Using Heart Rate Measurements to Understand and Support Decision Making in Electronic Auctions

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Emotions in Electronic Commerce

Excitement

Users' experienced emotional intensity and derived hedonic value from shopping

Social Presence

Users' perception of social embeddedness and interaction with another human being

Time Pressure

Users' perception of time restrictions imposed on them when making a decision

Auction Fever

Intense emotional state experienced by bidders who bid over pre-set price limits

Auction Platforms

Madbid.com
Created for Fun Shopping — Excitement

Price — Time Pressure

Kindle Fire HD

Like 0 +1 0 Tweet 0 Pin it Share

4 x

£3.07

00:00:08
madmax_de

BID

BuyNow Unavailable

BUY

Auction Information | Bidding History | Delivery Information

Social Presence

Bidder	Amount
madmax_de	£3.07
sniper0	£3.06
madmax_de	£3.05
sniper0	£3.04
CatherineH11	£3.03
madmax_de	£3.02

Focus of Investigation: Auction Fever

Auction Fever

Bidders' *"adrenaline starts to rush, their emotions block their ability to think clearly, and they end up bidding more than they ever envisioned"* (Murnighan, 2002, p. 63)

Selected Literature on Auction Fever

- Internet auctions often yield **higher prices** than fixed-price offers (Jones, 2011)
- Rivalry, social facilitation, and time pressure increase „competitive **arousal**" and bidding (Ku et al., 2005)
- Time pressure induces **aggressive** bidding behavior in ascending auctions (Haruvy & Popkowski Leszczyc, 2009)

Alternative Explanations

- Search costs (Carare & Rothkopf, 2005)
- Winner's curse (Kagel & Levin, 1986)
- Bidder's curse (Lee & Malmendier, 2011)
- Winner regret & loser regret (Engelbrecht-Wiggans & Katok, 2011)
- Quasi-/pseudo-endowment (Heyman et al., 2004)

Approach: Investigate the auction fever phenomenon in a controlled laboratory experiment with physiological measurements.

Agenda

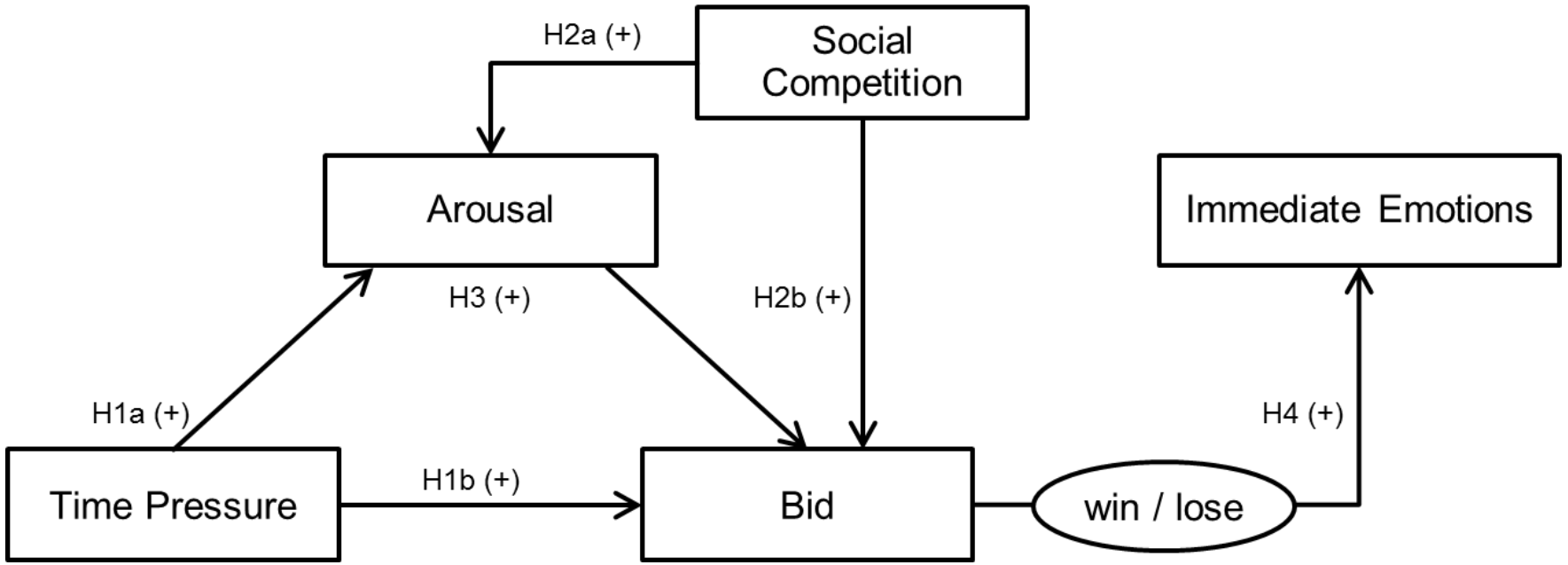
(1) An Experiment on Auction Fever

(2) Feature Selection

(3) Different Auction Paradigms

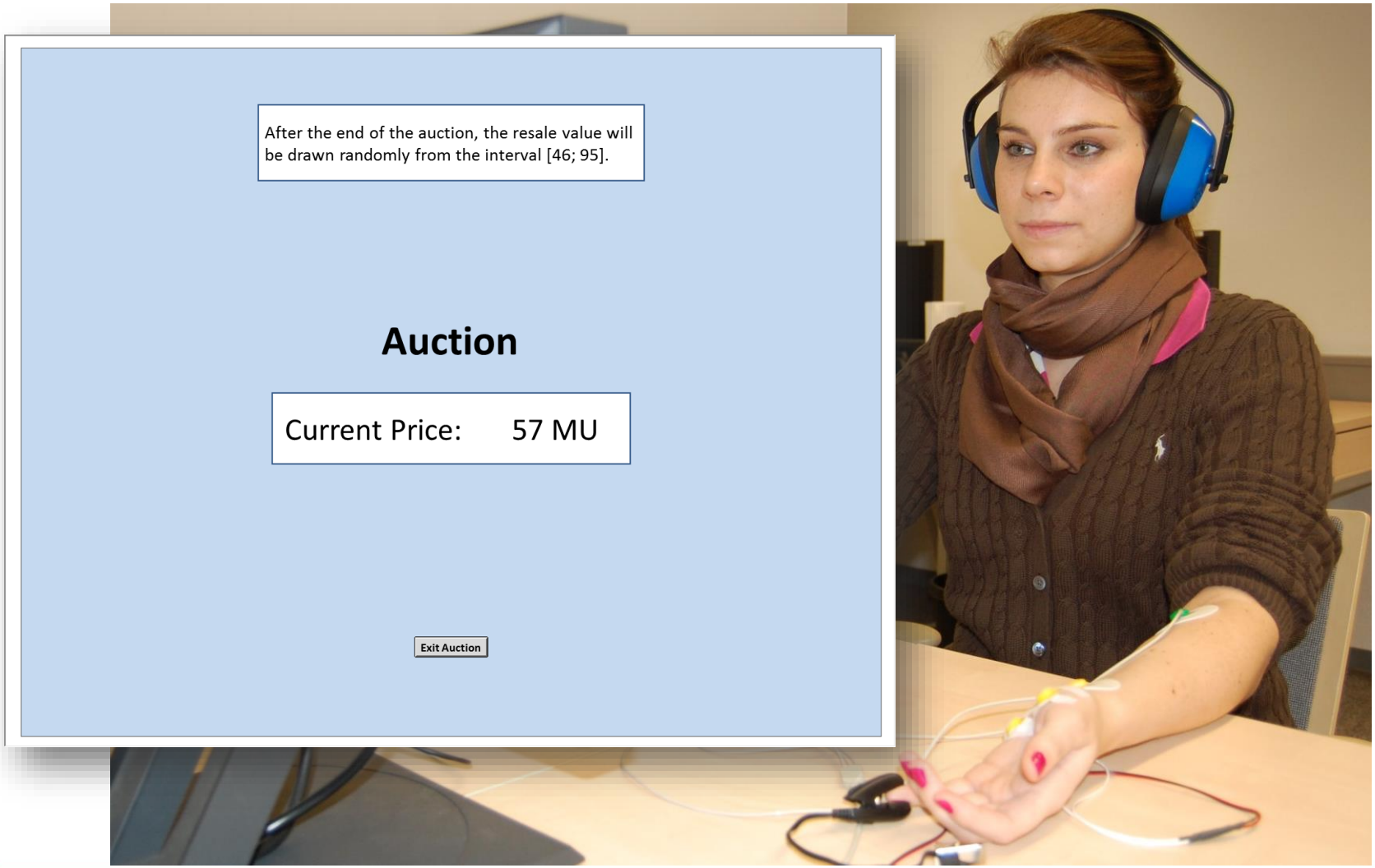
(4) Decision Support

Research Model



(Adam et al., 2015, *Journal of Retailing*)

Laboratory Environment



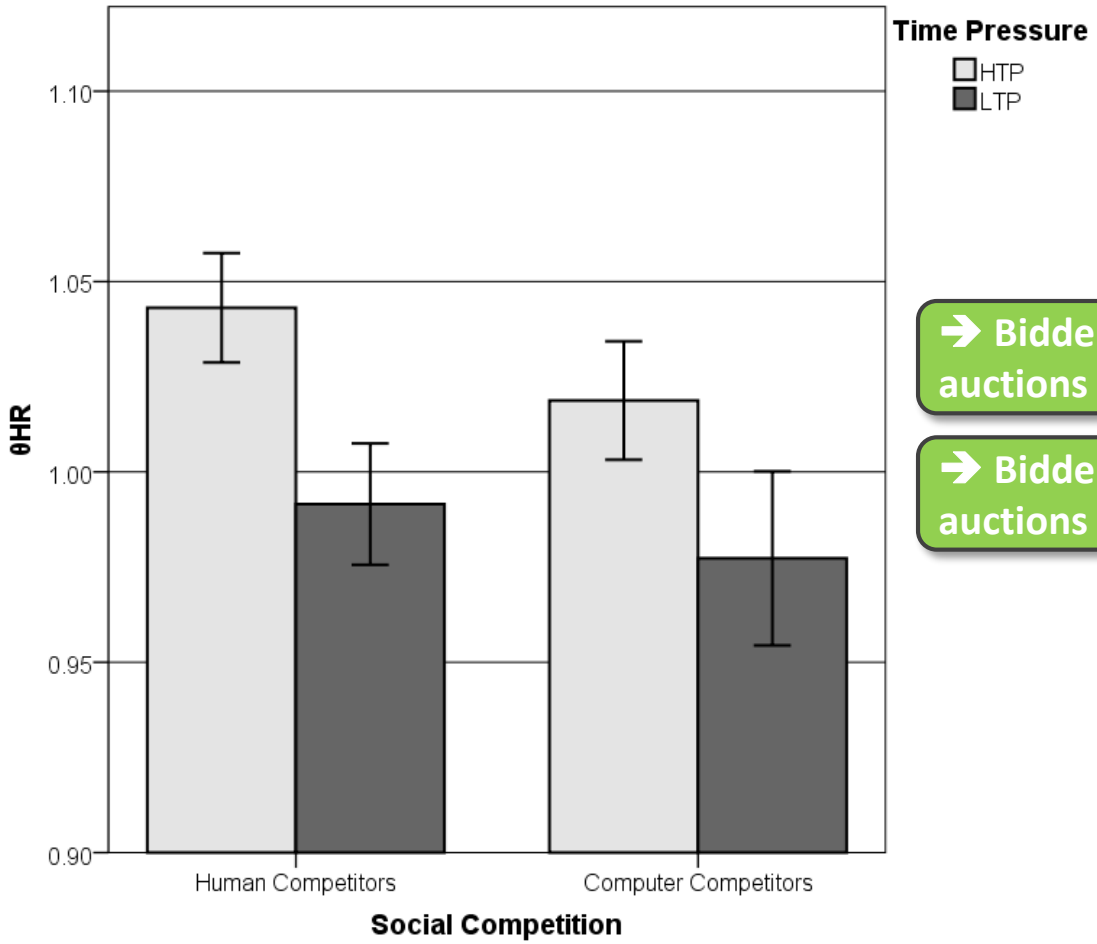
Experimental Design

		Time Pressure	
		Low time pressure [time interval τ = 5.0 s]	**High time pressure [time interval τ = 0.5 s]**
Social Competition	**Human competitors**	HUM_LTP (72 subjects)	HUM_HTP (72 subjects)
	Computer competitors	COM_LTP (48 subjects)	COM_HTP (48 subjects)

Setting

- ascending clock auctions
- 3 bidders per auction
- initial price = 25 MU (1 MU = 0.20 €)
- increment = 1 MU per time interval
- 15 rounds/auctions (1 practice round)
- 6 subjects per session
- 240 subjects in 40 sessions
- between-subjects design
- random stranger matching
- initial 5 minute resting period

Time Pressure, Social Competition, and Arousal

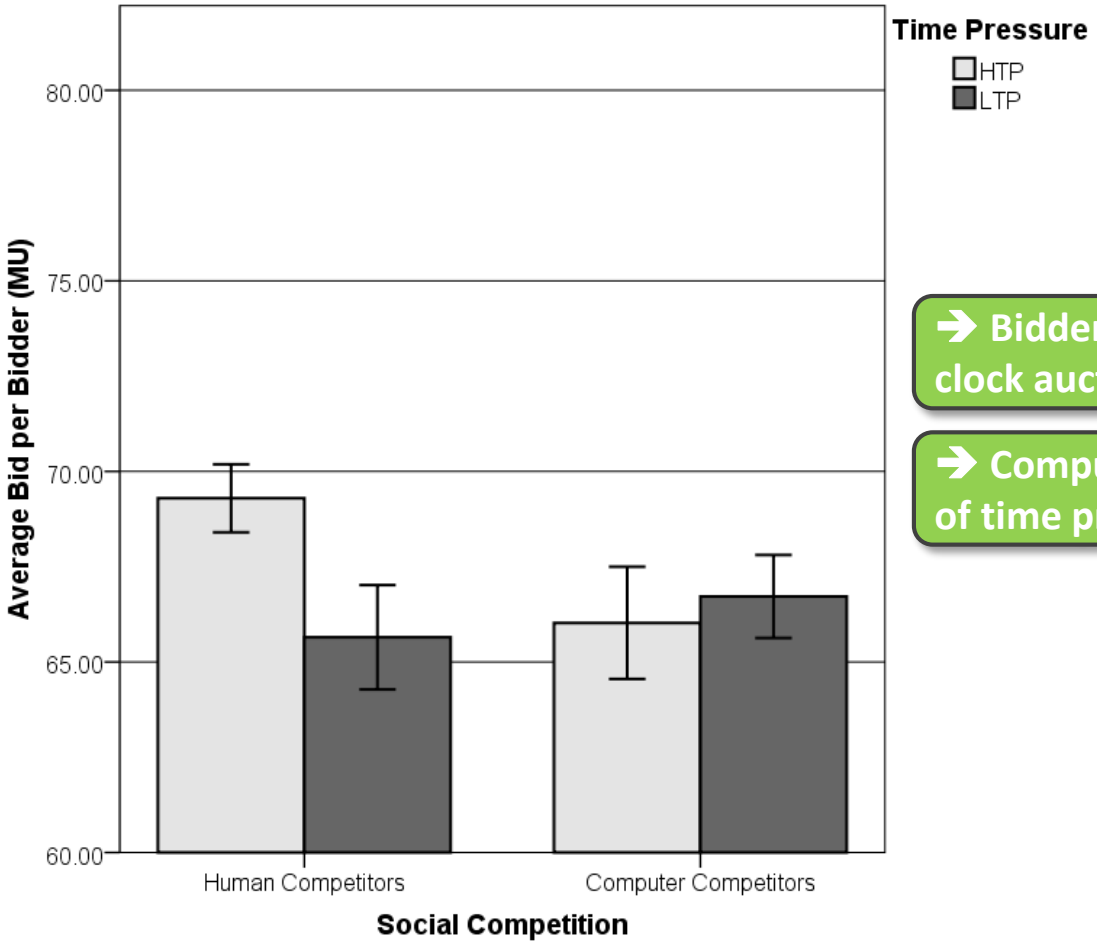


➔ **Bidders experience more arousal in auctions with high time pressure**

➔ **Bidders experience less arousal in auctions with computer competitors**

HTP = Hight Time Pressure
LTP = Low Time Pressure
θHR = Normalized Heart Rate

Time Pressure and Bidding Behavior



➔ Bidders place higher bids in ascending clock auctions with high time pressure

➔ Computer competitors mitigate the effect of time pressure on bids

HTP = Hight Time Pressure
LTP = Low Time Pressure
MU = Monetary Units

Arousal and Bidding Behavior

Independent variables	Dependent variables: (I) Arousal (ΘHR) b	SE	*t*-stat	Sig.	(II) Bid b	SE	*t*-stat	Sig.	(III) Bid b	SE	*t*-stat	Sig.
Dummy: HTP	.047	.009	5.380	<.001***	4.215	.863	4.887	<.001***	3.084	.924	3.339	.001**
Dummy: COM	-.019	.009	-2.197	.029*	1.235	.941	1.313	.191	.909	.970	.937	.350
Dummy: risk_averse	.002	.009	.185	.853	.629	.671	.938	.349	.654	.659	.993	.322
Dummy: female	.006	.010	.578	.564	-.787	.777	-1.013	.312	-.680	.770	-.883	.378
HTP × COM					-5.278	1.336	-3.950	<.001***	-4.229	1.406	-3.007	.003**
Arousal (ΘHR)									21.474	6.951	3.089	.002**
Arousal × COM									-19.698	10.765	-1.830	.069+
	N = 210 R^2 = .149				N = 210 R^2 = .125				N = 210 R^2 = .165			

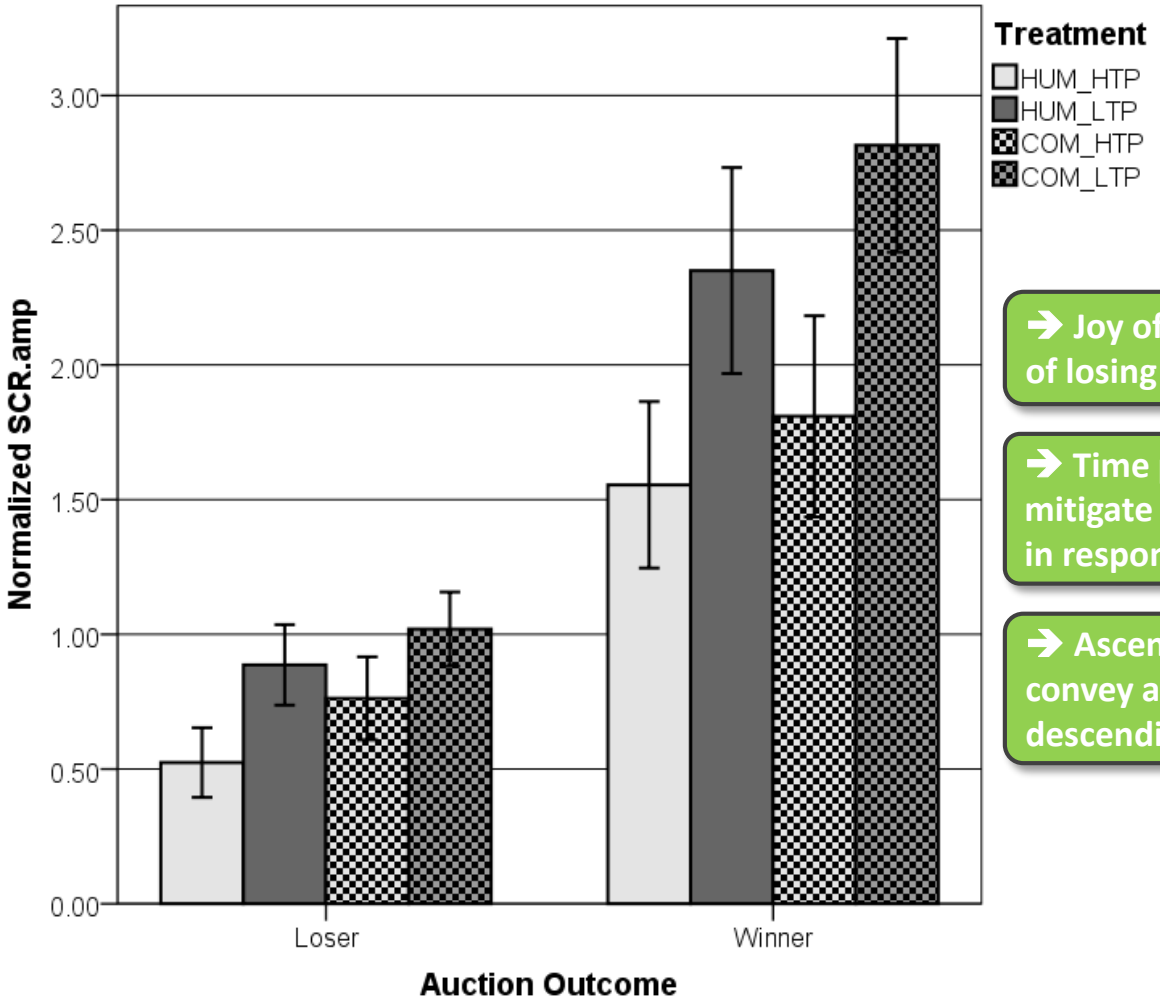
+ $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$

Treatment	Indirect Effect	SE	95% CI	
HUM	.999	.424	.312	2.039
COM	.083	.357	-.584	.839

➔ Bidders' arousal mediates the effect of time pressure on bids.

➔ Computer competitors mitigate the effect of arousal on bids.

Emotions in Response to Auction Outcome



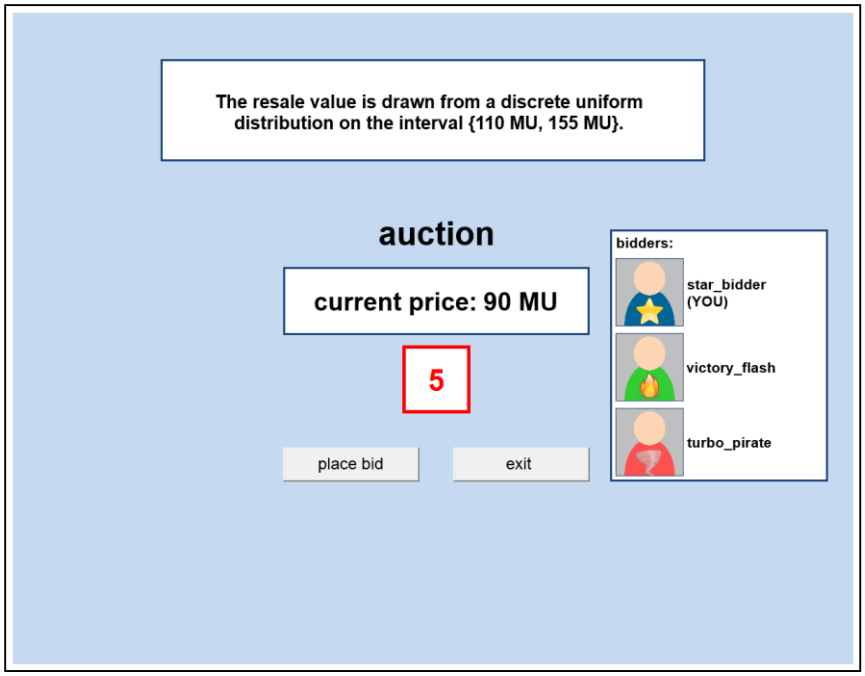
➔ Joy of winning is stronger than frustration of losing in ascending clock auctions

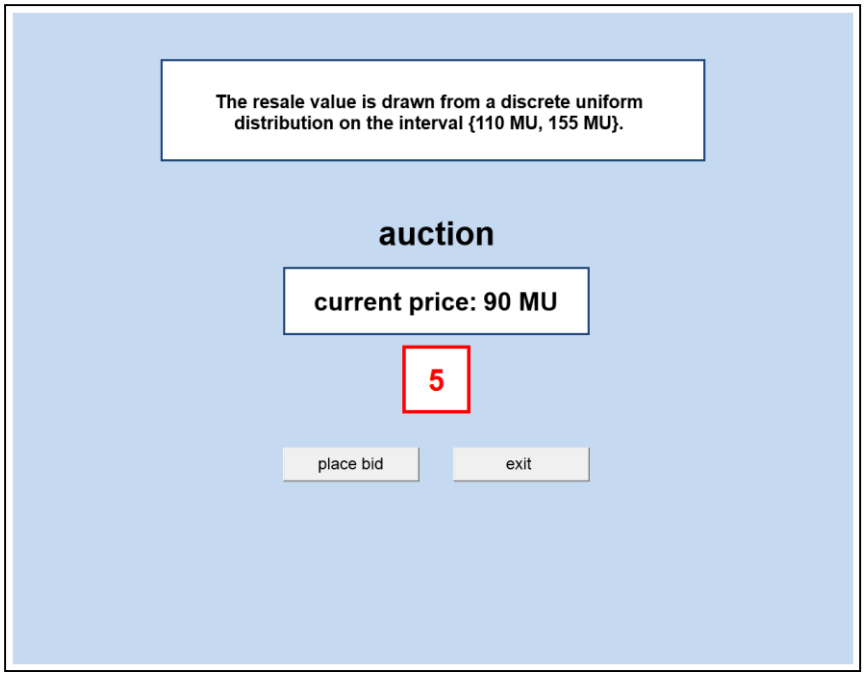
➔ Time pressure and human competitors mitigate the intensity of immediate emotions in response to the auction outcome.

➔ Ascending auctions have the potential to convey a more rewarding experience than descending auctions (e.g., Dutch auctions).

HTP = Hight Time Pressure
LTP = Low Time Pressure
HUM = Human Competitors
COM = Computer Competitors
SCR = Skin Conductance Response

Study 2 – Avatars & Social Competition





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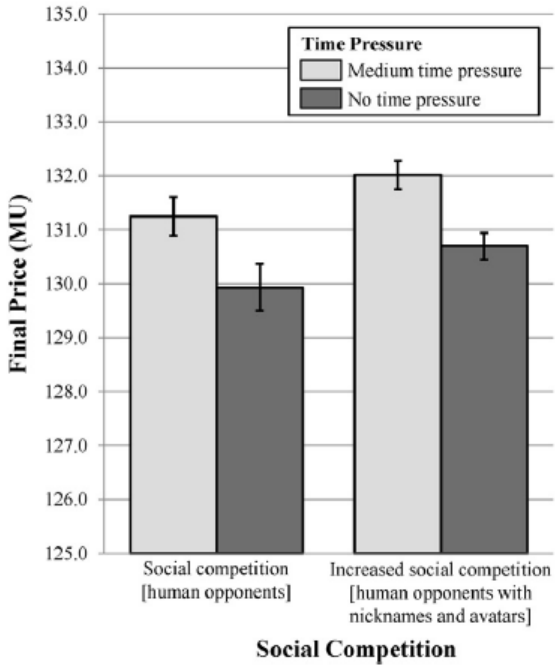

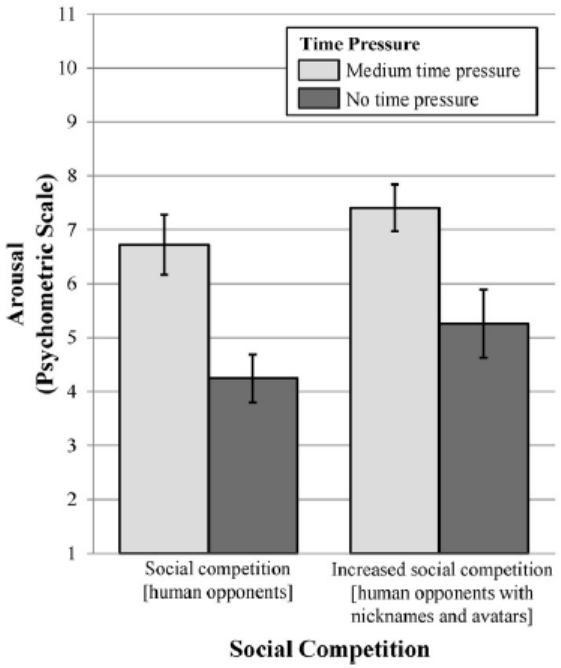

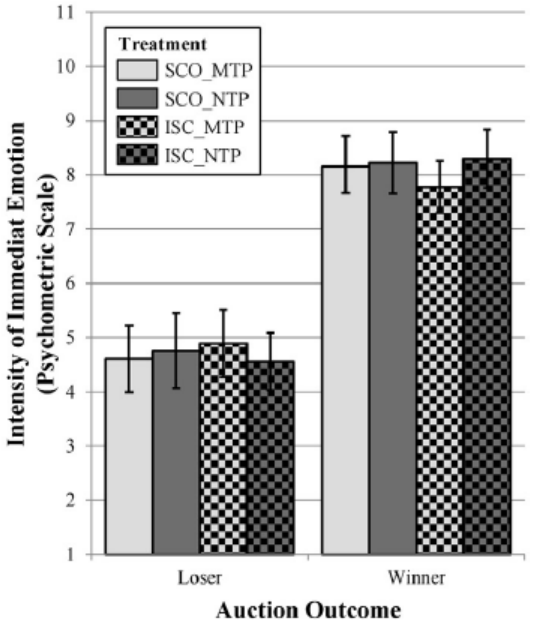

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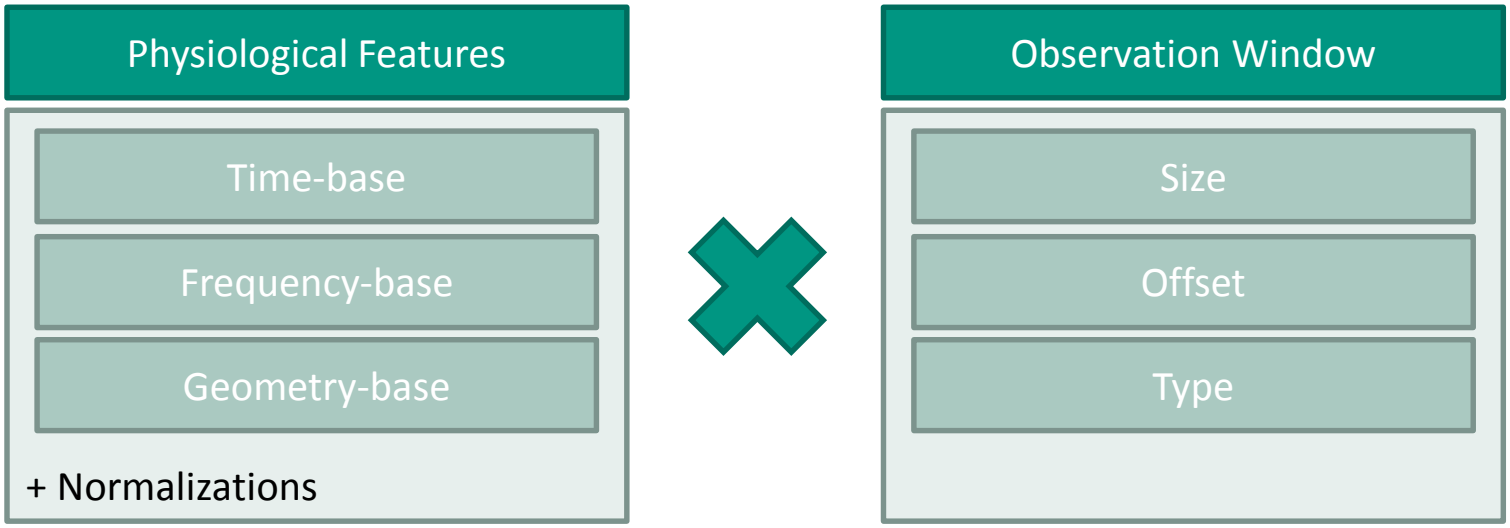
(2) Feature Selection

(3) Different Auction Paradigms

(4) Decision Support

Physiological Measures (Candidate Features)

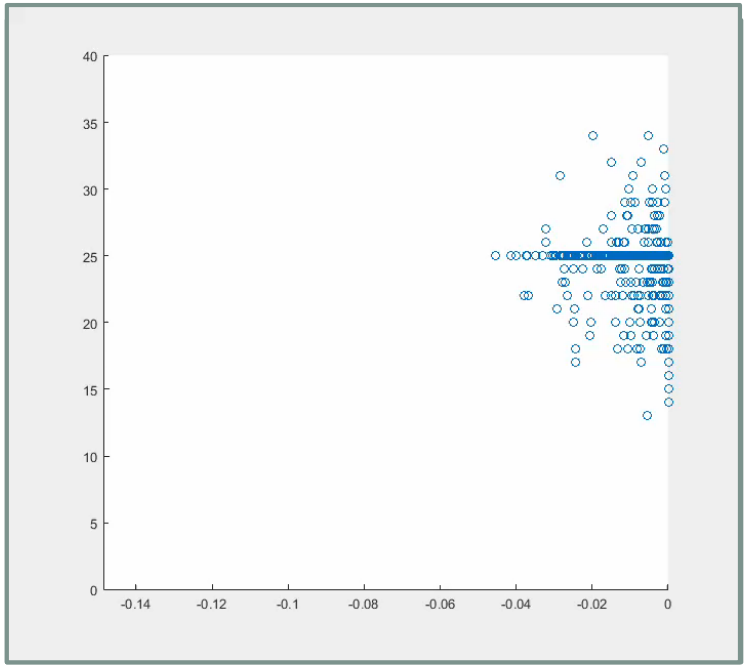


- Total combinations: 5772 (Candidate Features)
- Much more possible model inputs than observations

Approach – Evolutionary Algorithm

Non-Dominated Sorting Genetic Algorithm II **(NSGA-II)**
[Deb et al. 2002]

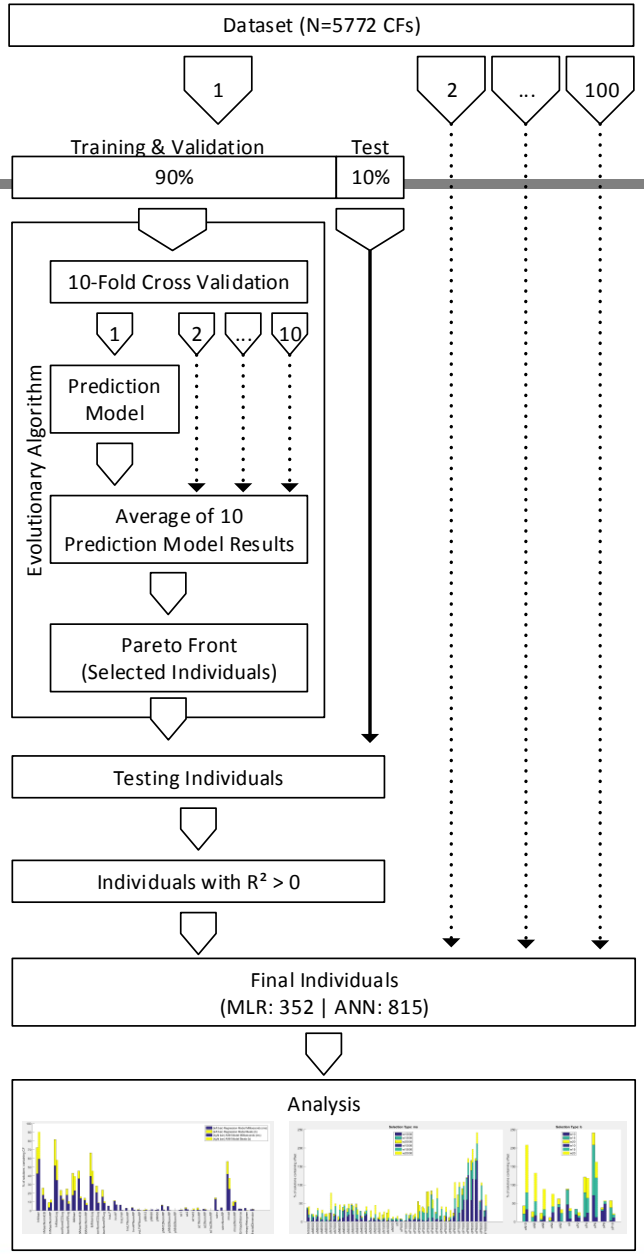
- Evolutionary-based metaheuristic
- Minimizes objectives based on their fitness values
  - R^2 is supposed to be maximized → minimize R^2 * (-1)
- Does not calculates a single solution but a *Pareto Front*
- Orders individuals based on their *Rank*
  - $\forall i \in \{1..\beta\}: f_i(a) \leq f_i(b)$
  - $\exists i \in \{1..\beta\}: f_i(a) < f_i(b)$
- Starts with random initial population of 25 CFs (max. 50 CFs) per individual
- Existing MATLAB implementation



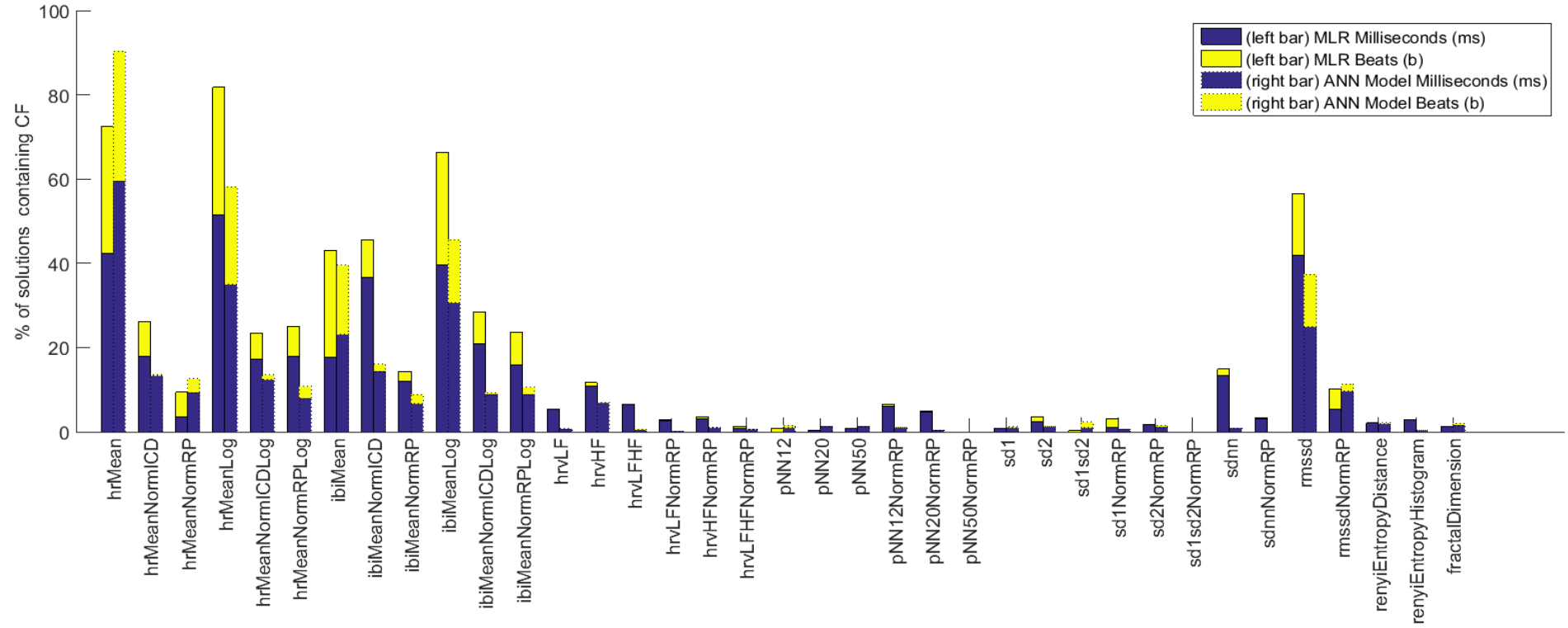
Approach – Robustness

Due to the stochastic nature of the Evolutionary Algorithm, the robustness of the results needs to be backed by:

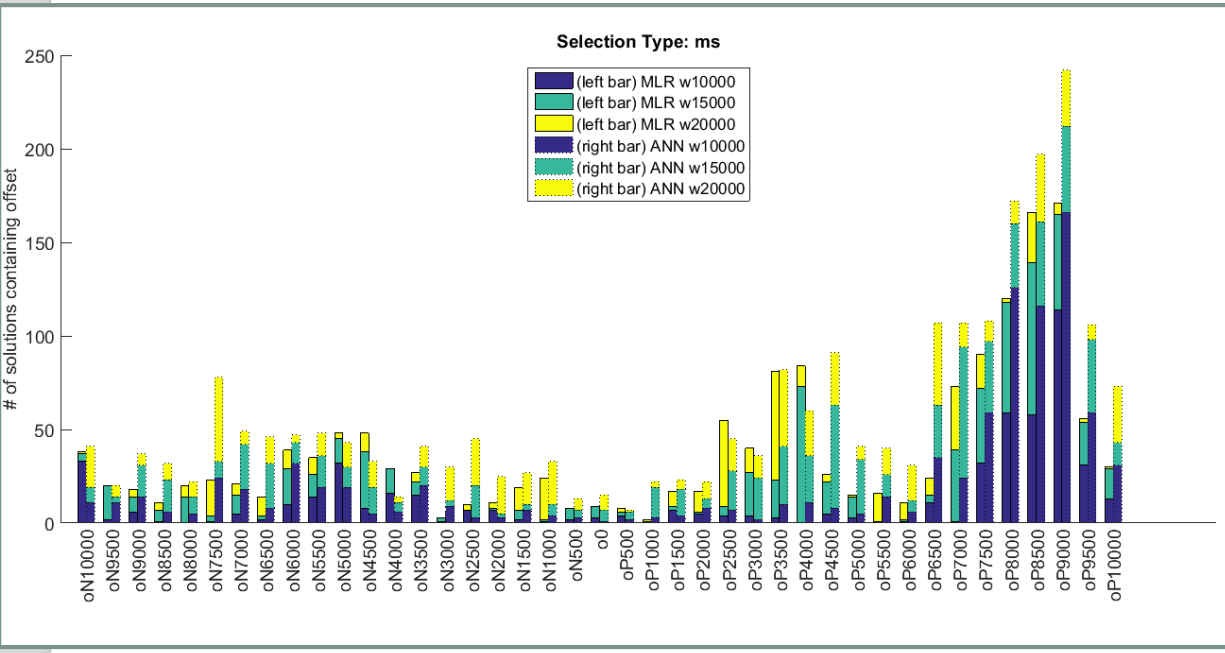
- **Multiple Runs**
  - 100-times for each prediction model
- **Splitting the Dataset**
  - Use Training, Validation, and Test data
- **Cross Validation**
  - Use 10-Fold Cross Validation at each iteration
- **No single result**
  - Use sum of all results

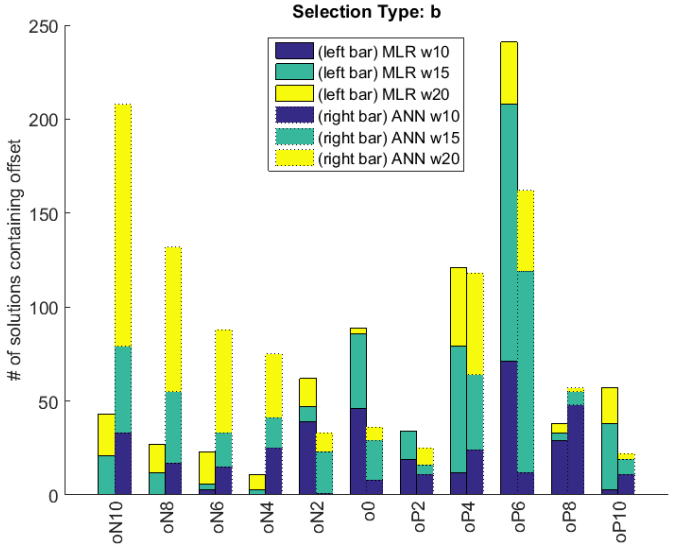


Results – Measures



Results – Windows & Offsets





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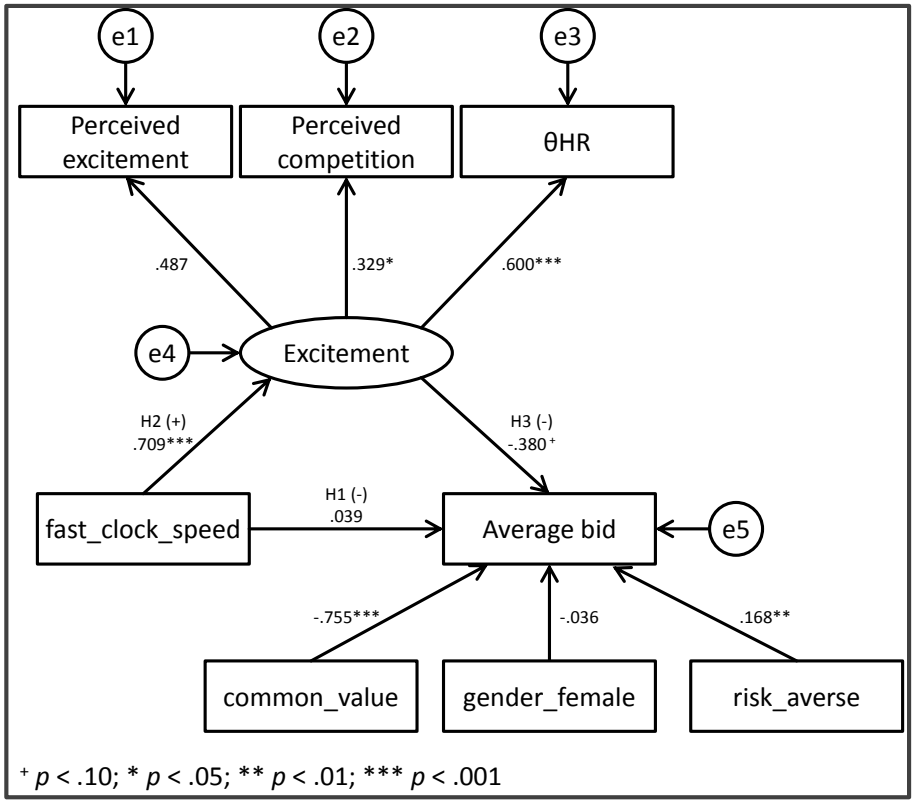
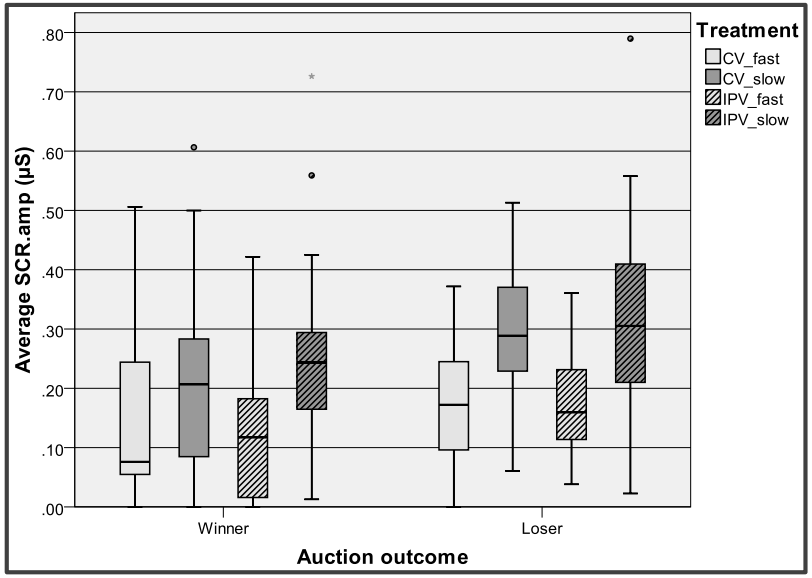
Adam, Krämer, Weinhardt (2012-13). "Excitement up! Price down! Measuring emotions in Dutch auctions," *International Journal of Electronic Commerce*, *17*(2), 7–39.

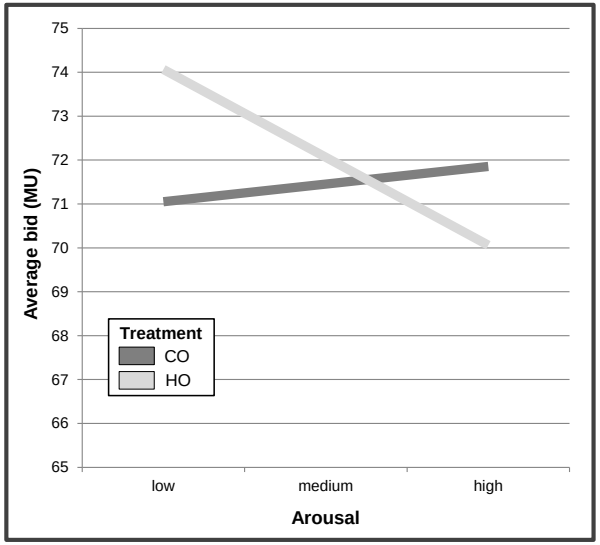


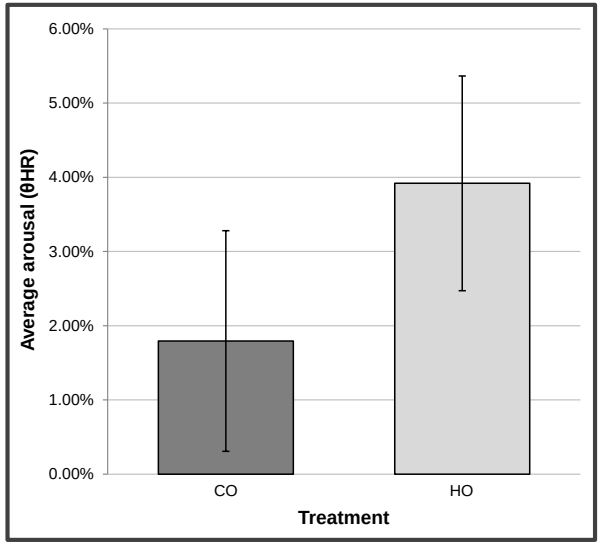
Clock speed / Value model	Fast (2.0 MU / sec)	Slow (0.2 MU / sec)
Common value (CV)	CV_fast (24 subjects)	CV_slow (24 subjects)
Independent private value (IPV)	IPV_fast (24 subjects)	IPV_slow (24 subjects)

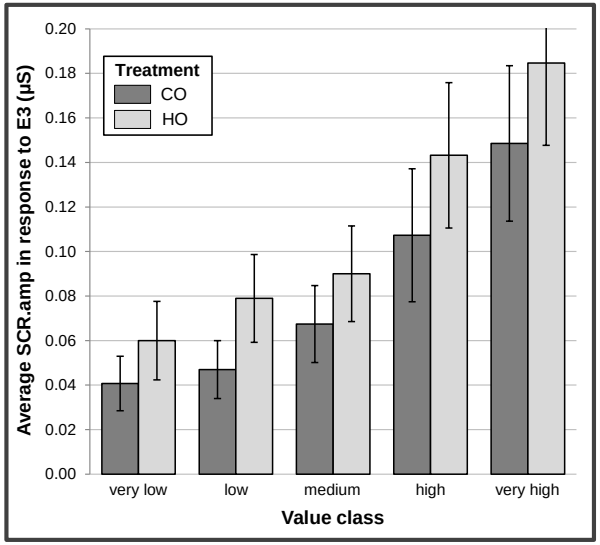


- → Clock speed induces exicitement
- → Excitement mediates impact on prices
- → Clock speed mitigates immediate emotions
- → Frustration of losing stronger than joy

Teubner, Adam, Riordan (in press). "The impact of computerized agents on arousal and bidding behavior in electronic auctions," *Journal of the Association for Information Systems*.







➔ **Arousal is correlated with bids in FPSB auctions when the bidders compete with human opponents.**

➔ **Stronger immediate emotions in FPSB auctions when competing with human opponents.**

➔ **Higher arousal in FPSB auctions when competing with human opponents**

- first-price sealed-bid (FPSB) auctions
- human or computer opponents
- independent private values {11, …, 110}

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CO = Computer Opponents
HO = Human Opponents

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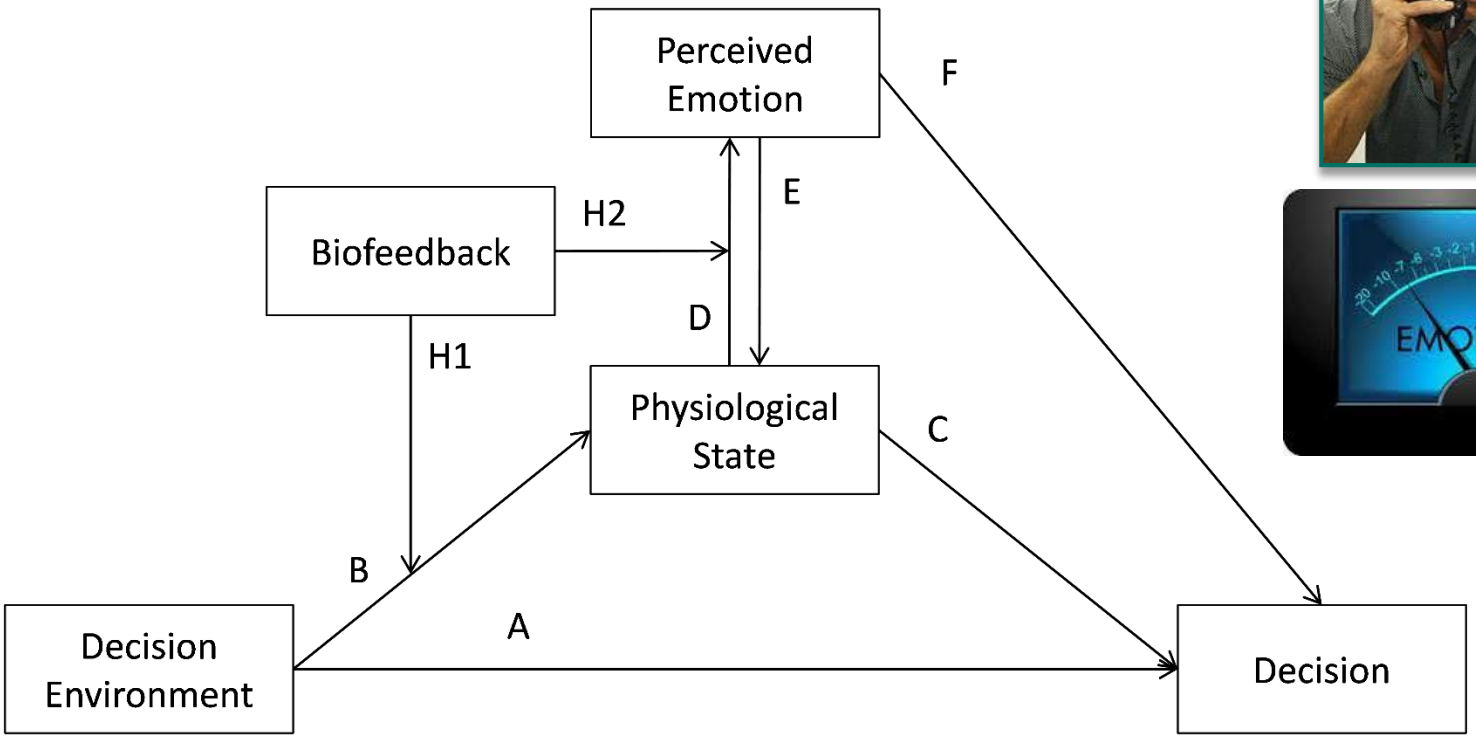
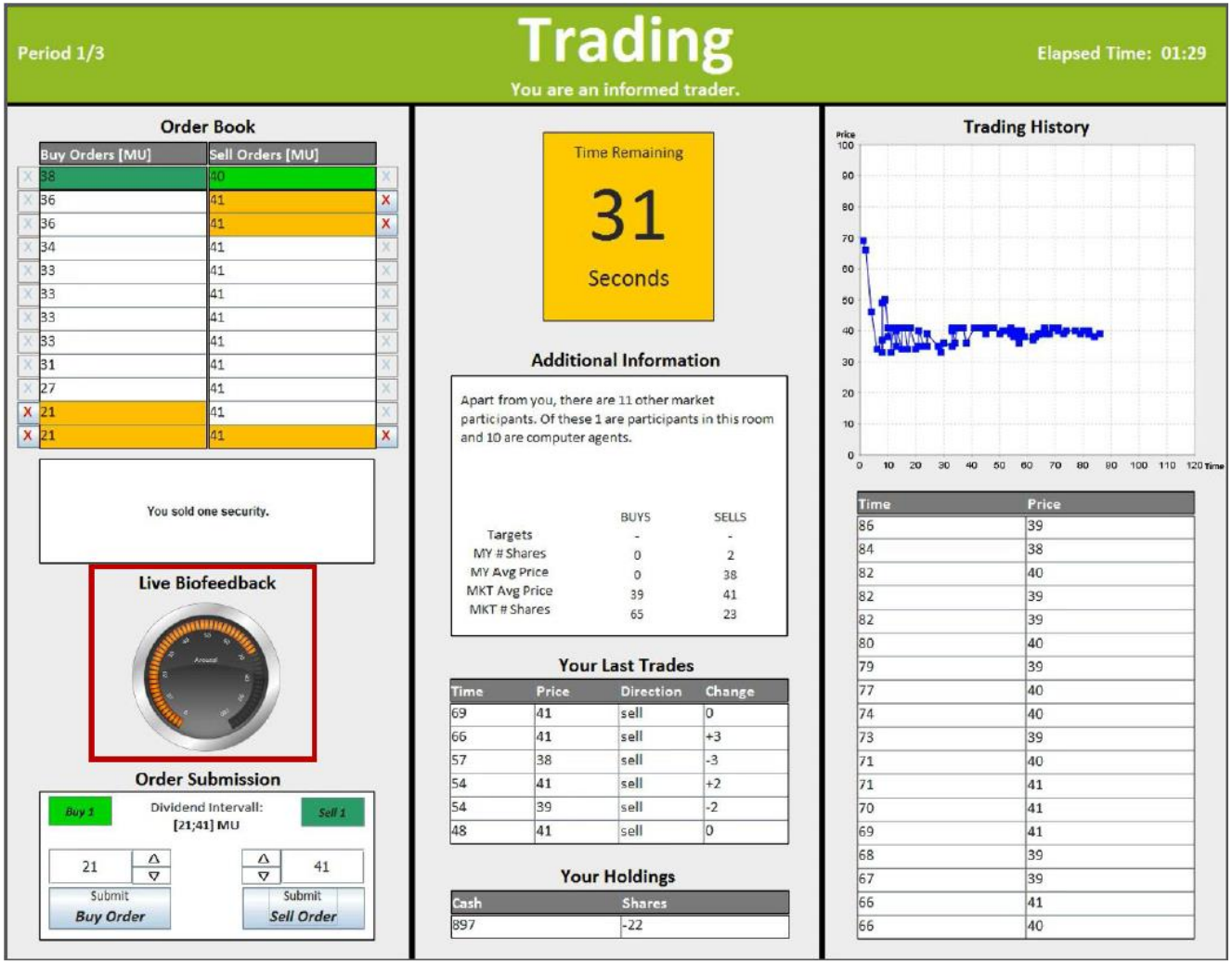
Emotion Regulation & Biofeedback

Consideration

- Arousal can have **detrimental** effects on decision making
- Being aware of arousal might help to **regulate emotions**



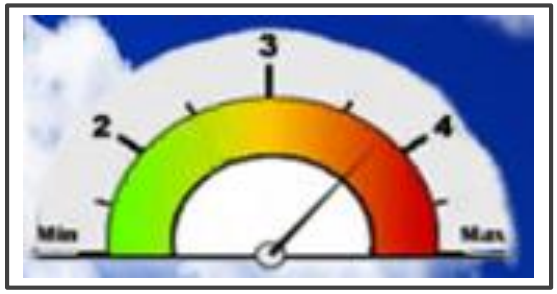
Sample Trading Interface



Emotion Regulation & Biofeedback

Integrating Live Biofeedback into Information Systems

- Providing users with **live biofeedback** on their arousal level supports self-monitoring the emotional state
- Use **serious games** with real-time biofeedback to provide users with an engaging learning environment
- With the serious game effective **emotion regulation** can be actively practiced and rewarded.



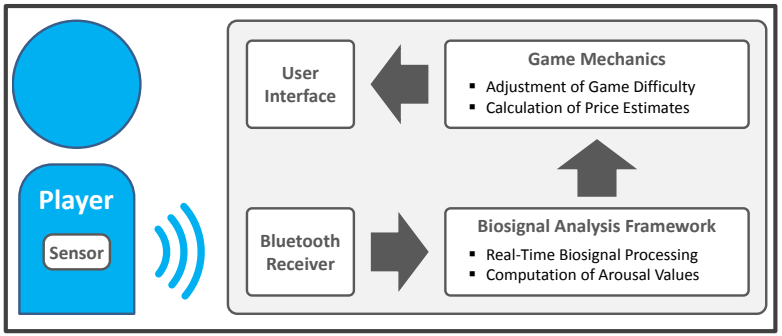
Application in Electronic Auctions

- Provide market participants with live biofeedback
- Train emotion regulation to investigate whether the impact of arousal on behavior can be actively regulated

> *"sound and rational decision making, in fact, depends on prior accurate emotional processing"* (Bechara & Damasio, 2005)

(Astor, Adam, Jerčić, Schaaff, Weinhardt, 2013, JMIS)

Astor, Adam, Jerčić, Schaaff, Weinhardt (2013). "Integrating biosignals into information systems: A NeuroIS tool for improving emotion regulation" *Journal of Management Information Systems*.



Design Guideline 1: Choose measurements which are adequate for the environment of the users; e.g., use ECG recording with dry electrodes and wireless data transmission for providing users in fast-paced environments with live biofeedback in an unobtrusive way.

Design Guideline 2: Present biofeedback in an intuitive and meaningful way. Reduce complexity and use salient visual, auditory, or tactile cues (e.g., colors, arousal meter), while taking into account the contextual and situational circumstances of the users.

Design Guideline 3: Biofeedback is to some extent processed unconsciously; include objective measurements (e.g., eye tracking) during demonstration sessions in order to evaluate and iteratively re-design the way in which biofeedback is presented to users

Design Guideline 4: Use serious games with real-time biofeedback and arousing game elements in order to provide users with an engaging learning environment in which effective emotion regulation can be actively practiced and rewarded.

➔ **Real-time biofeedback based serious game to improve emotion regulation.**

Thank you!

Schaaff, Degen, Adler, Adam (2012). "Measuring affect using a standard mouse device", *Biomedical Engineering/ Biomedizinische Technik, 57*(Suppl. 1), 761–764.

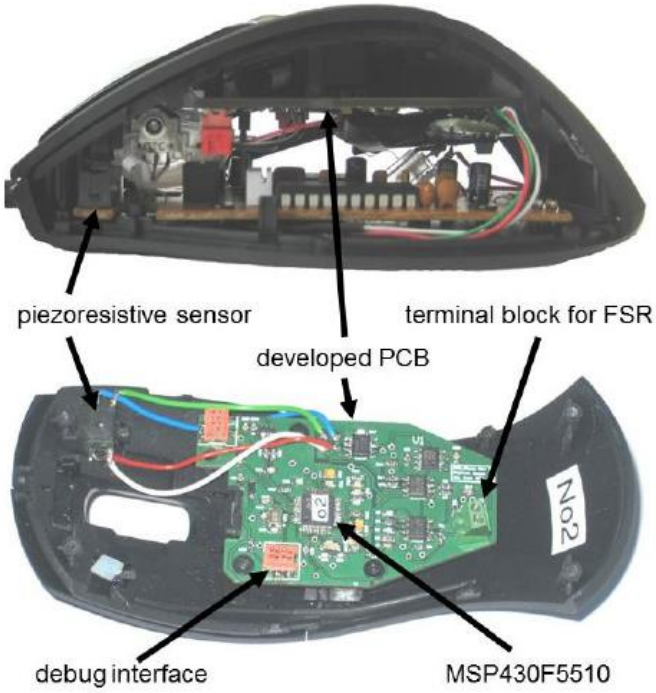


Figure 2 Modified mouse device with developed printed circuit board