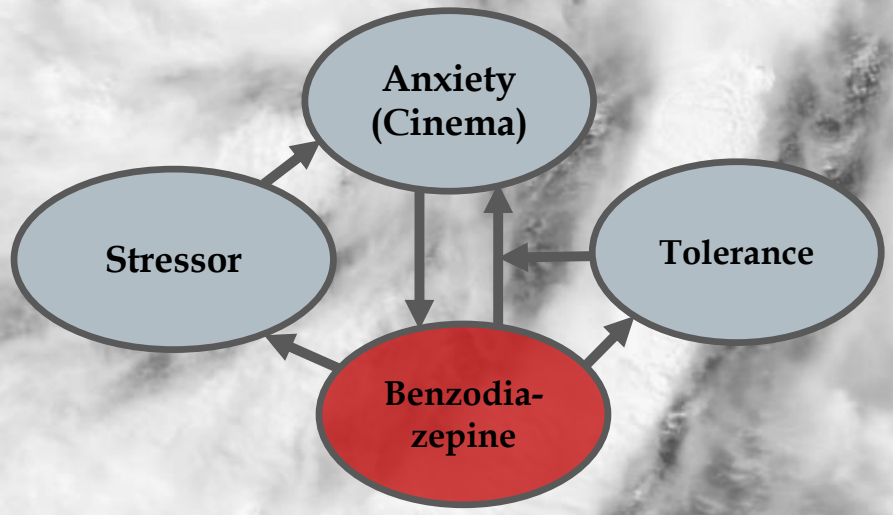


Scenario 2: **Behavioral Techniques**



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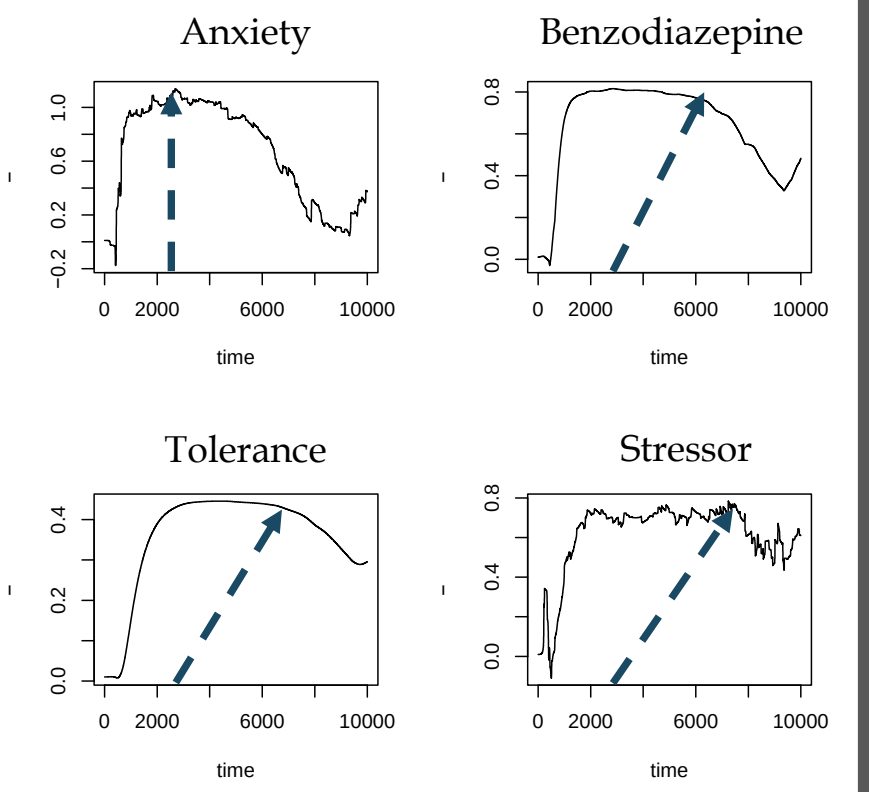
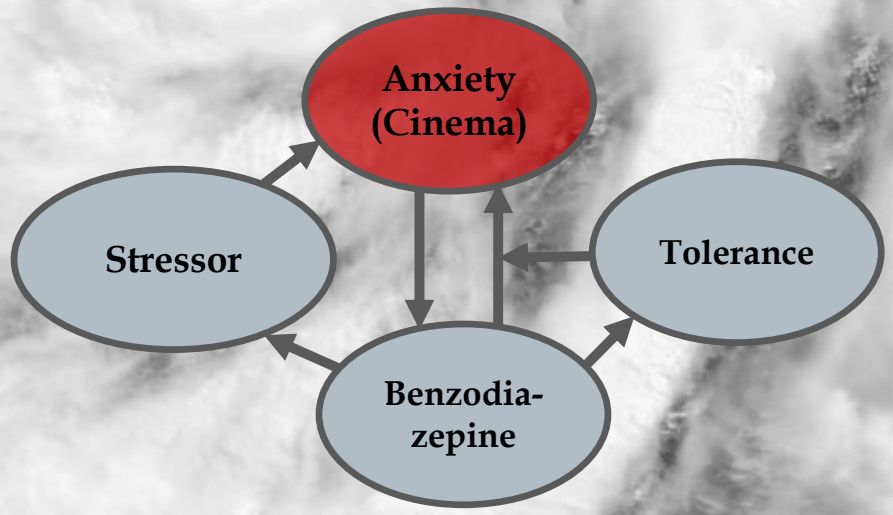


Scenario 3: **Cognitive Techniques**



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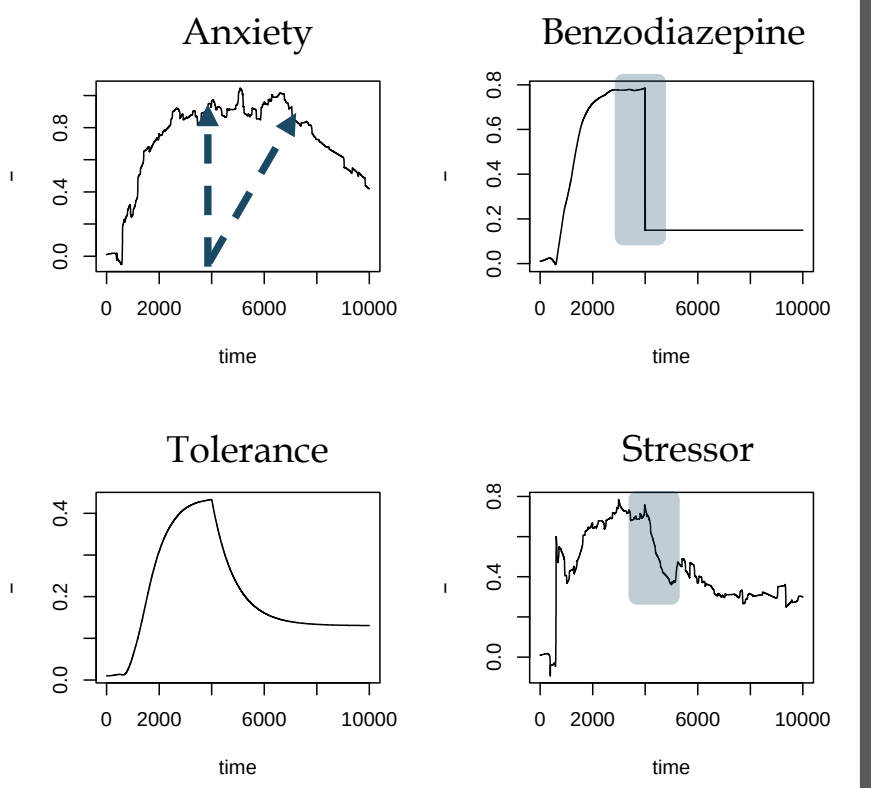
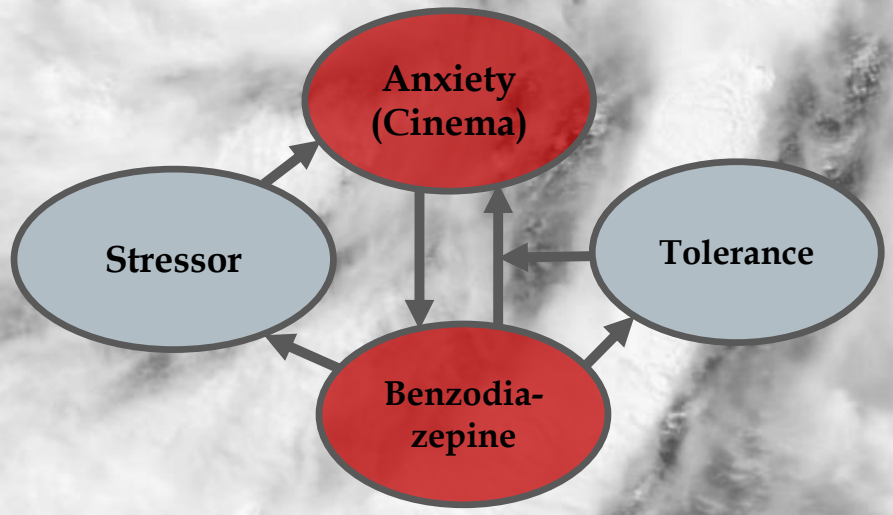


Scenario 4: **Cognitive Behavioral Therapy**



Summary

- Theory-based Models, Hypotheses and Interventions.
- Practical Considerations.
- Accessibility.

Thus:

Tackling a major Barrier in Bridging the Gap between Network Models and Clinical Practice.

Future Directions

- Patient-Specific Parameter Estimation Technique.
- Varying System Behavior: Limit Cycles and Chaos.
- Matching Disorder and Patient Characteristics with Different System Behaviors.

The Team

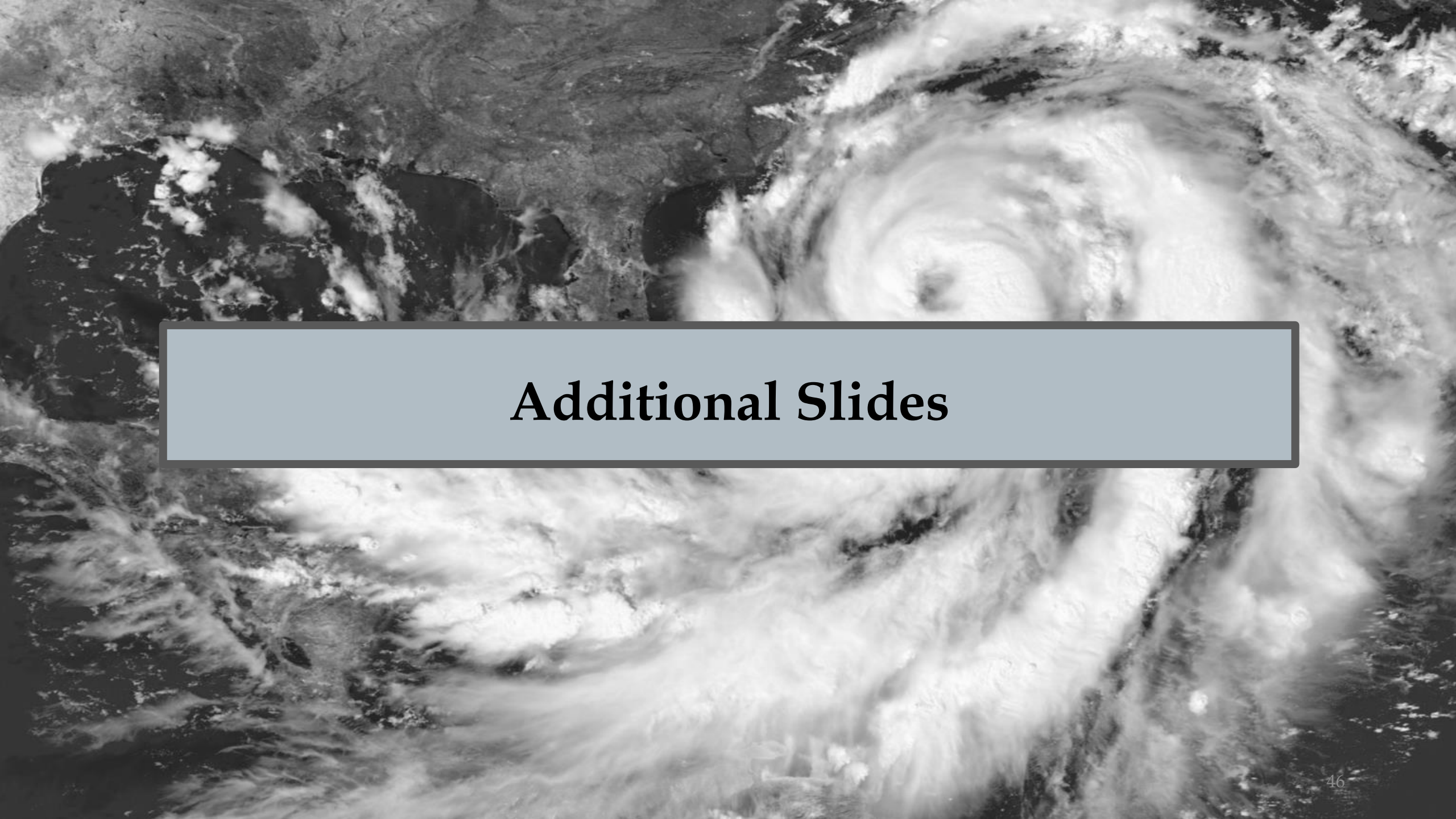
Dr. Sacha Epskamp
University of Amsterdam

Date van der Veen
University Medical Center Groningen

Dr. Harriëtte Riese
University Medical Center Groningen

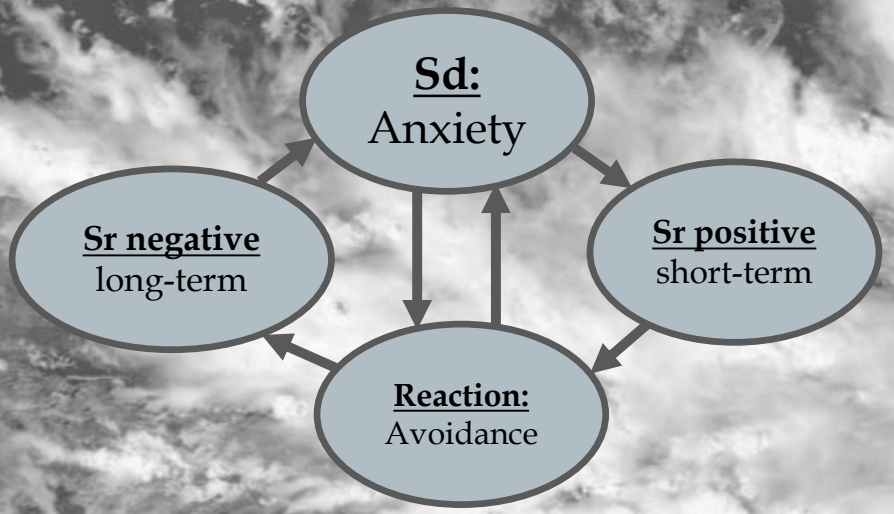
Prof. dr. Robert Schoevers
University Medical Center Groningen

Thank you very much for your attention!



Additional Slides

Dynamical Case Conceptualization



Differential Equations

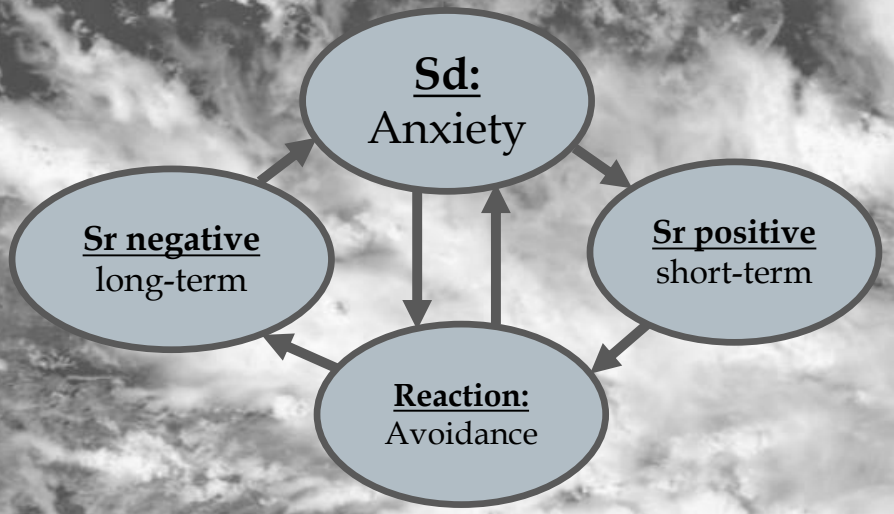
$$\frac{dAnx}{dt} = A \cdot Anx(t) - B \cdot Av(t) + C \cdot SrNeg(t)$$

$$\frac{dAv}{dt} = D \cdot Anx(t) + E \cdot SrPos(t) - F \cdot Av(t)$$

$$\frac{dSrPos}{dt} = G \cdot SrPos(t) - H \cdot Anx(t)$$

$$\frac{dSrNeg}{dt} = I \cdot SrNeg(t) + J \cdot Av(t)$$

Dynamical Case Conceptualization: Limit Cycles



System 2: Non-Linear Equations

$$\frac{dAnx}{dt} = rAnx(t) - \alpha Anx(t)Av(t)$$

$$\frac{dAv}{dt} = -[\mu - SrPos(t) + SrNeg(t)] \cdot Av(t) + \gamma\alpha Anx(t)Av(t)$$

$$\frac{dSrPos}{dt} = \delta SrPos(t) + [-Anx'(t)Av(t)]$$

$$\frac{dSrNeg}{dt} = \lambda SrNeg(t) + \rho Av(t)$$

Lotka-Volterra Equations

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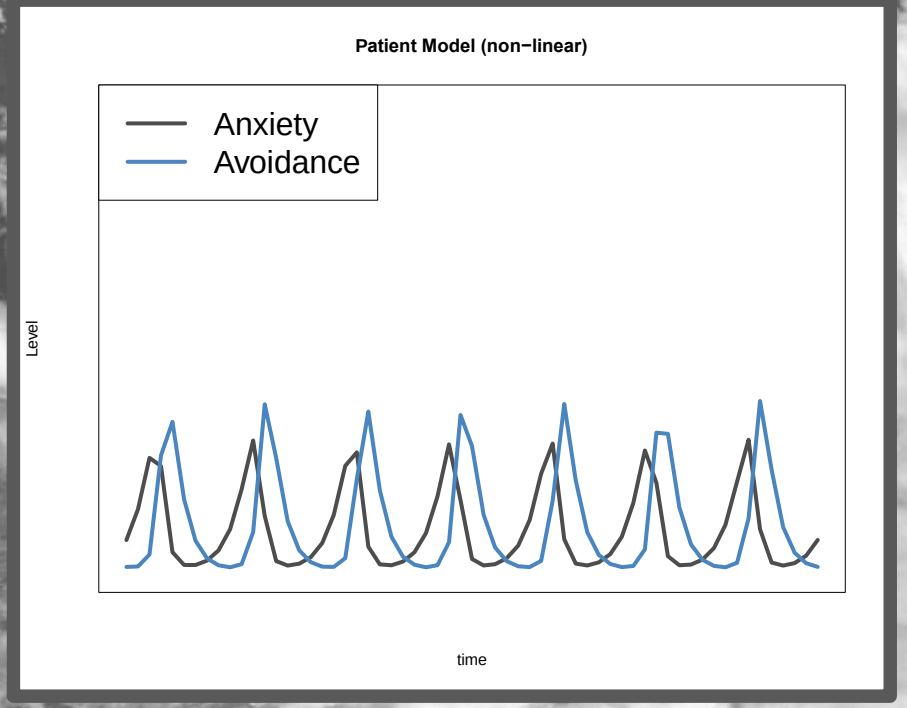

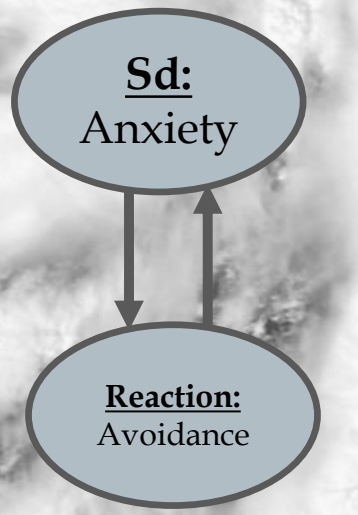

Scenario 1: Disregarding negative consequences of avoidance behavior ('Patient Model')

- **Avoidance ('Predator') reduces Anxiety ('Prey').**
- **Avoidance is an efficient strategy.**

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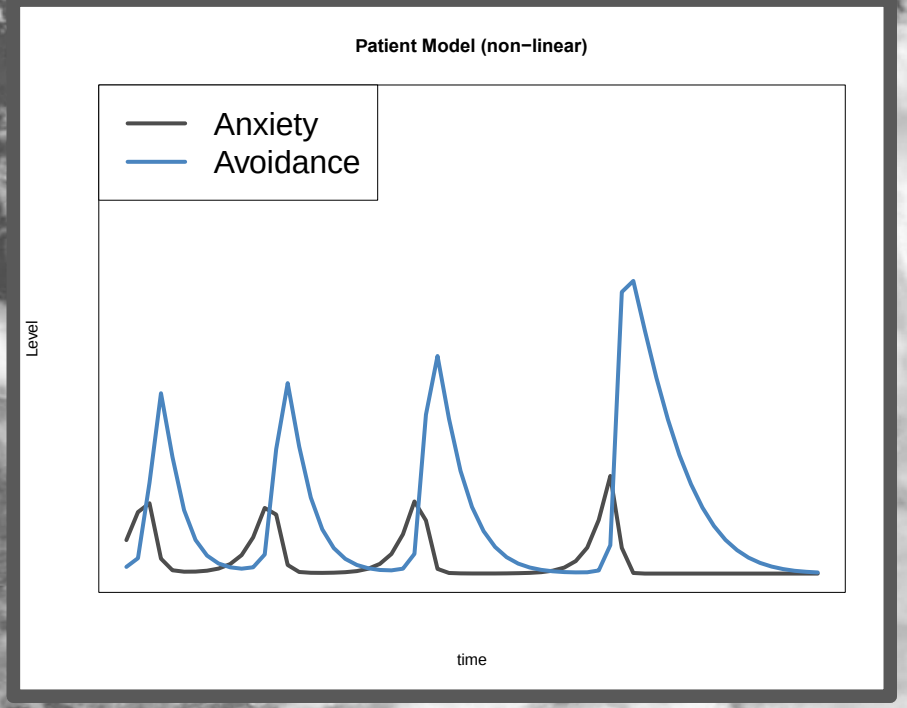
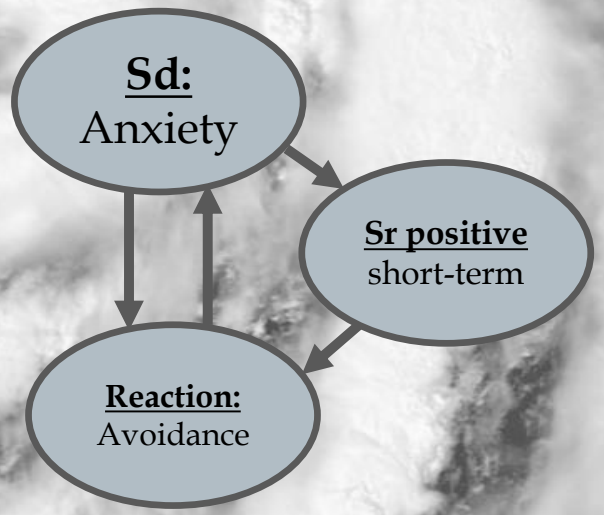
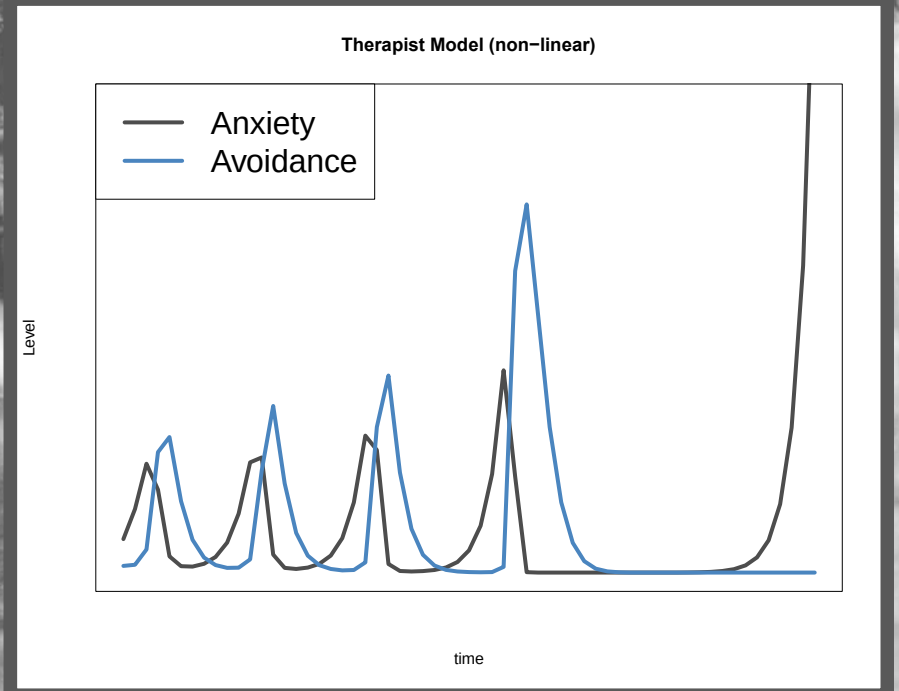


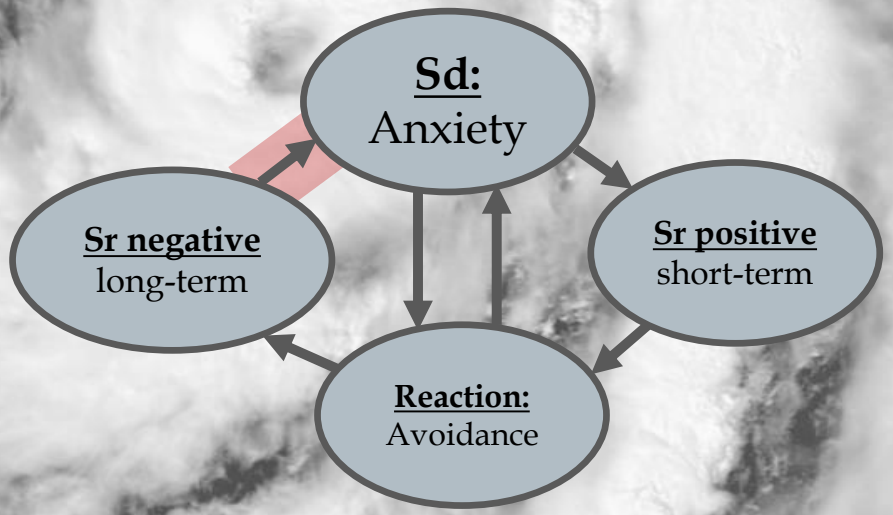


Scenario 2: Positive Evaluation of Avoidance Behavior

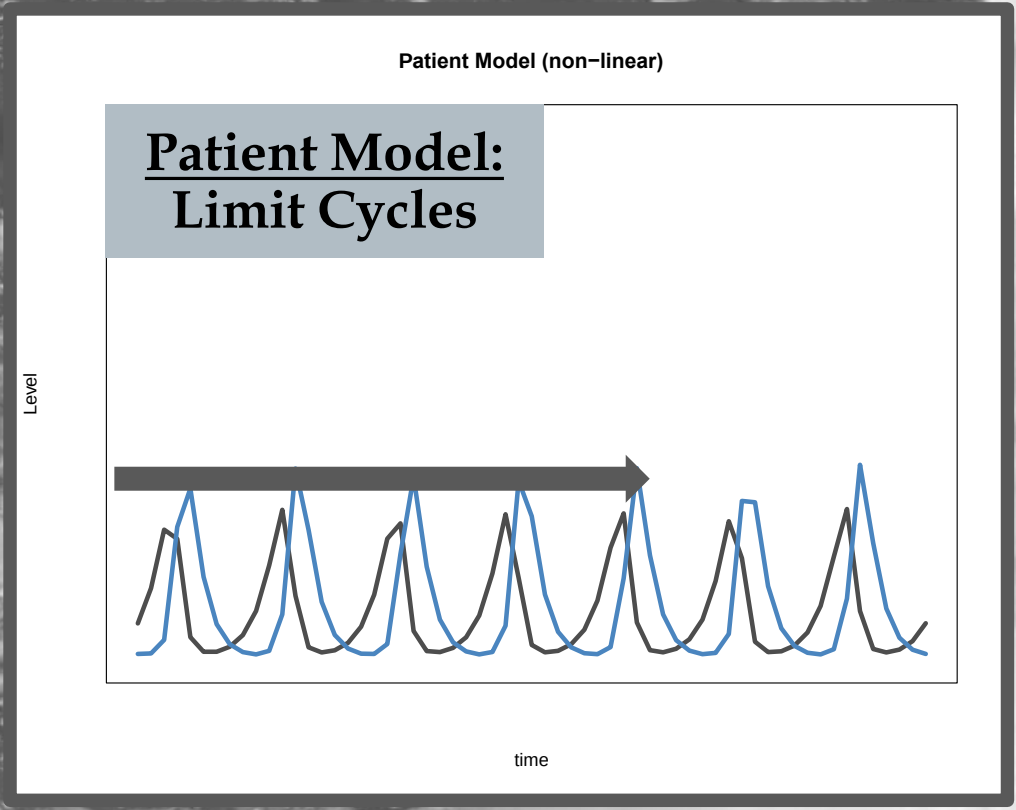
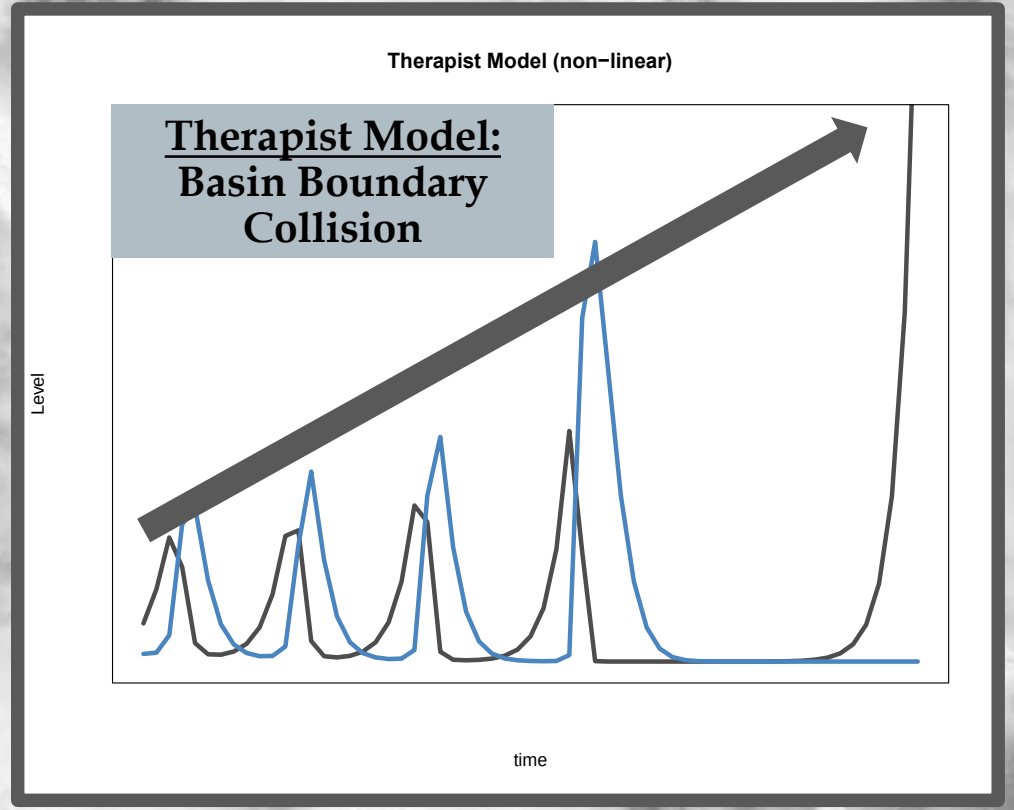
- **If Avoidance helps, the patient is more likely to avoid in future situations.**
- **Over time, patient needs higher degrees of avoidance to compensate anxiety.**

Dynamical Case Conceptualization: Limit Cycles





Scenario 3: Basin Boundary Collision ('Therapist Model')

- **Taking negative consequences of avoidance behavior into account.**
- **The amplitude of avoidance and anxiety increases, eventually leading to a critical. transition.**

Dynamical Case Conceptualization: Limit Cycles