Derivative estimation to quantify pain variability in chronic pain patients

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Background

Previous Literature:
- Pain is a dynamic experience that unfolds over time. Yet, it is often measured as if it is a static process with any intraindividual variability averaged out and/or treated as noise/error. [2]
- Pain that is variable is unpredictable and can be perceived as less controllable and more distressing [1].
- In chronic pain patients, pain variability is positively correlated with pain severity [1] and depression [4].

Open Questions:

1. Would chronic pain patients rate pain stimuli more variably than pain-free controls?
2. Is pain catastrophizing related to higher variability in pain ratings?

Methods

Chronic pain patients (F=19, M=11, M_{age}=53) and pain-free controls (F=13, M=9, M_{age}=53.6) provided informed consent and completed the following procedure:

1. **Questionnaire Battery:** Participants completed a pain catastrophizing scale [3] alongside a PROMIS® (Patient-Reported Outcomes Measurement Information System) battery, including measures of Pain Intensity, Sleep Disturbance, Depression, Anxiety, and Physical Functioning.

0-not at all, 1-to a slight degree, 2- to a moderate degree, 3-to a great degree, 4-all the time

When I'm in pain…

1. I worry all the time about whether the pain will end
2. I feel I can't go on
3. It's terrible and I think it's never going to get any better
4. It's awful and I feel that it overwhelms me
5. I feel I can't stand it anymore
6. I become afraid that the pain will get worse
7. I keep thinking of other painful events
8. I anxiously want the pain to go away
9. I can't seem to keep it out of my mind
10. I keep thinking about how much it hurts
11. I keep thinking about how badly I want the pain to stop
12. There's nothing I can do to reduce the intensity of the pain
13. I wonder whether something serious may happen

2. **Thermal Pain Task:** Participants rated (on computerized VAS scale ranging from 0-100) a constant thermal pain stimulus that was set at 1° c above their pain tolerance.

Note: Baseline pre-experiment pain ratings: $M_{chronicpain}$=4.23, $M_{control}$=.68

Results

Pain–Free Controls

Chronic Pain Patients
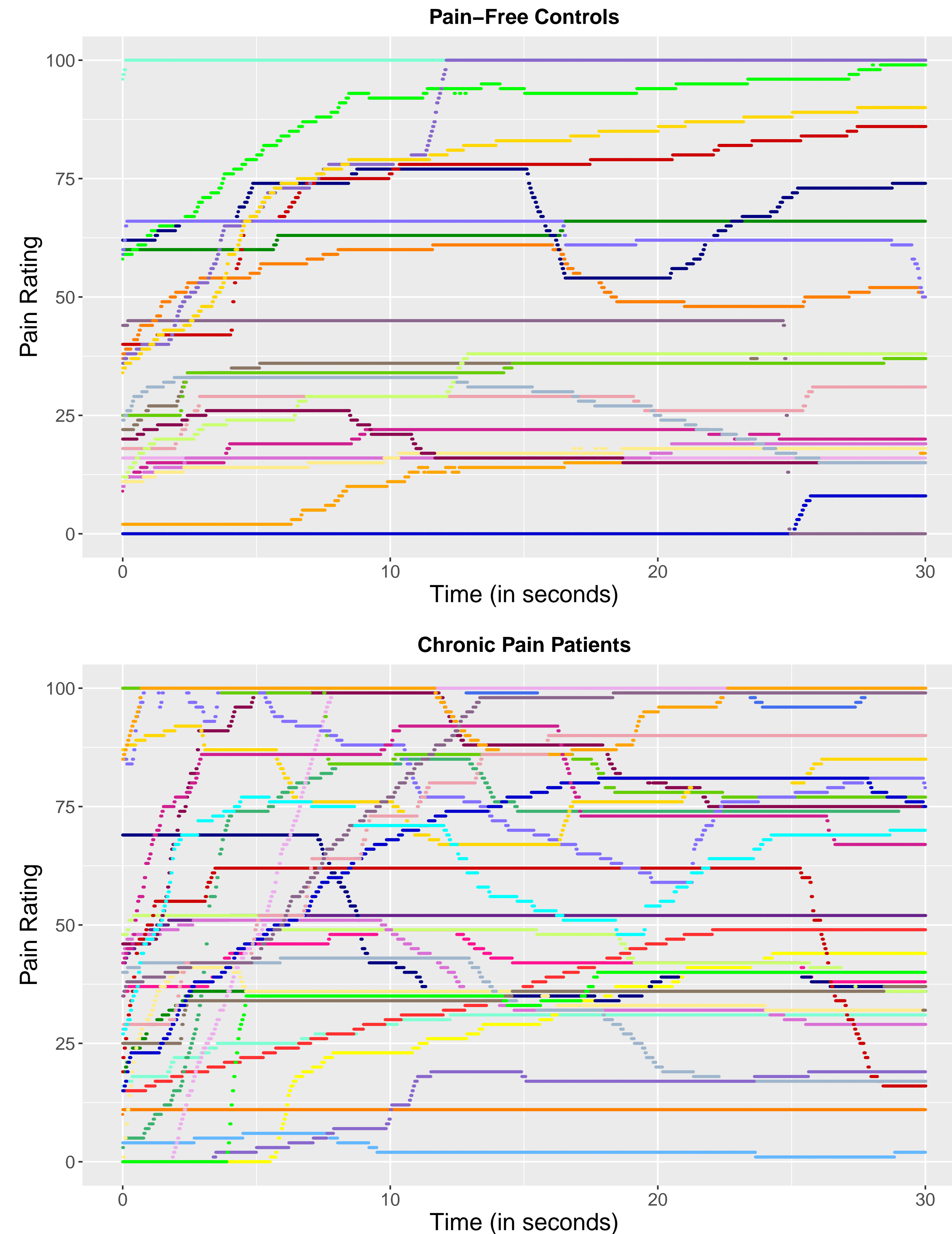
Results Cont.

- Data were cleaned by taking the data marked by event codes for the start and end of the thermal pain task.
- Pain responses were sampled approximately every 12 ms.
- Derivatives were estimated using GLAA over 2-second intervals.

Do chronic pain patients rate pain stimuli more variably compared to pain-free controls?

Table 2. Effect of Group

	Dependent variable:		
	SD of 0th	SD of 1st	SD of 2nd
Group	3.590*	0.991*	0.849
	(1.729)	(0.493)	(.694)
R^2	0.079	0.075	0.029
Adjusted R^2	0.061	0.056	0.009

Note: *p<0.1; **p<0.05; ***p<0.01; PCS = pain catastrophizing score

Is pain catastrophizing related to higher variability in pain ratings?

Table 2. Effect of Group & PCS

	Dependent variable:		
	SD of 0th	SD of 1st	SD of 2nd
Group	1.569	0.268	-0.001
	(1.816)	(0.497)	(0.725)
PCS	0.205*	0.073**	.086**
	(0.079)	(0.022)	(0.032)
R^2	0.189	0.250	0.156
Adjusted R^2	0.156	0.219	0.122

Note: *p<0.1; **p<0.05; ***p<0.01; PCS = pain catastrophizing score

Discussion & Future Directions

This study suggests that chronic pain patients experience pain stimuli differently over time, and pain catastrophizing may help explain this differential experience. More specifically this study:

- Demonstrates that chronic pain patients show higher variability when rating constant pain stimuli
- Adds another point of evidence indicating that pain variability is linked to important metrics (i.e. pain catastrophizing, pain severity,depression)
- Highlights opportunities for using novel variability metrics in pain research to further understand the dynamic process of pain

In future research we hope to:

- Examine pain variability in other contexts and chronic pain conditions
- Further develop statistical approaches to capture variability in pain experiences

References

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[4] Karolina M Zakoscielna and Patricia A Parmelee. Pain variability and its predictors in older adults: depression, cognition, functional status, health, and pain. *Journal of aging and health*, 25(8):1329–1339, 2013.