Peripheral Nerve Stimulation
For the Treatment of Postoperative Pain

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Disclosure (PI)

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  - Varian Medical
  - SPR Therapeutics, Gate Science, Masimo

Disclosure (Additional Investigators)

- **Drs. Abdullah and Finneran:** Varian Medical Systems, SPR Therapeutics, Masimo, Gate Science, Pacira BioSciences, Vertex Pharmaceuticals, Avanos Medical
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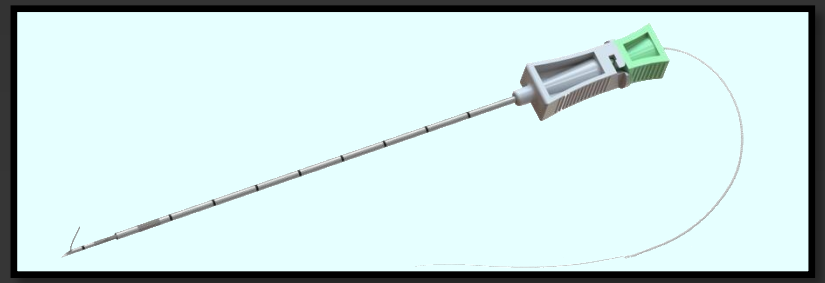
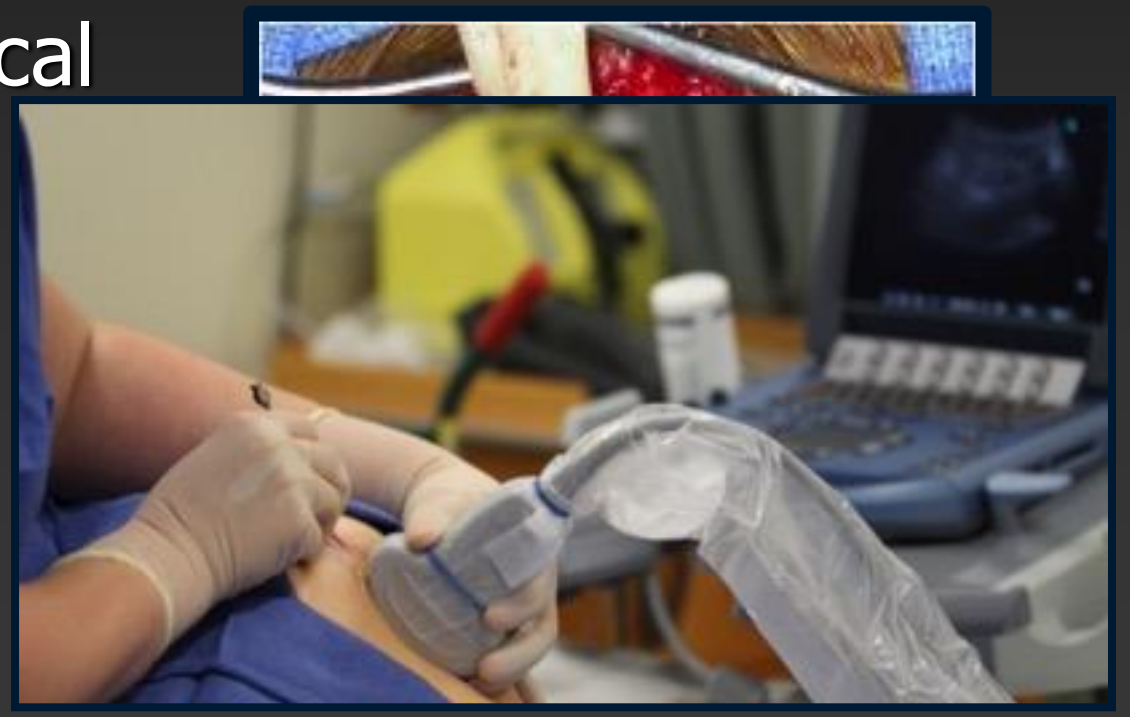
- **Dr. Sessler:** Pacira BioSciences and Masimo

Peripheral Nerve Stimulation

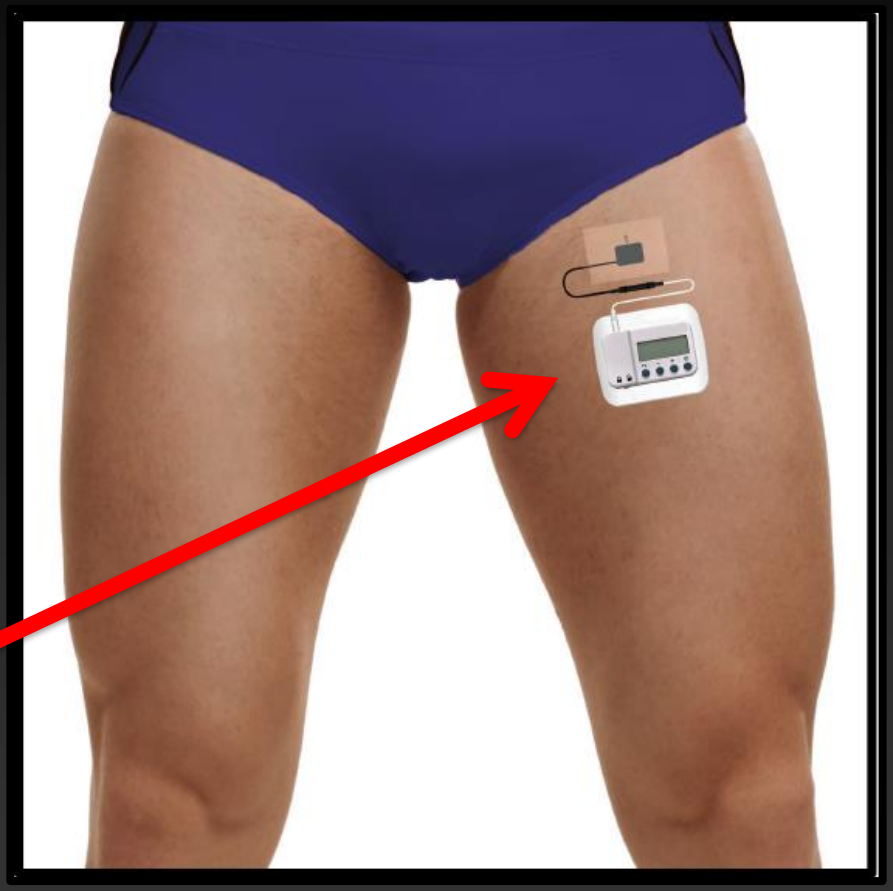
- "Neuromodulation": based on "gate control theory"
  - Stimulation of large-diameter afferent peripheral nerves
  - Spinal cord: stops small-diameter pain fiber communication
- Traditional leads require surgical implantation
- Newly-approved leads allow percutaneous lead insertion





Percutaneous Peripheral Nerve Stimulation

- Pulse generator
- Adhere to patient



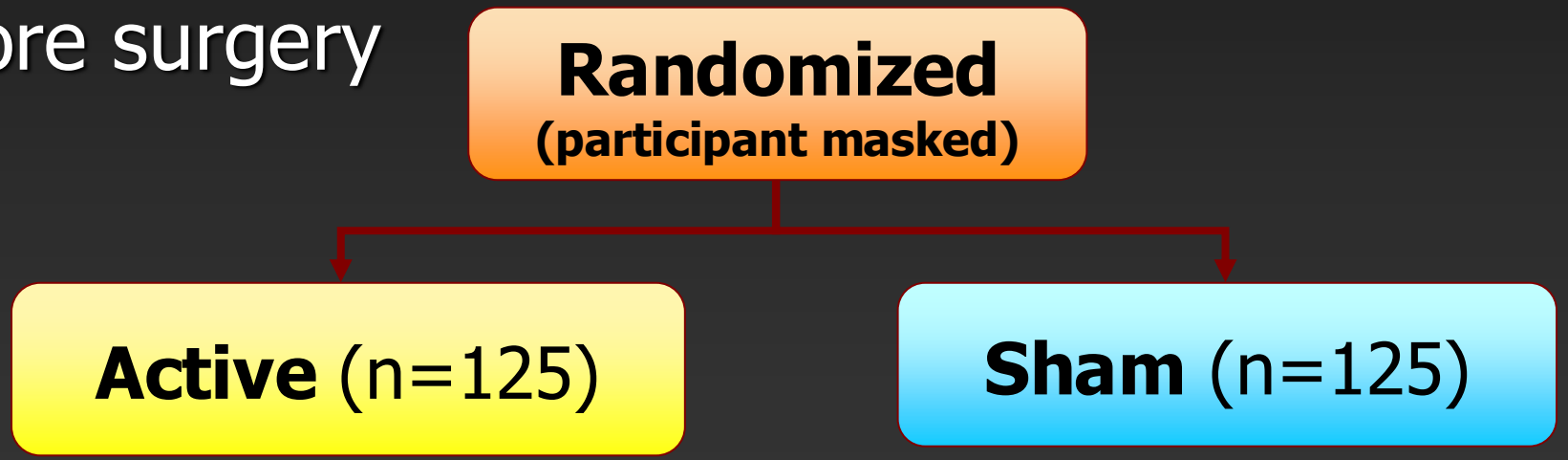
- Maxumum 60 days [2 weeks]
- Removal: gently pull

Aims

- Determine the effects of PNS following painful surgery
- Hypotheses: over first week PNS will decrease…
  - Mean pain intensity (0-10 Numeric Rating Scale)
  - Cumulative opioid consumption (oral morphine equivalents)

Protocol

- Eligibility: Unilateral, primary orthopedic surgery
  - Foot or ankle: sciatic nerve lead [n=130]
  - Shoulder (rotator cuff repair): brachial plexus lead [n=120]
- Lead inserted before surgery
- In recovery room:

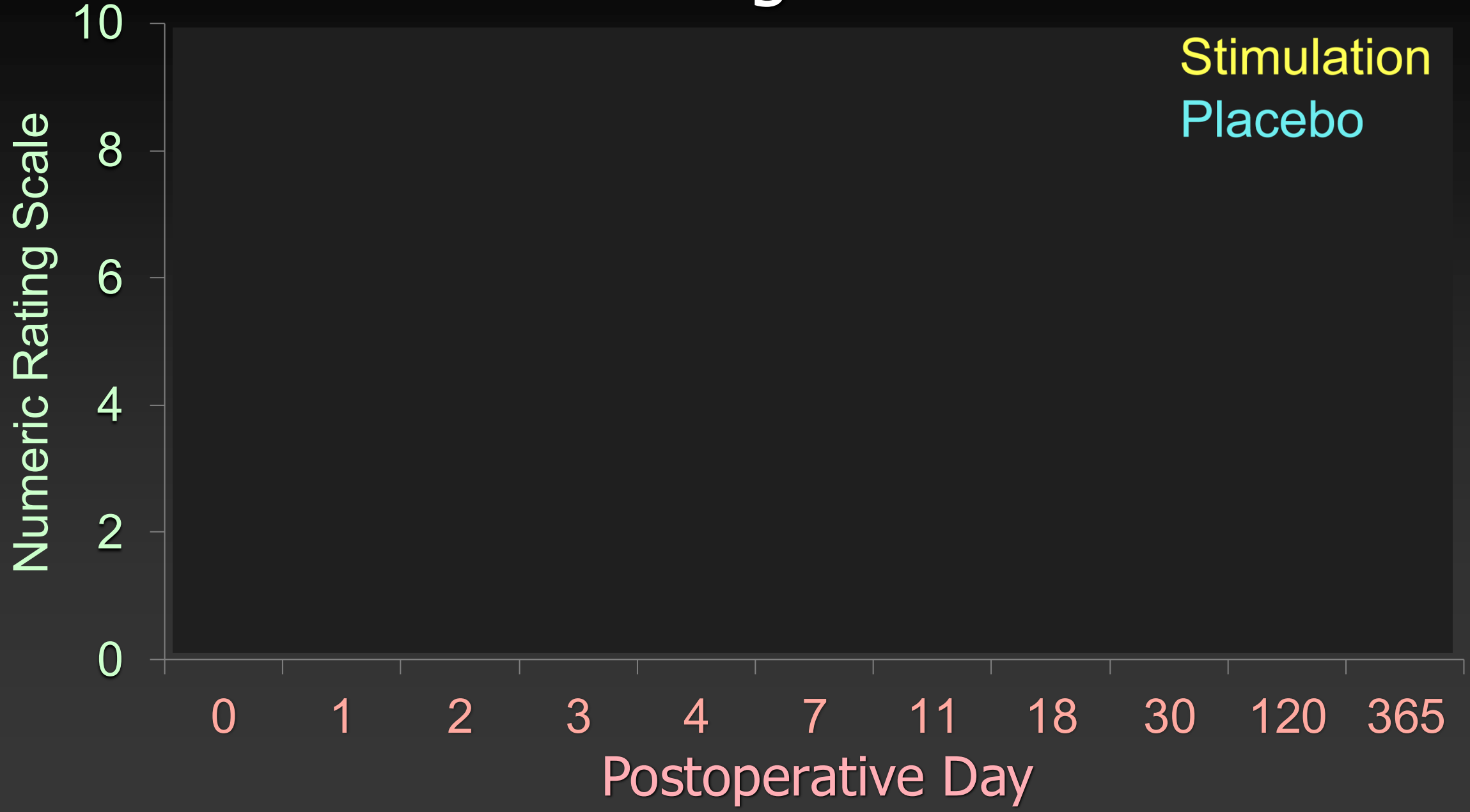


- Lead removal during 2-week surgical visit (gently pull)
- Data collection for 1 year (assessor masked)

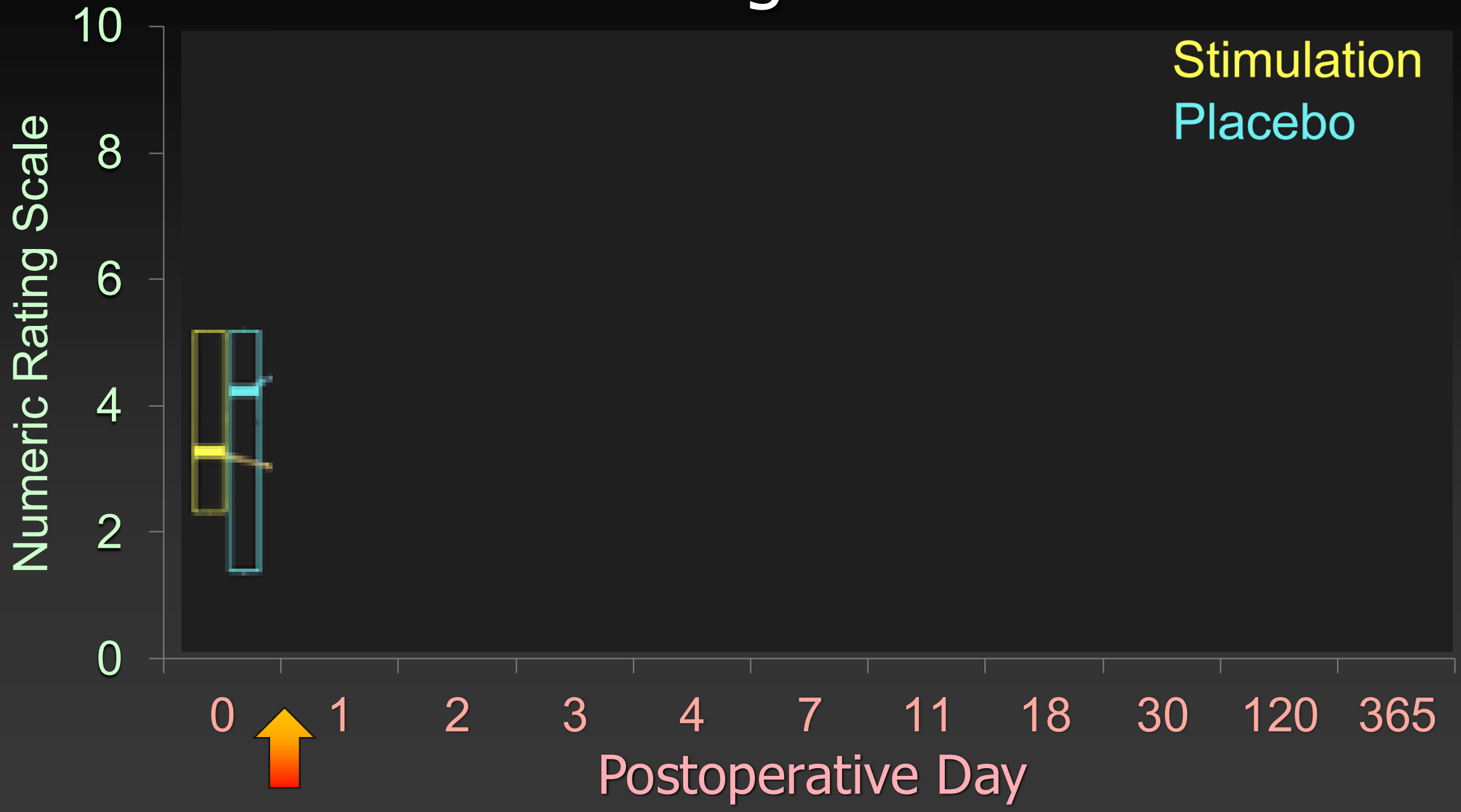
Results: Dual Primary End Points

- Average daily pain intensity 1st week
  - Reduced 59%, mean (SE), 0-10 NRS:
  - Sham **3.2** (0.3)
  - Stimulation **1.1** (0.3)
    - p<0.001
- Cumulative opioid consumption 1st week
  - Reduced 70%, median [IQR], mg morphine equivalents:
  - Sham **68** [15, 131]
  - Stimulation **15** [0, 45]
    - p<0.001

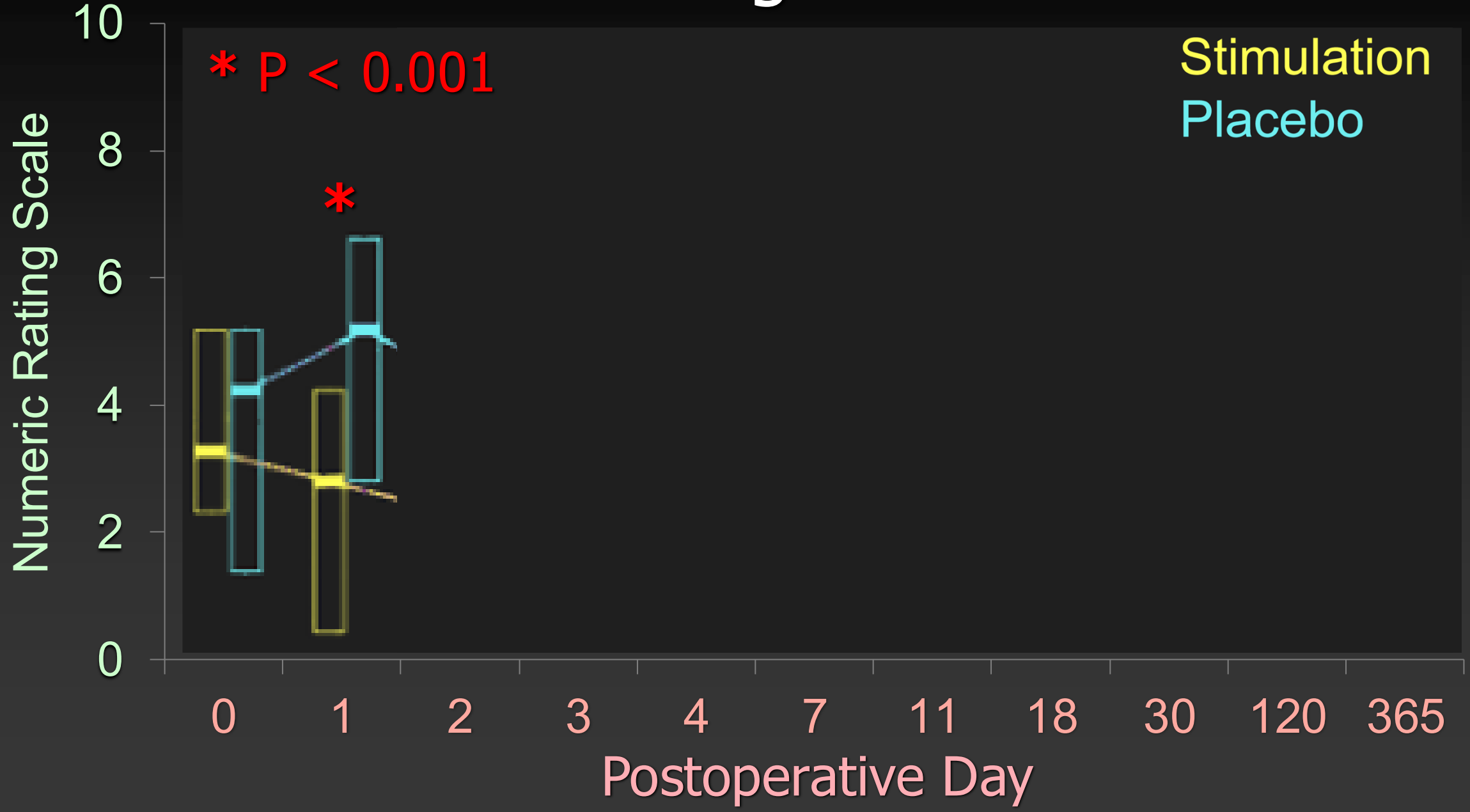
Average Pain



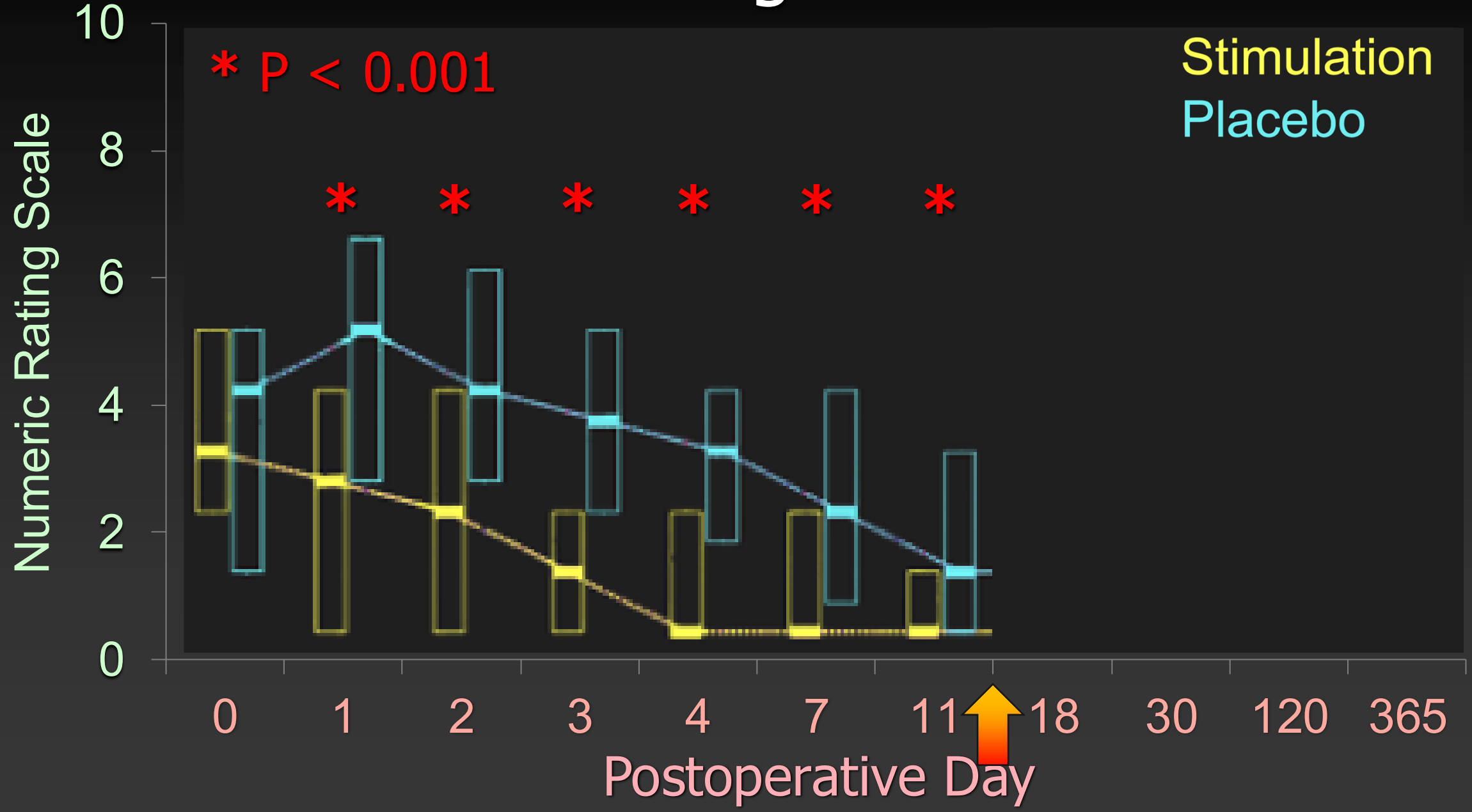
Average Pain



Average Pain



Average Pain



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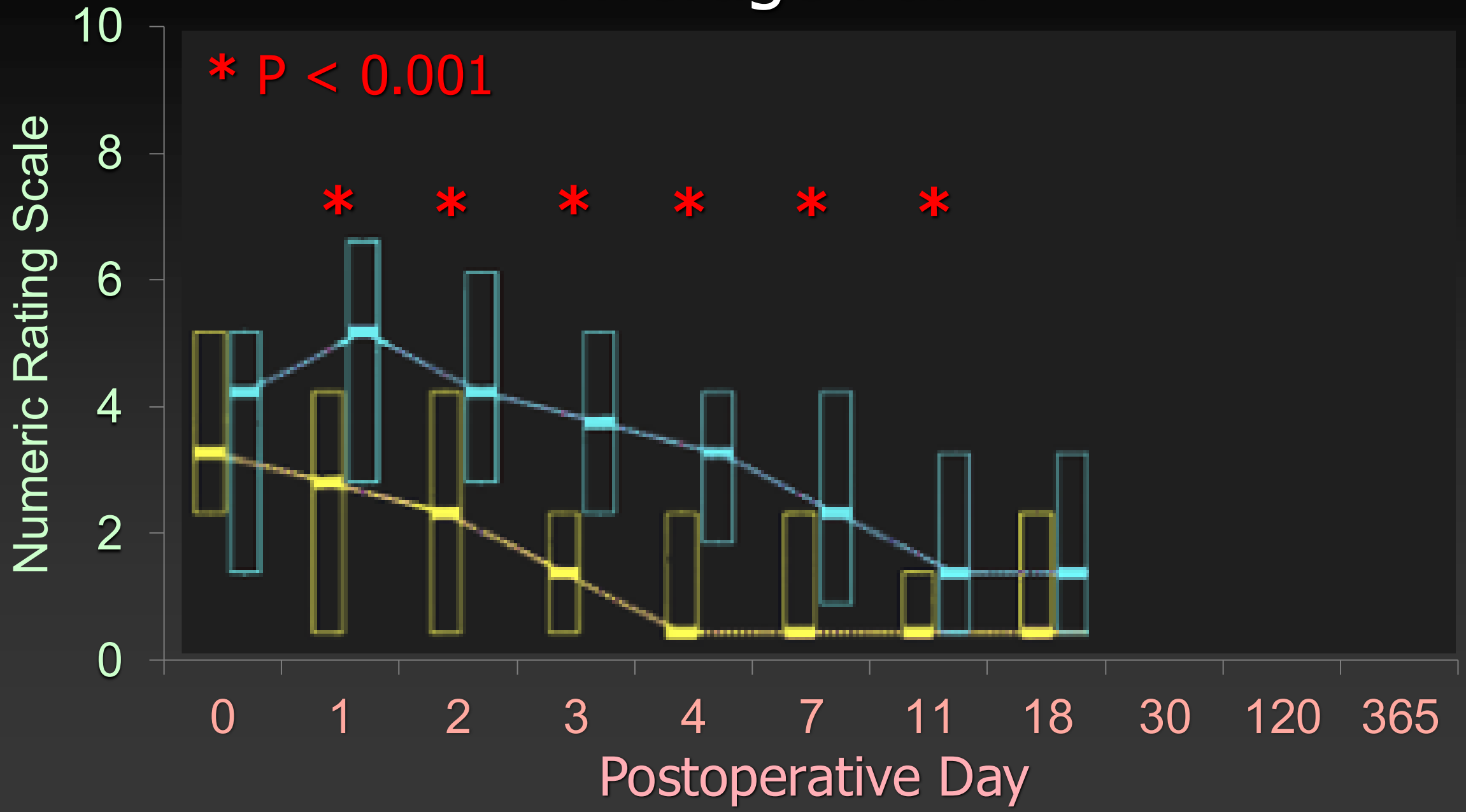

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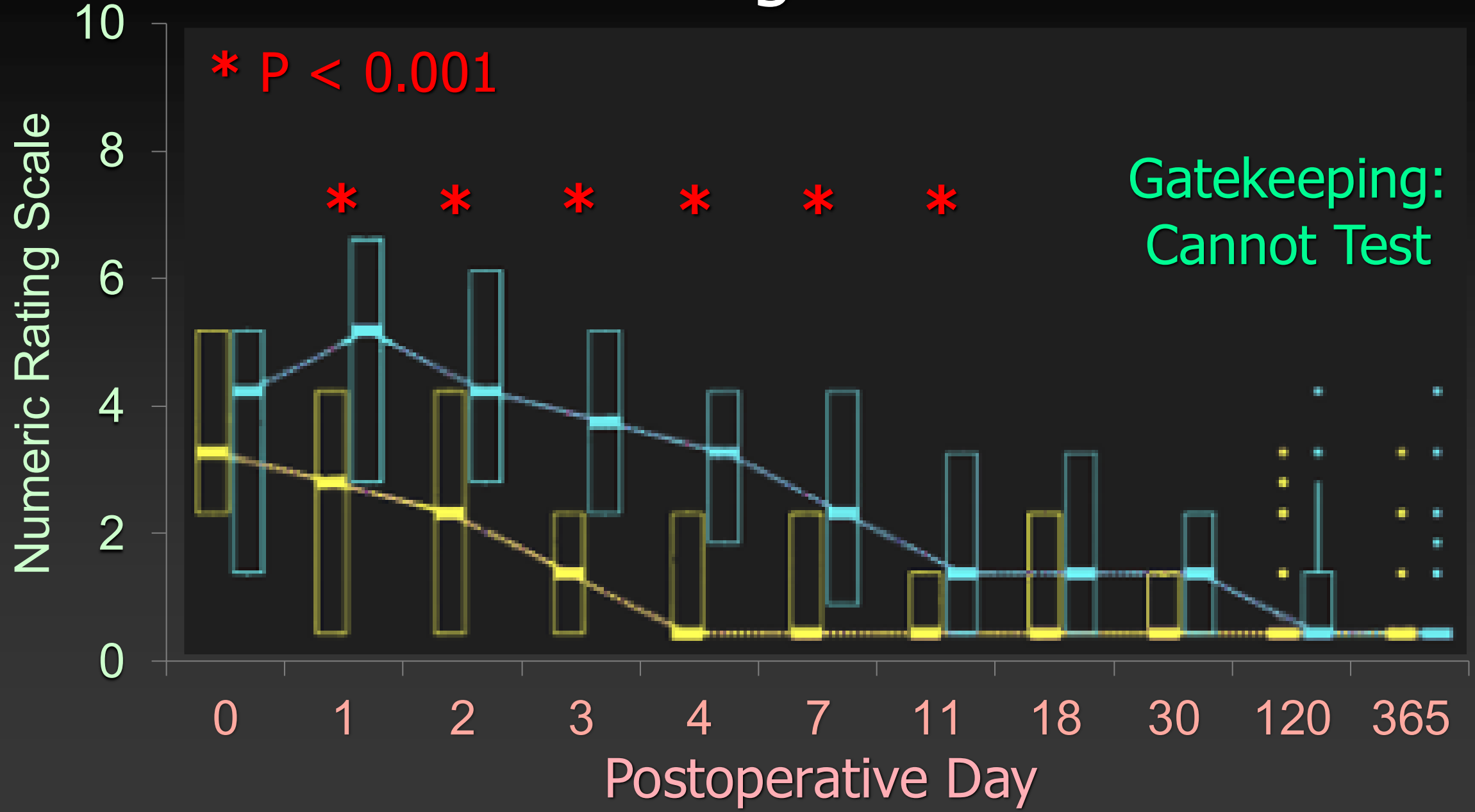
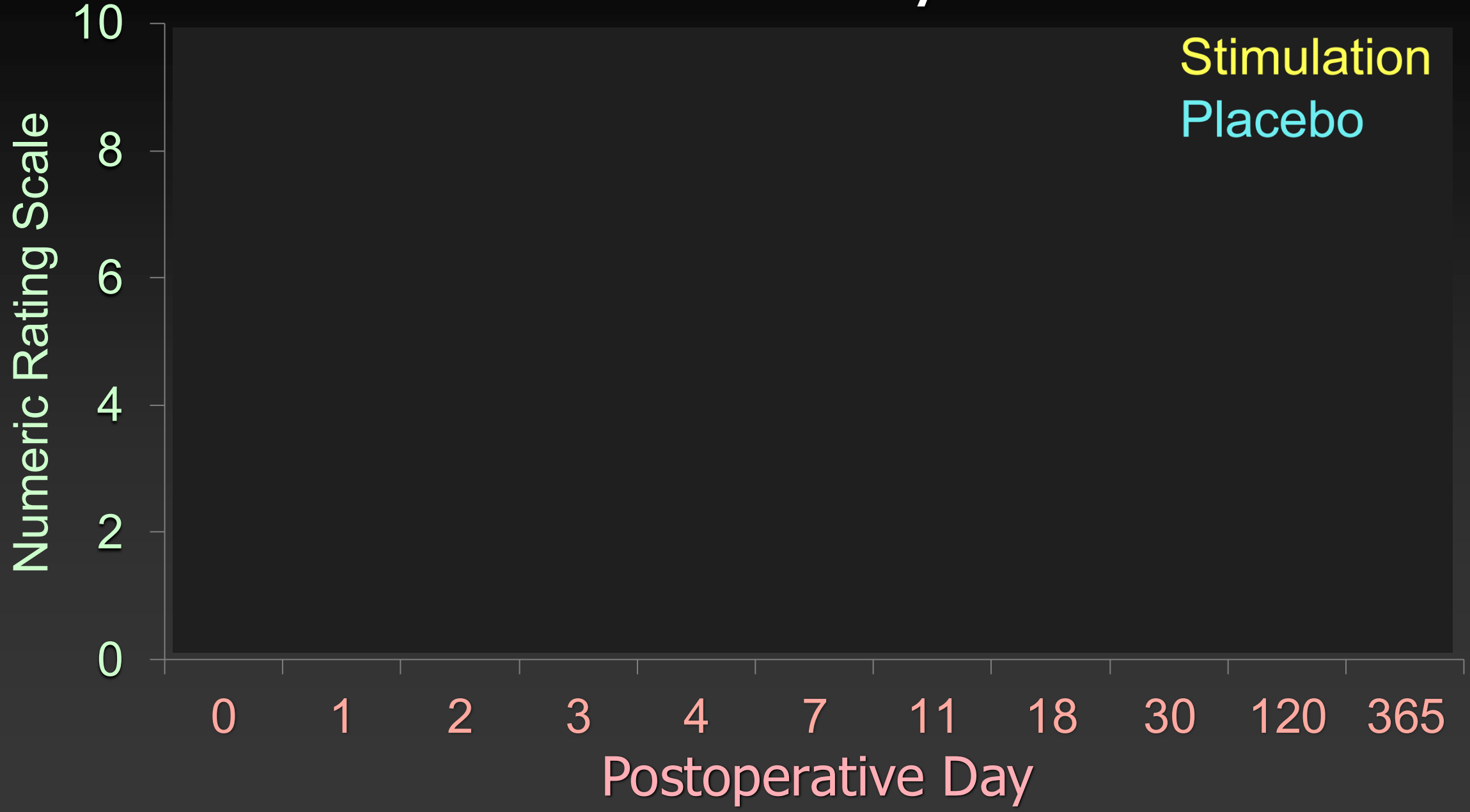


Maximum Daily Pain



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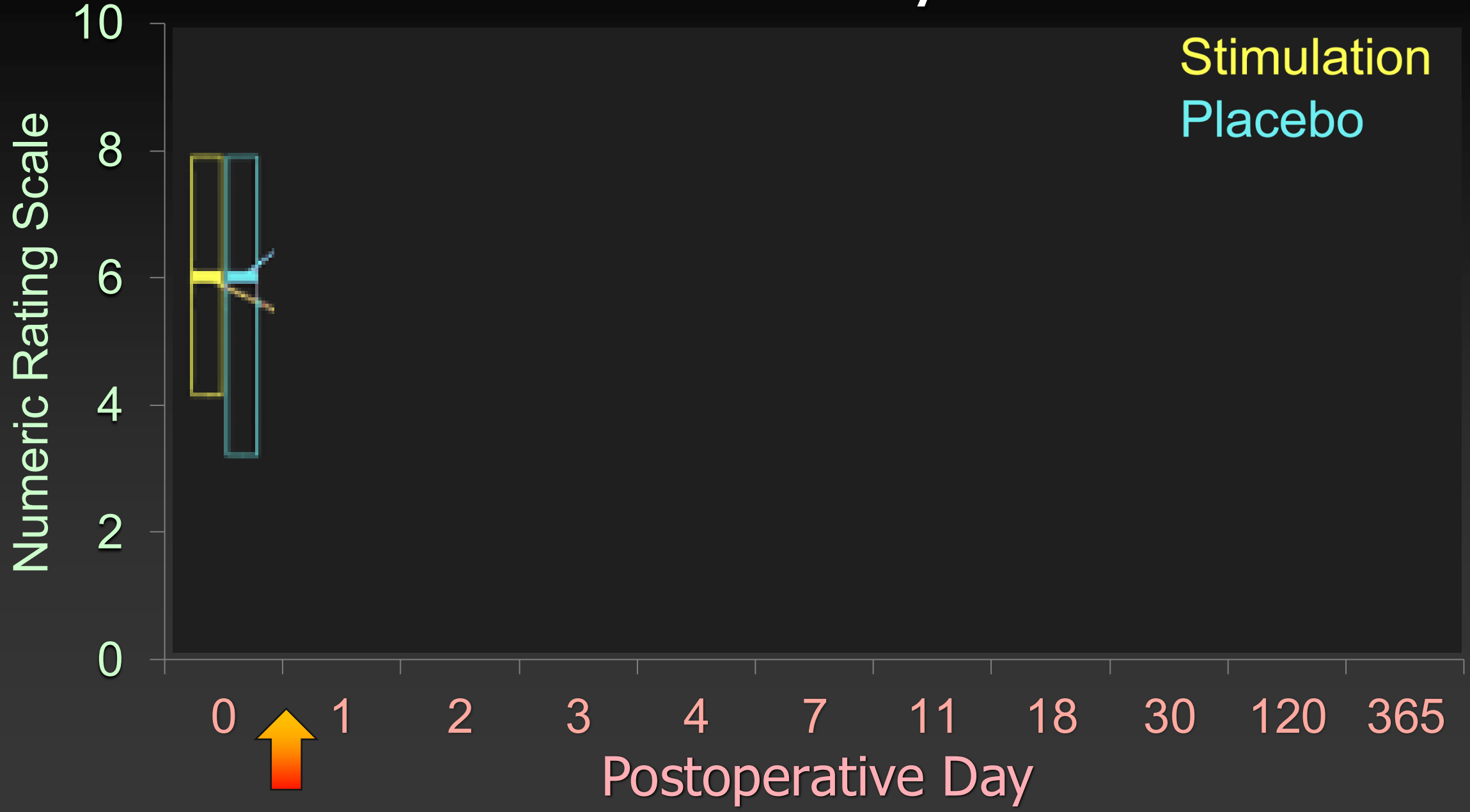

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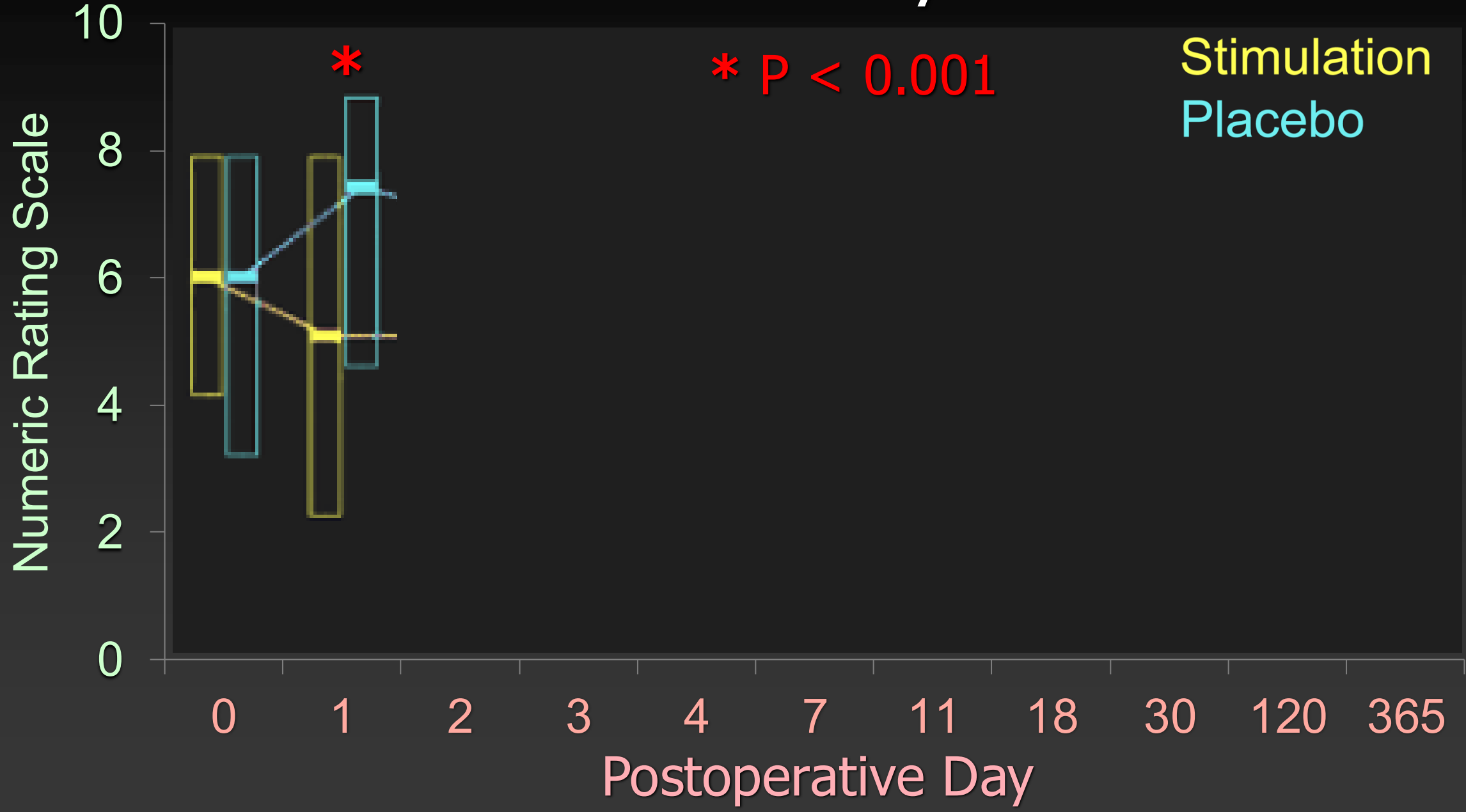

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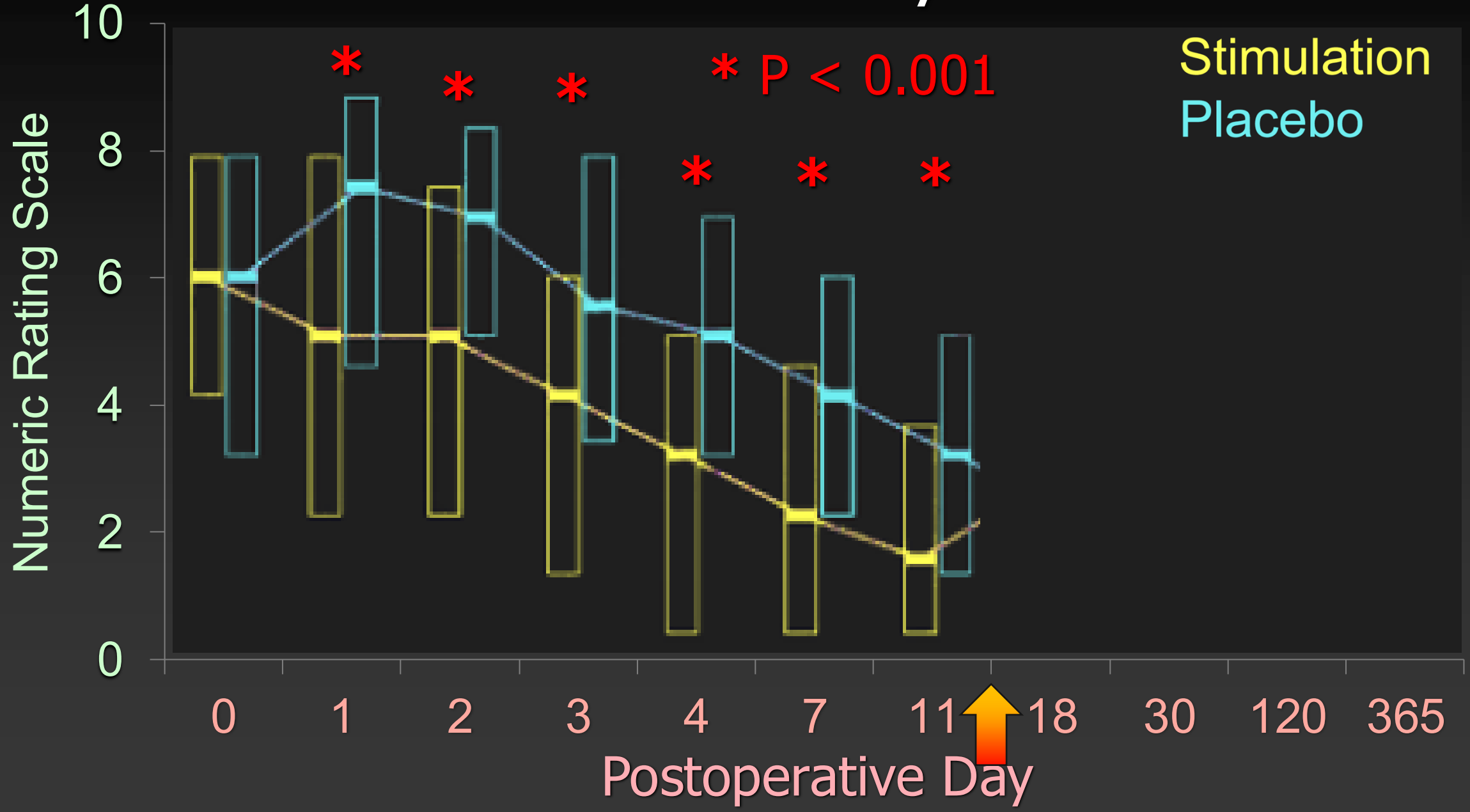

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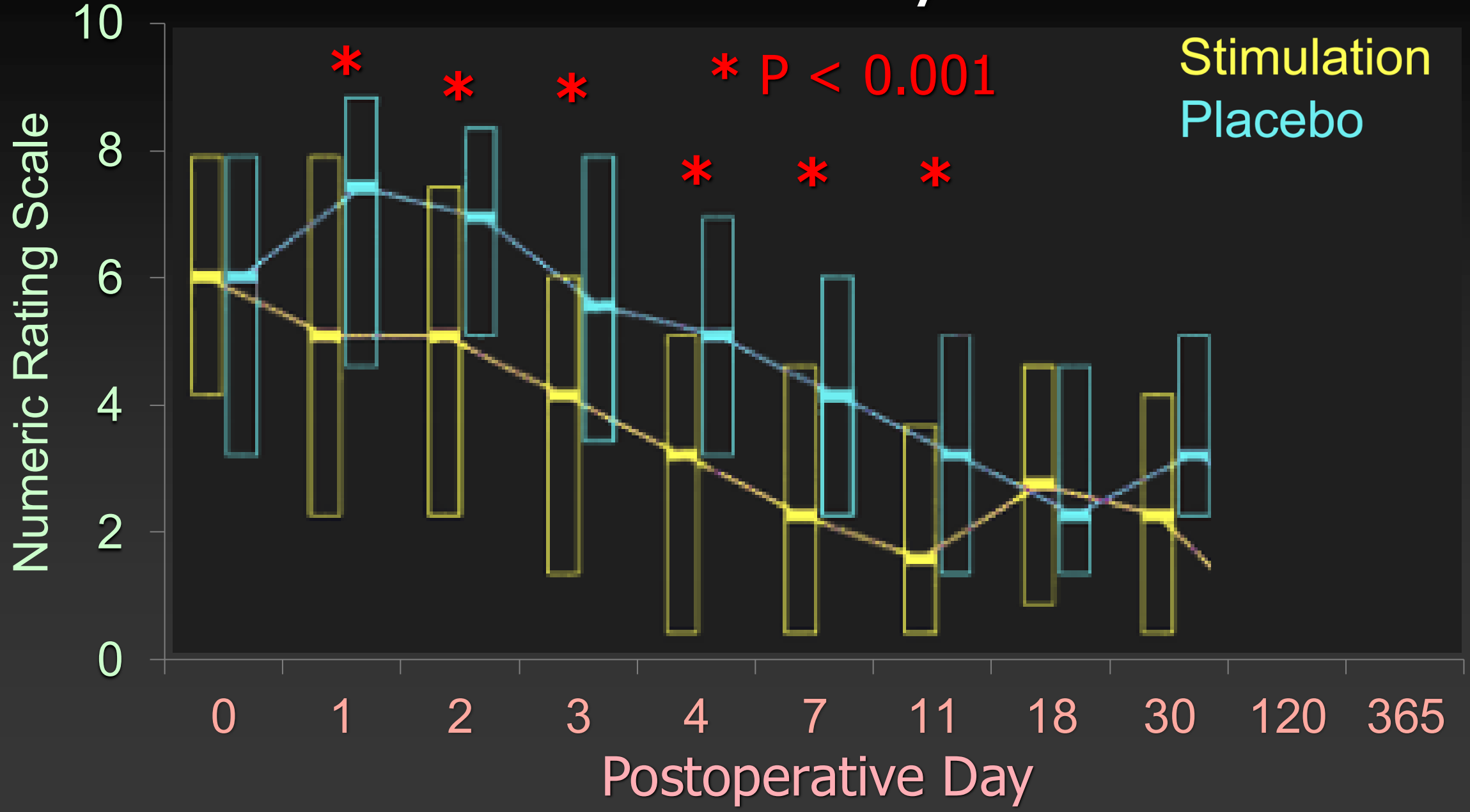

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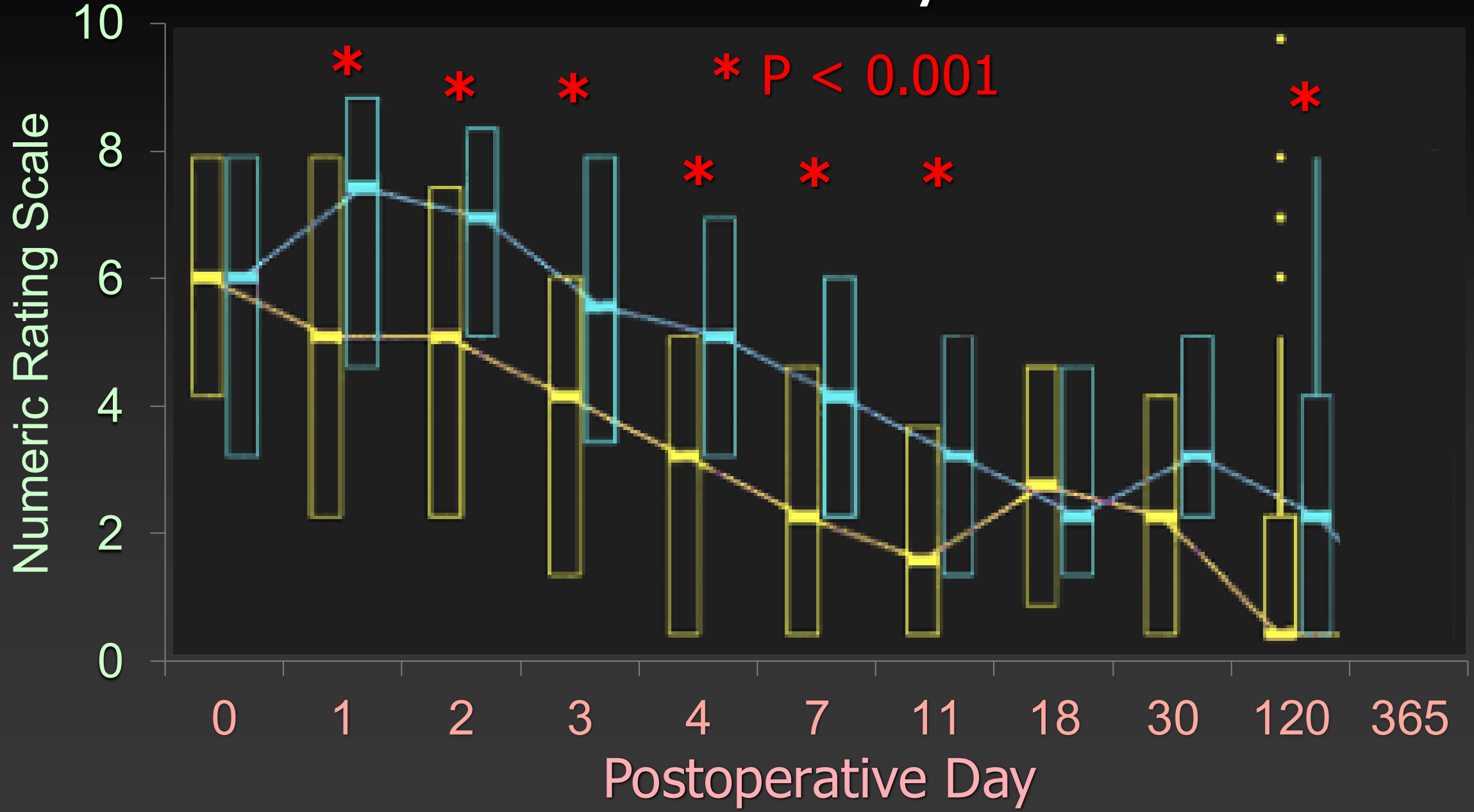

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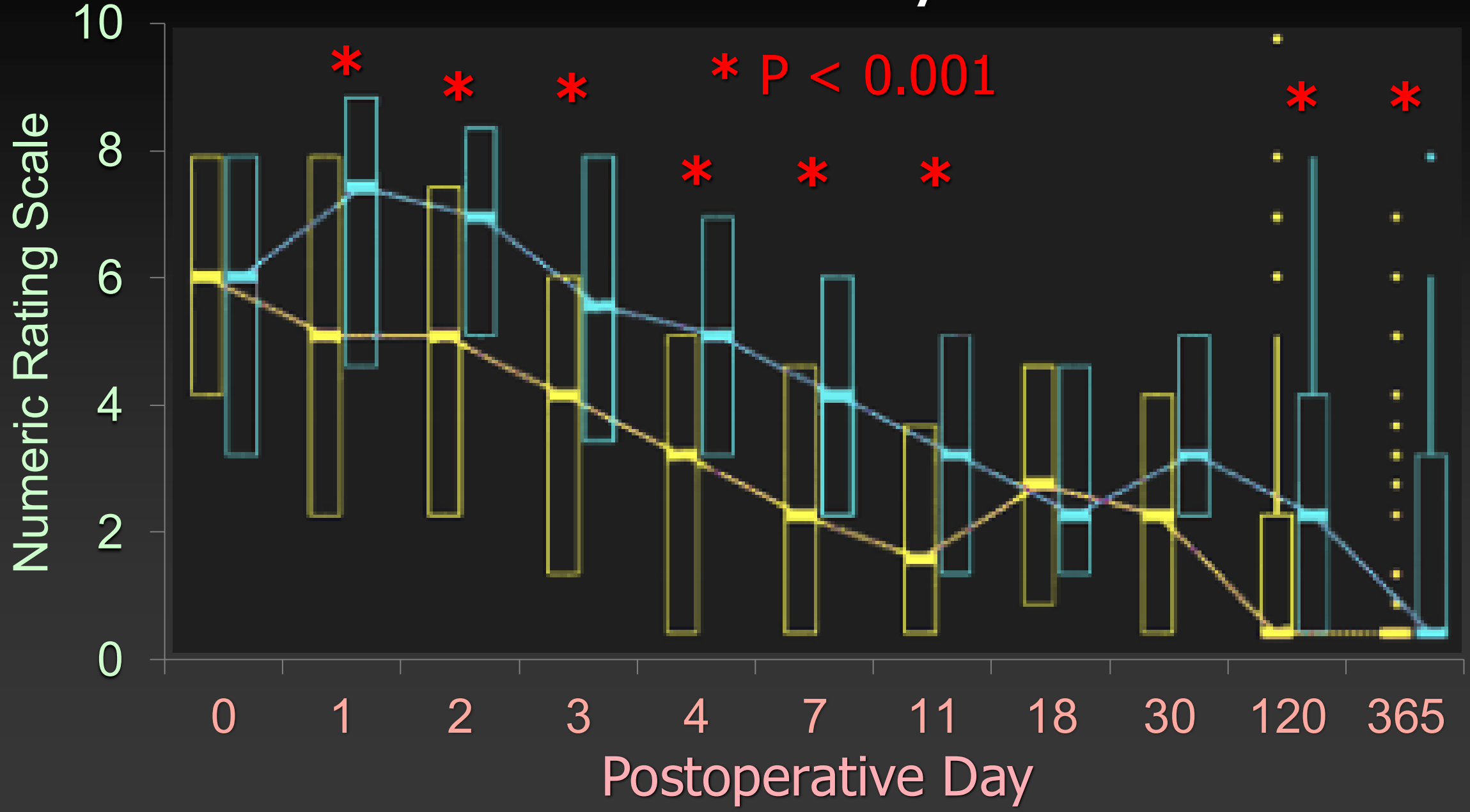
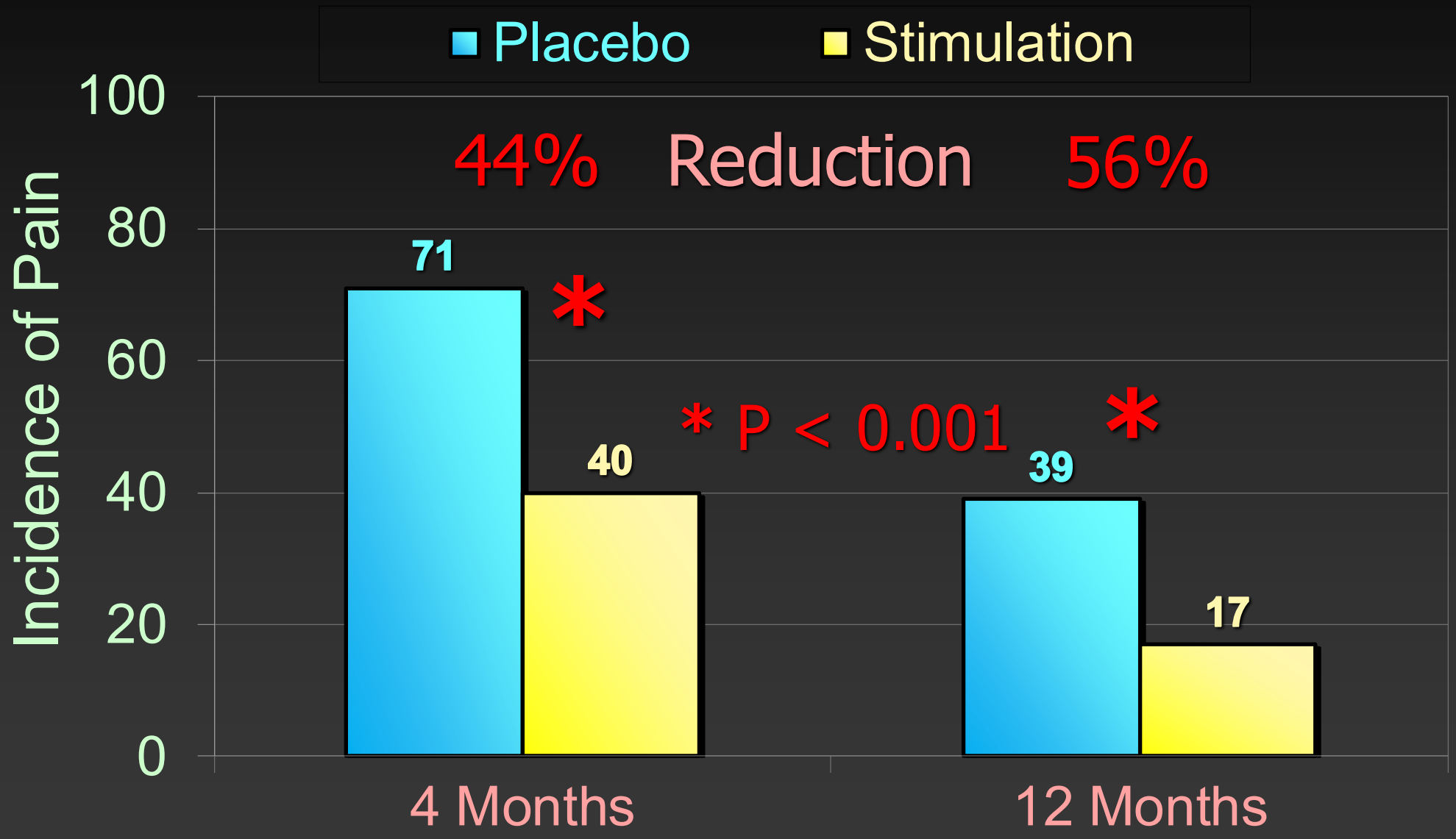


Transition from Acute to Chronic Pain



Gatekeeping Protocol

Gate	**Outcomes**	**Time Point**	**Pass?**

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1	Average Pain and Opioids	Days 1-7	Yes

Gatekeeping Protocol

Gate	**Outcomes**	**Time Point**	**Pass?**
1	Average Pain and Opioids	Days 1-7	Yes
2	Worst Pain and DVPRS	Days 1-7	Yes
3	Brief Pain Inventory	Days 3 and 7	Yes
4	Worst and Average Pain, DVPRS	Day 11	Yes

Gatekeeping Protocol

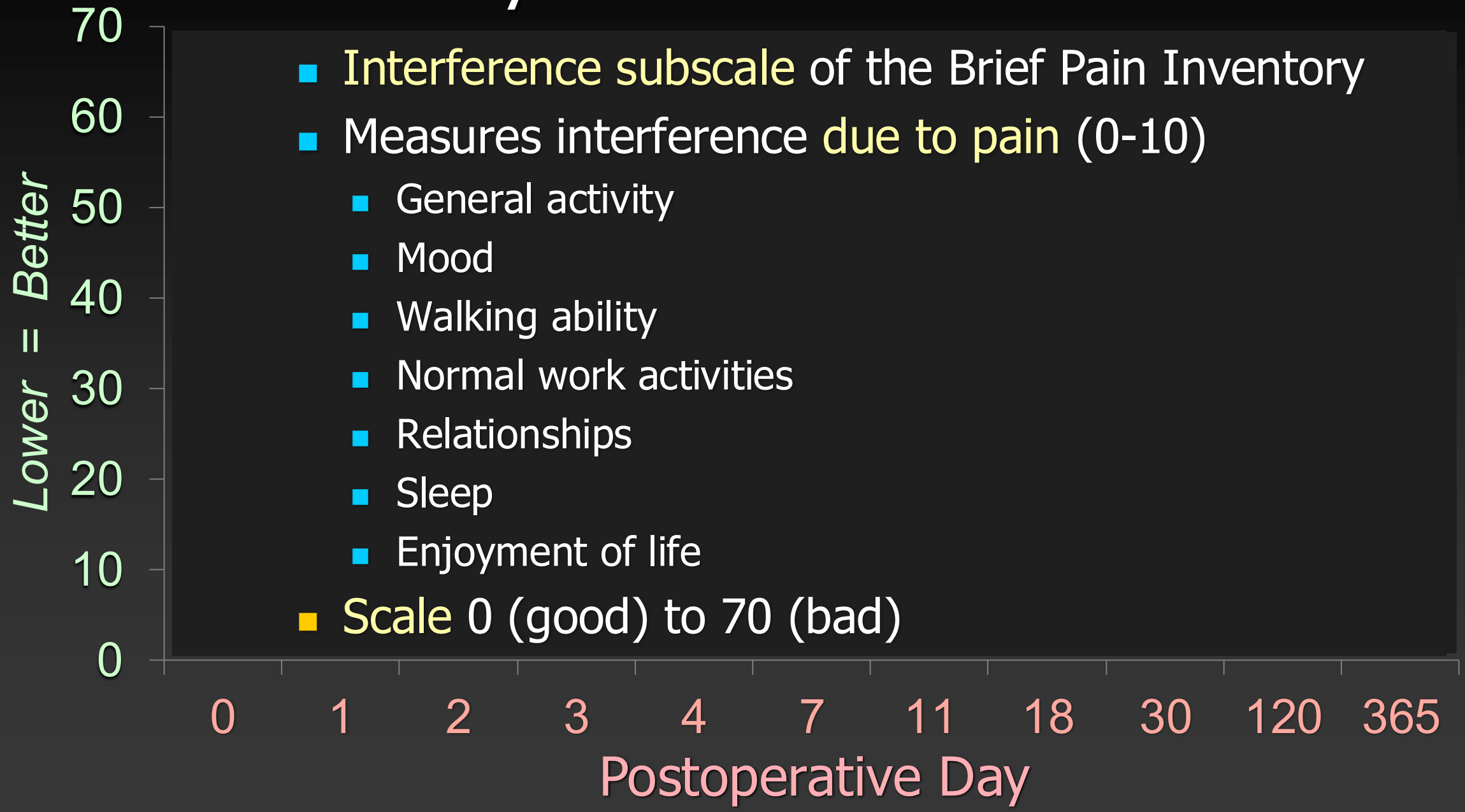
Gate	**Outcomes**	**Time Point**	**Pass?**
1	Average Pain and Opioids	Days 1-7	Yes
2	Worst Pain and DVPRS	Days 1-7	Yes
3	Brief Pain Inventory	Days 3 and 7	Yes
4	Worst and Average Pain, DVPRS	Day 11	Yes
5	* Worst Pain *	Months 4 and 12	Yes

* High confidence in results for transition from acute to chronic

Gatekeeping Protocol

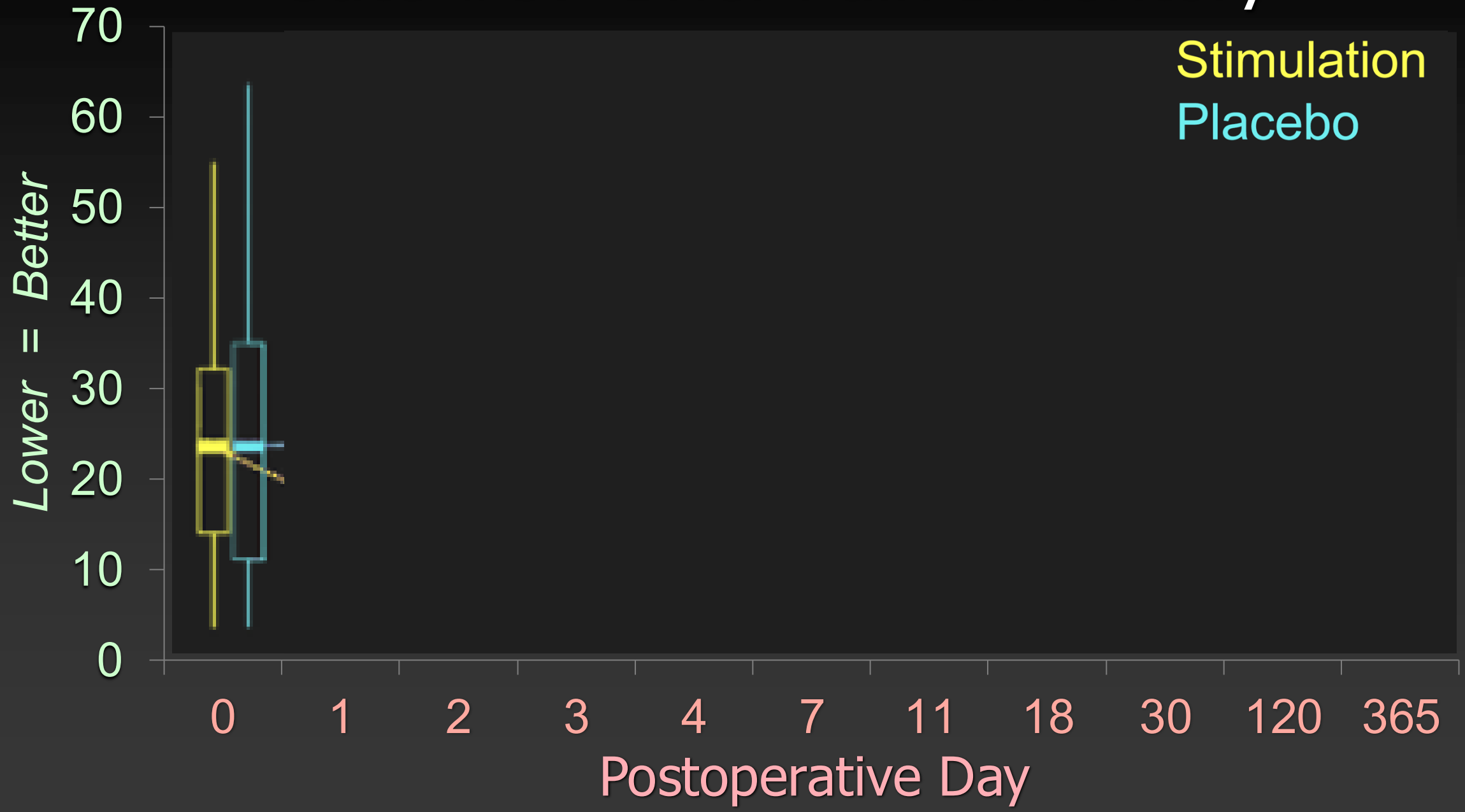
Gate	**Outcomes**	**Time Point**	**Pass?**
1	Average Pain and Opioids	Days 1-7	Yes
2	Worst Pain and DVPRS	Days 1-7	Yes
3	Brief Pain Inventory	Days 3 and 7	Yes
4	Worst and Average Pain, DVPRS	Day 11	Yes
5	Worst Pain	Months 4 and 12	Yes
6	Worst and Average Pain, DVPRS	Day 18	Stop

Gate #3: Physical and Emotional Function



- Interference subscale of the Brief Pain Inventory
- Measures interference due to pain (0-10)
  - General activity
  - Mood
  - Walking ability
  - Normal work activities
  - Relationships
  - Sleep
  - Enjoyment of life
- Scale 0 (good) to 70 (bad)

Gate #3: Brief Pain Inventory



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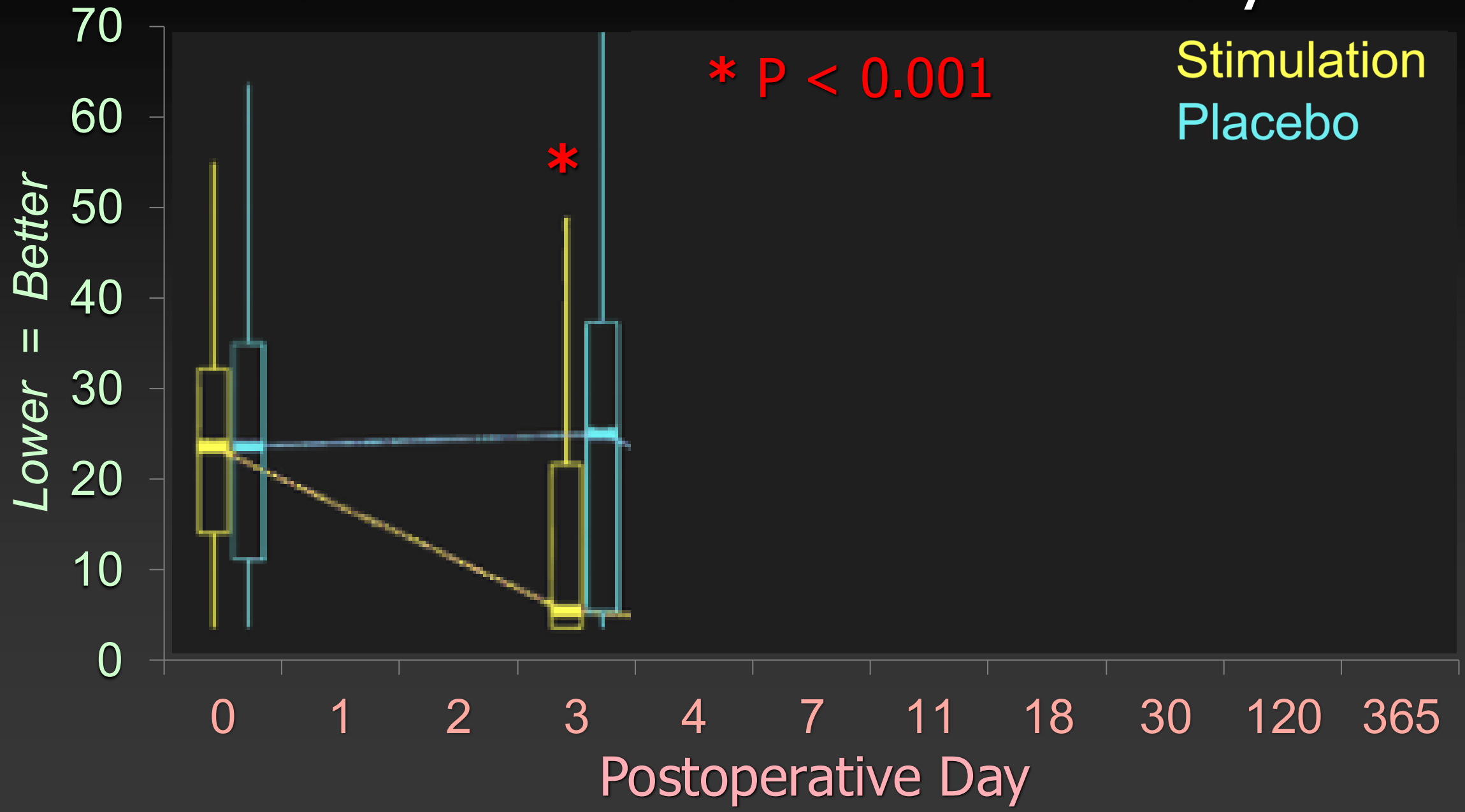

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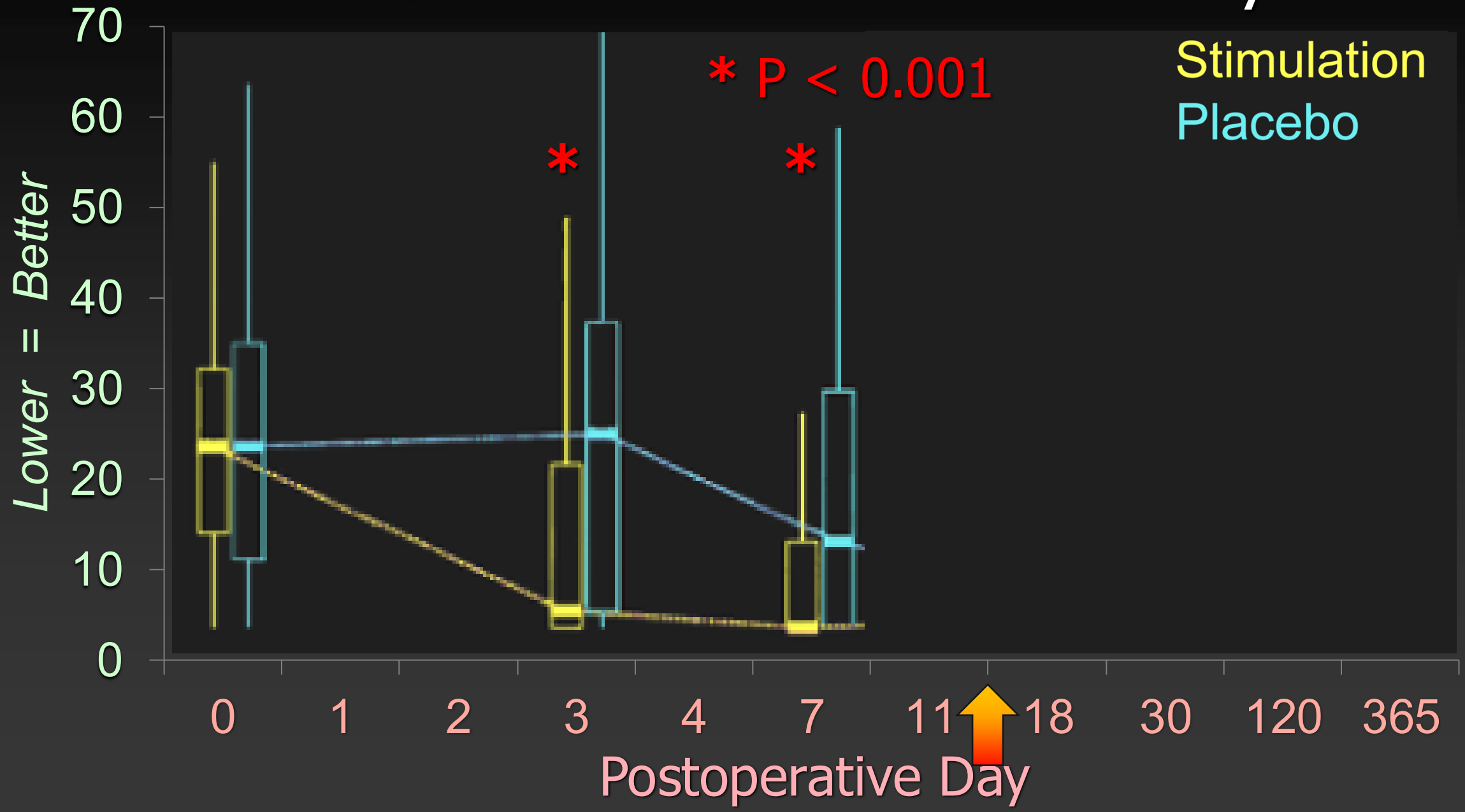

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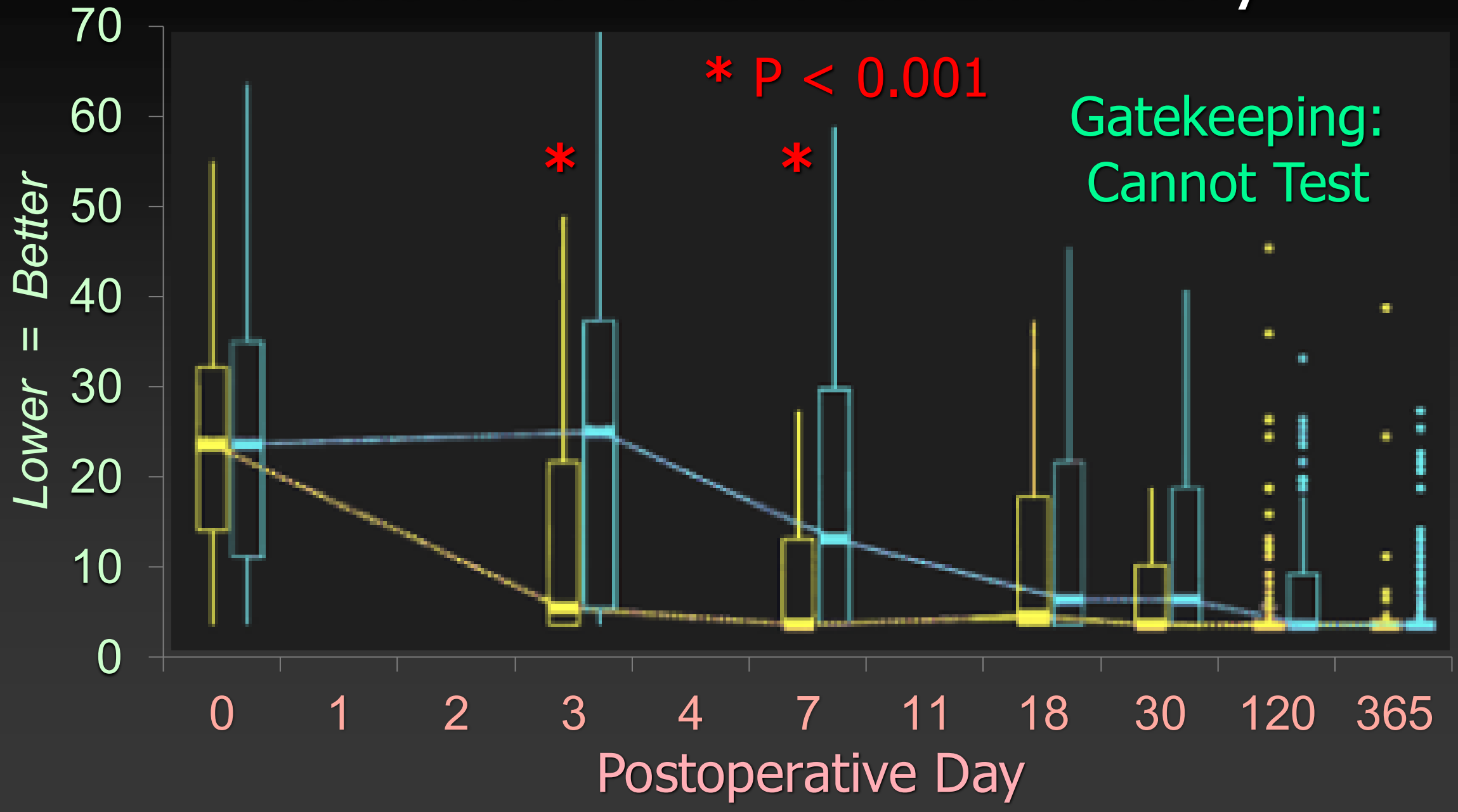
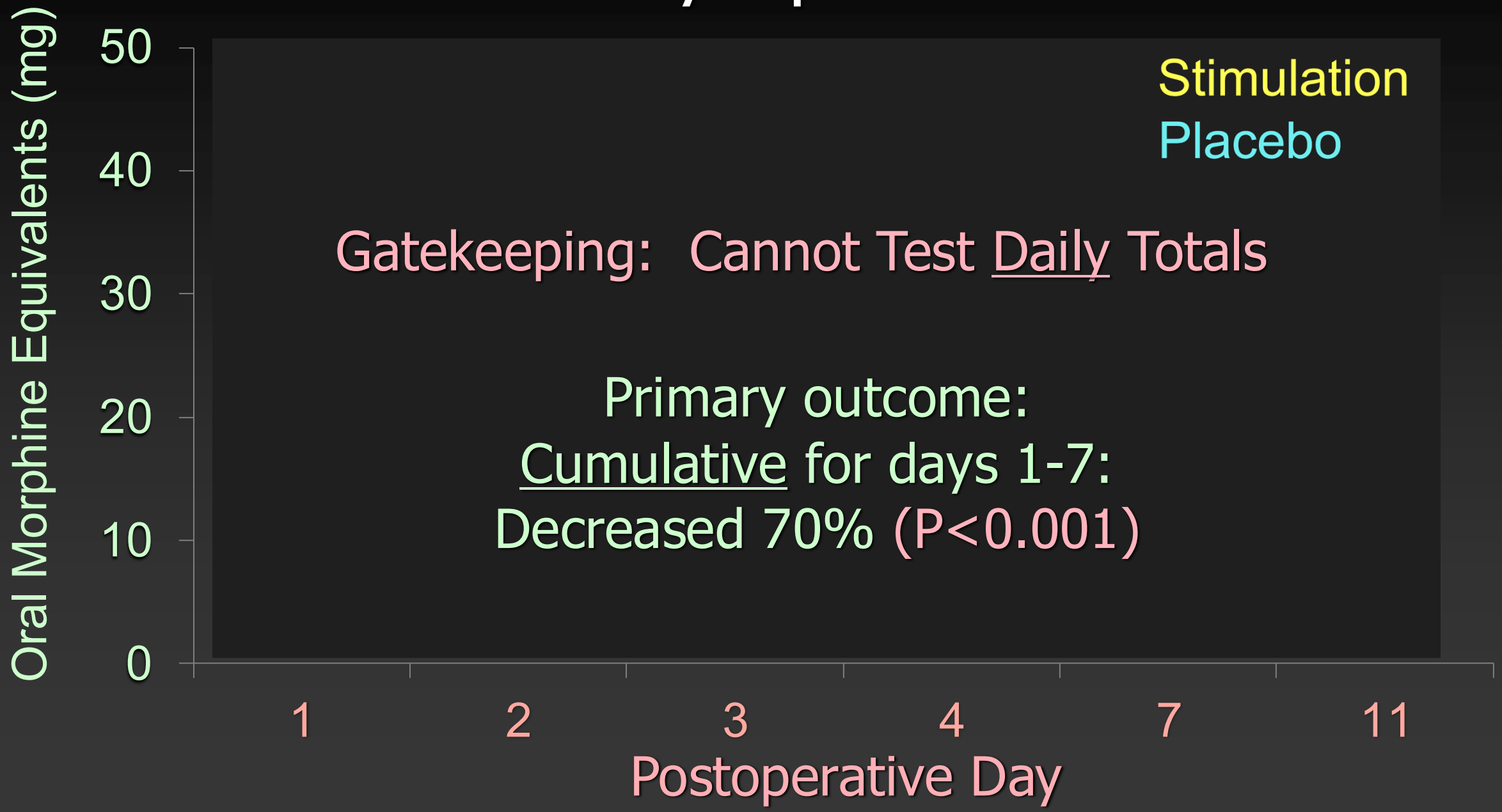


Daily Opioids



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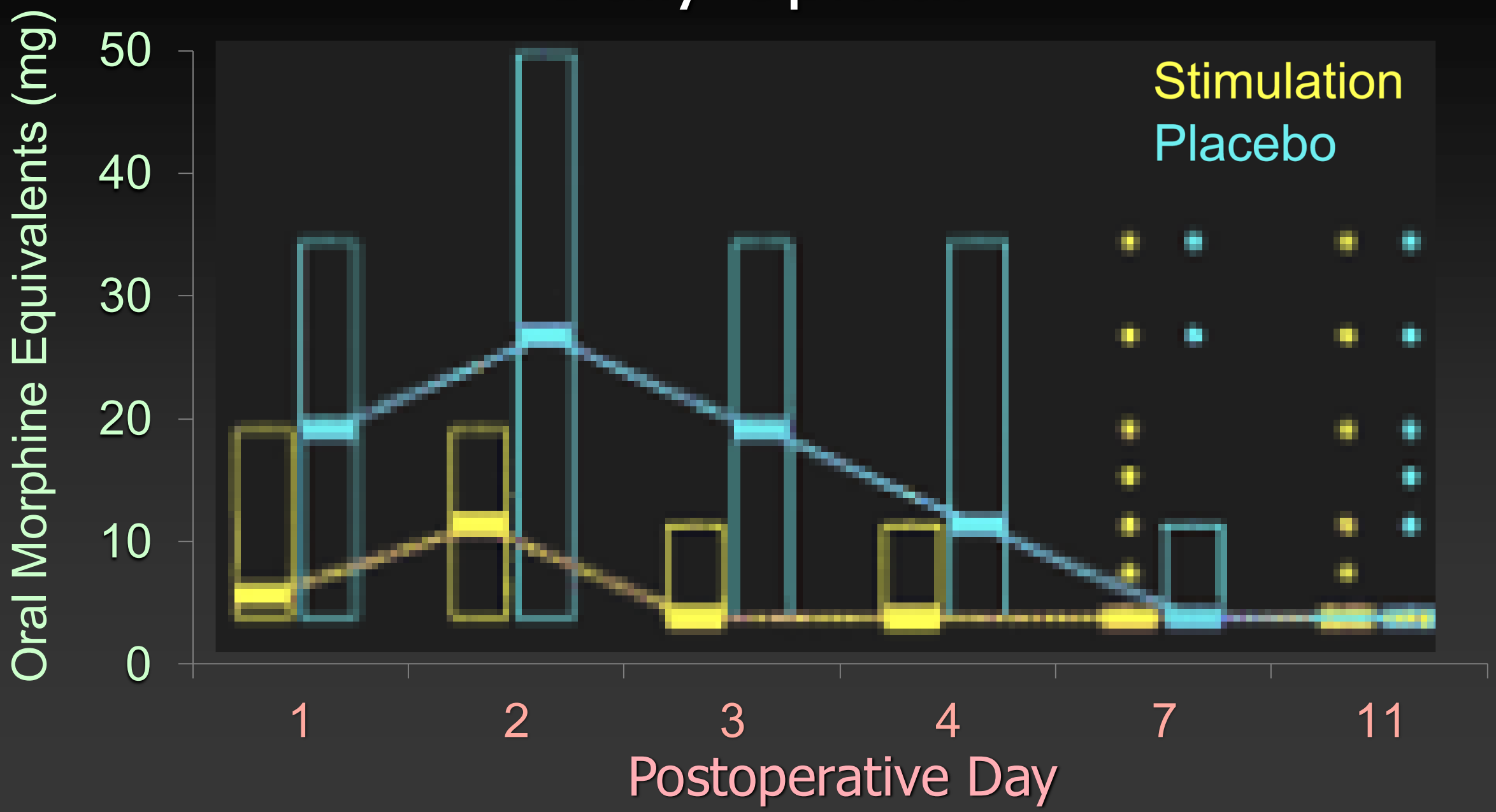

Device-Related Complications

- Most common: lead fractures in 2% (n=6)
  - Leave fragments in place (no sequelae over 1st year)
  - Retained fragments do not preclude safe MRI subsequently
- Only significant complication: 2 infections
  - Lead removal and oral antibiotics cleared inf
  - Corrected lead entry site and no further infections

Summary

- Percutaneous PNS after orthopedic surgery:
  - Decreases pain by a clinically relevant degree at least 14 days
  - Decreases opioid use by a clinically relevant degree at least 7 days
  - Decreases transition from acute to chronic pain at 4 and 12 months
- Risk-benefit ratio: no serious adverse events (n=250)
- Major benefits:
  - No proprioception, sensory, or motor block (vs local anesthetics)
  - No systemic side effects (vs pharmacologic therapies)
- Major drawback: cost ($4,000)
  - Time for insertion

Thank you: Department of Defense (CDMRP)

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