Financial Networks and Systemic Risk
FNet 2013 Kyoto

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Risk of Herd and Phase Transition in a Sequential Voting Experiment

Experimental Econophysics

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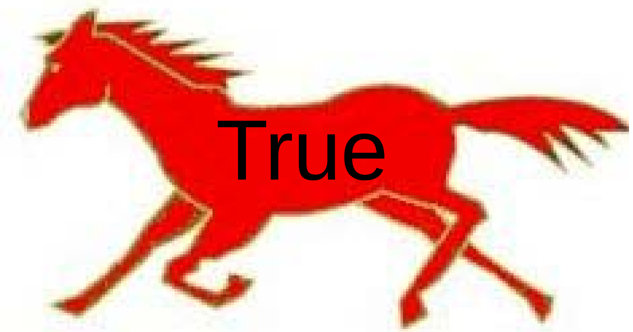
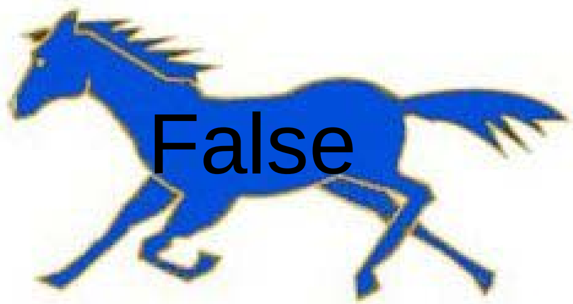
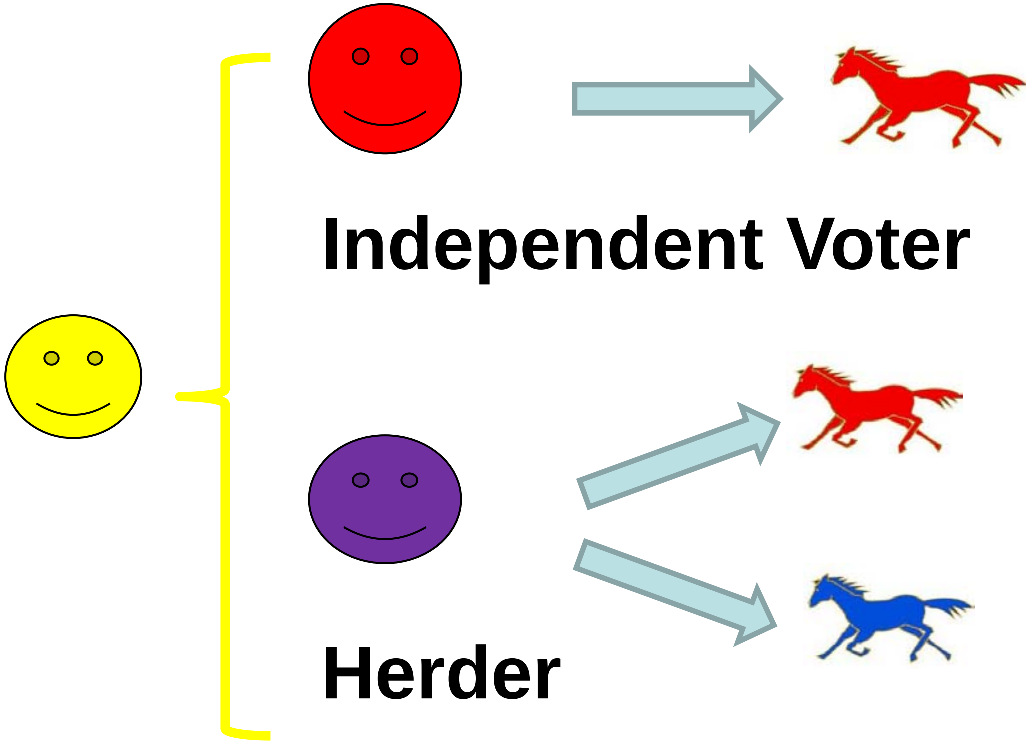
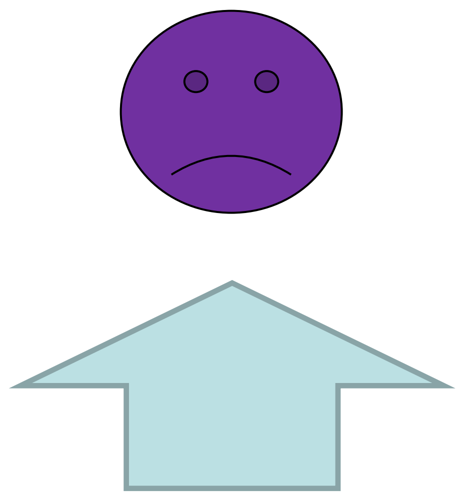
Quiz : A or B



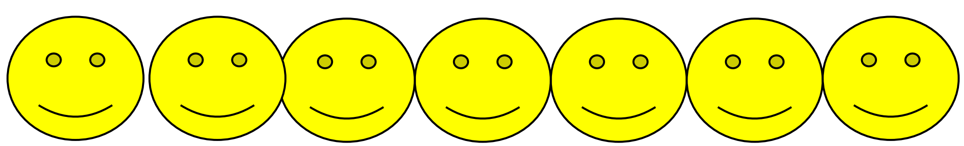



Independent Voter
Herder

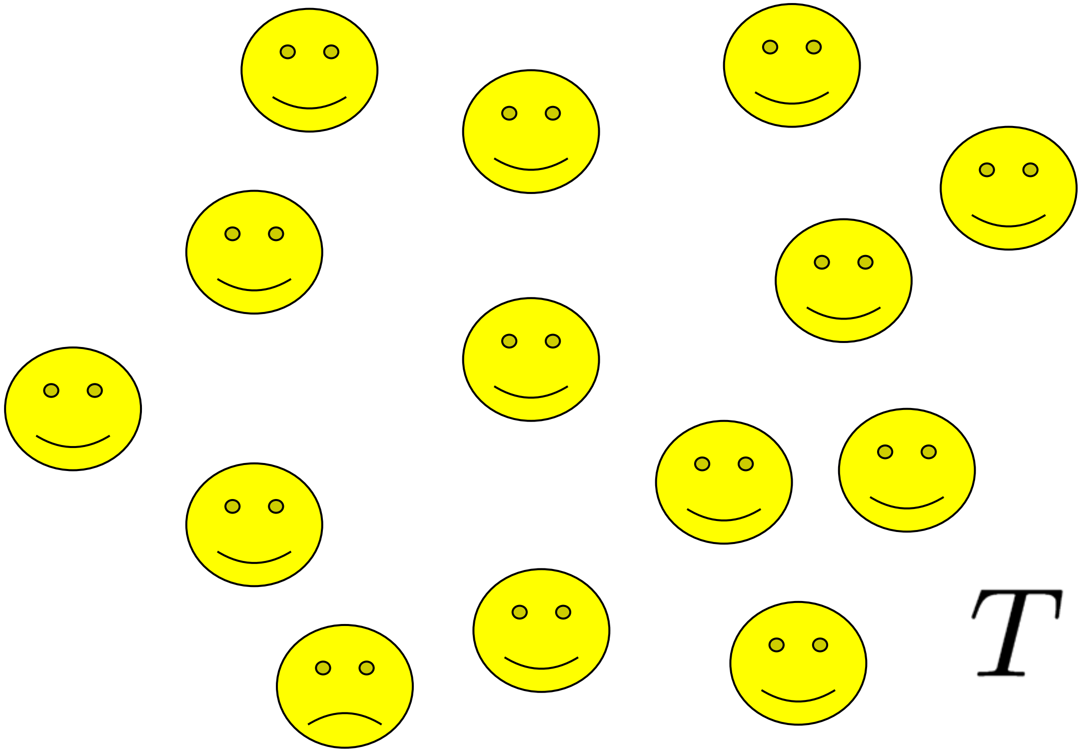
Q. How he chooses ?



Others' Choices



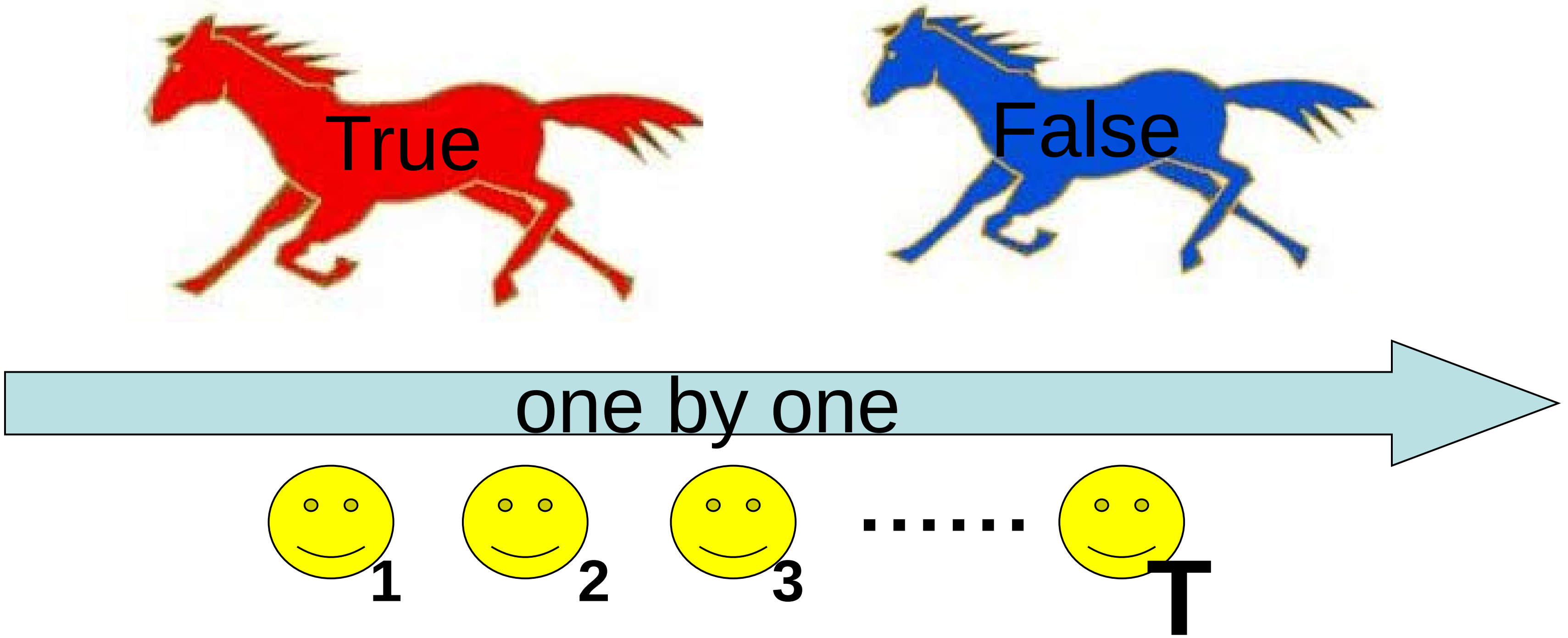
Q. What happens at the macroscopic level ?



$$T \to \infty$$

Experimental Setup

Quiz : A or B



EXP-I : T_{avg}=60,2 Groups,120 questions @Hokkaido Univ.

EXP-II : T_{avg}=50 ,2 Groups,120 questions @Hokkaido Univ.

EXP-III: T=31 ,2 Groups,100 questions @Kitasato Univ.

Q: On which thigh does the Thinker of Rodin rest his elbow ?

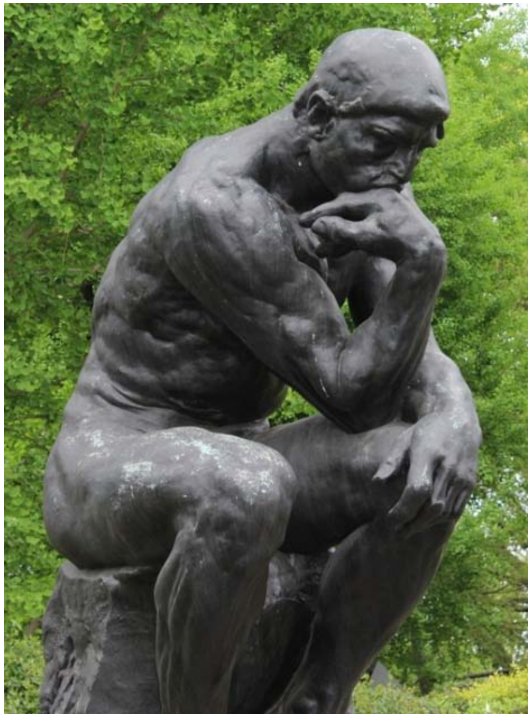
No Hint

A	B
Left	Right

Hint

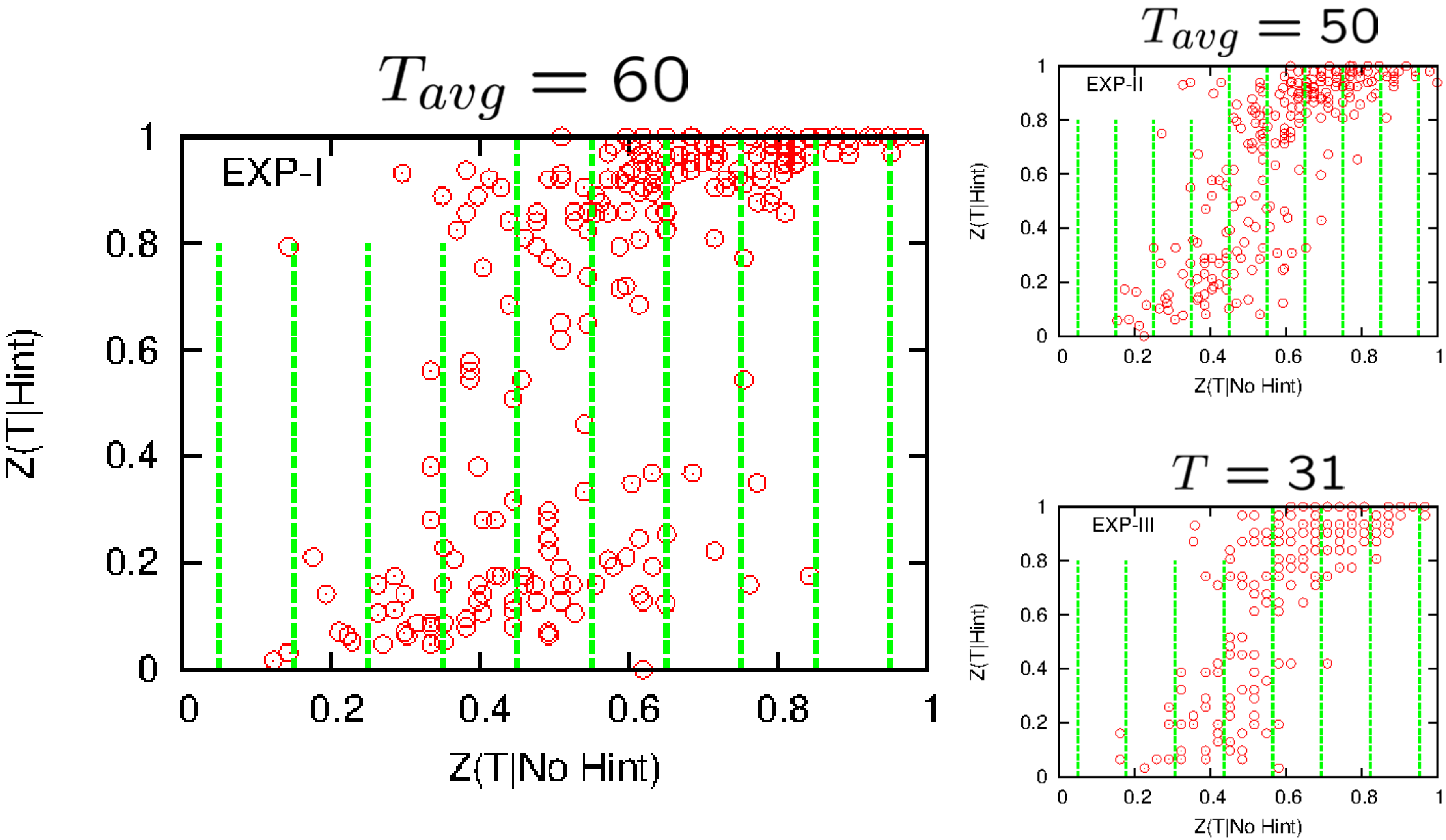
A	B
10	20
Left	Right

Ans. Left



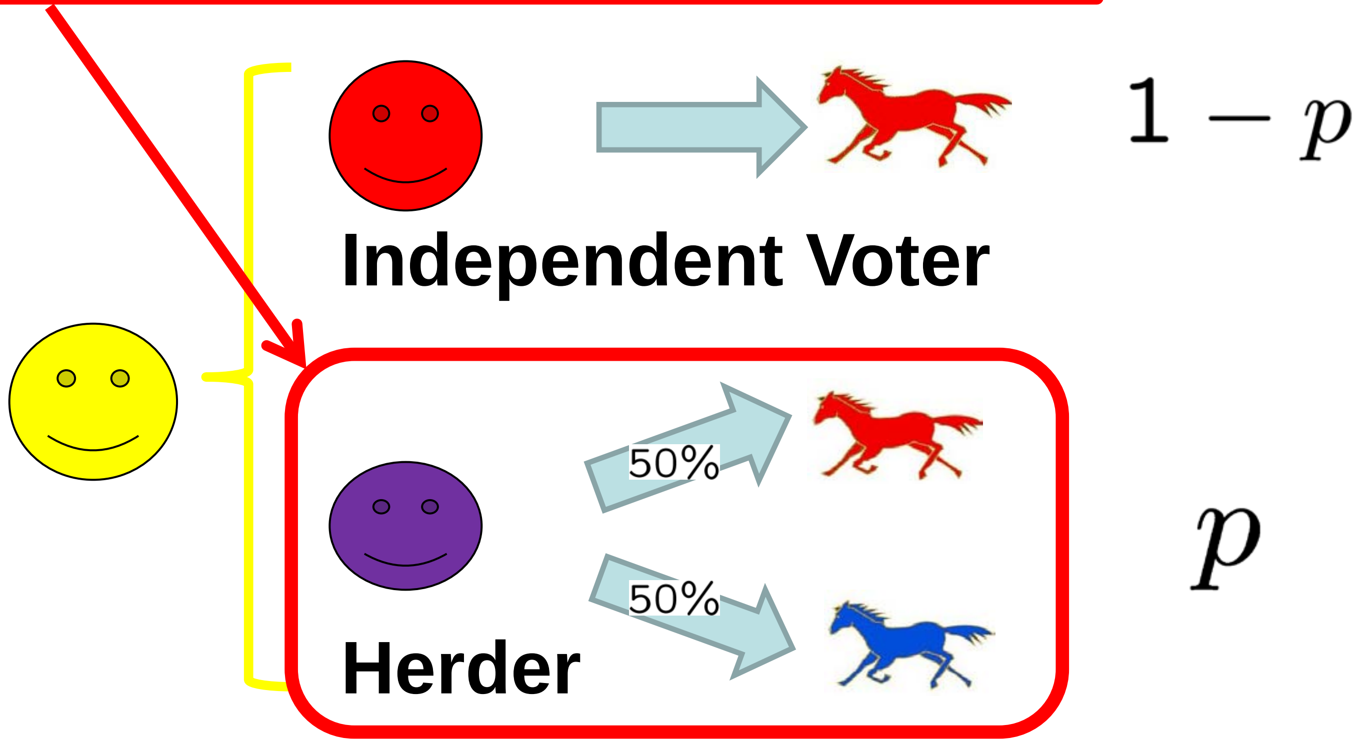
% of Correct Ans.	Group I	Group II
Z(T| No Hint)	53%	46%
Z(T|Hint)	86%	16%

From EXP-I



$T_{avg} = 60$
EXP-I
Z(T|Hint)
Z(T|No Hint)
0
0.2
0.4
0.6
0.8
1
$T_{avg} = 50$
EXP-II
$T = 31$
EXP-III

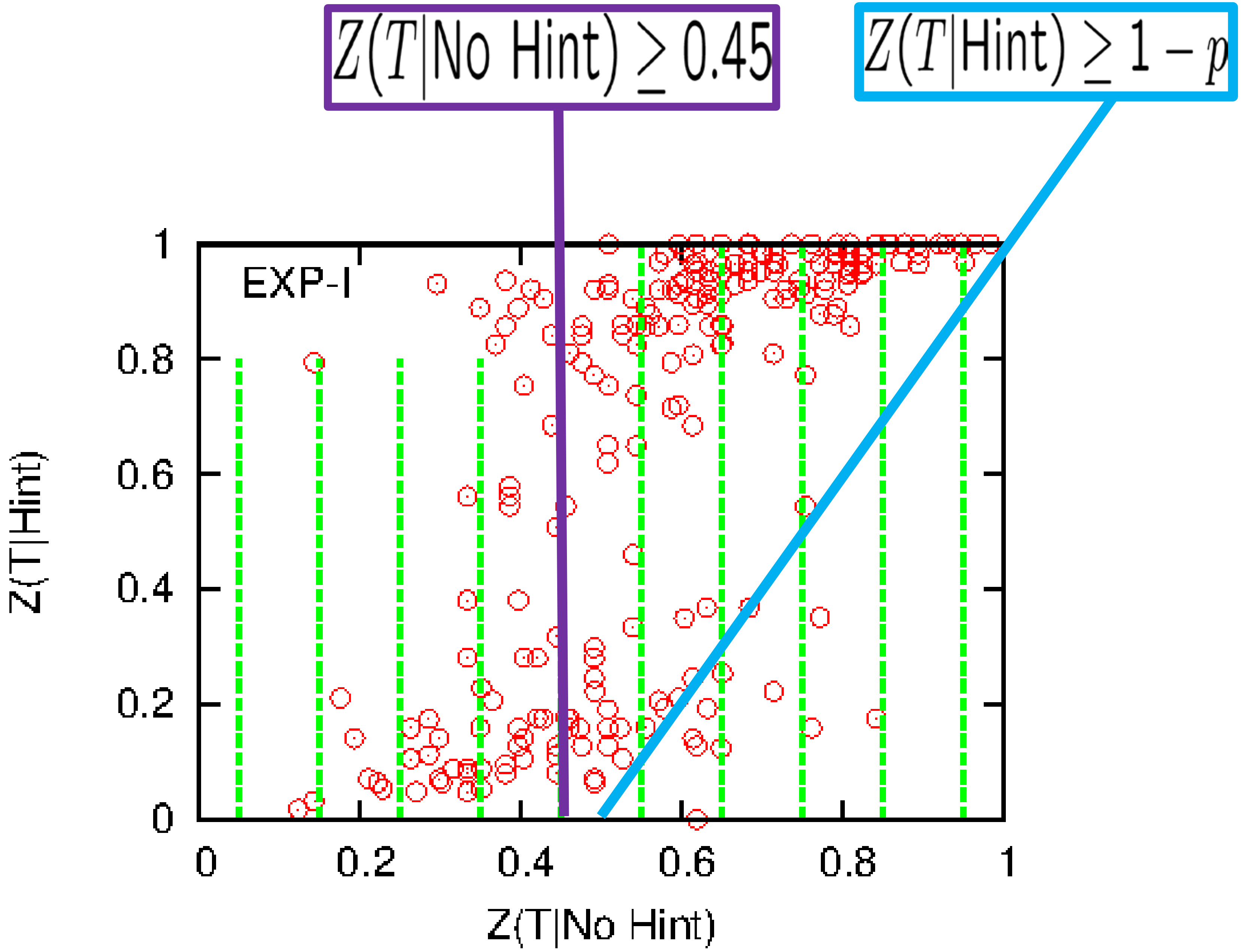
Precondition of Experiment = No Bias



$$Z(T|\text{No Hint}) = (1-p)\cdot 1 + p\cdot\frac{1}{2} = 1-\frac{1}{2}p$$

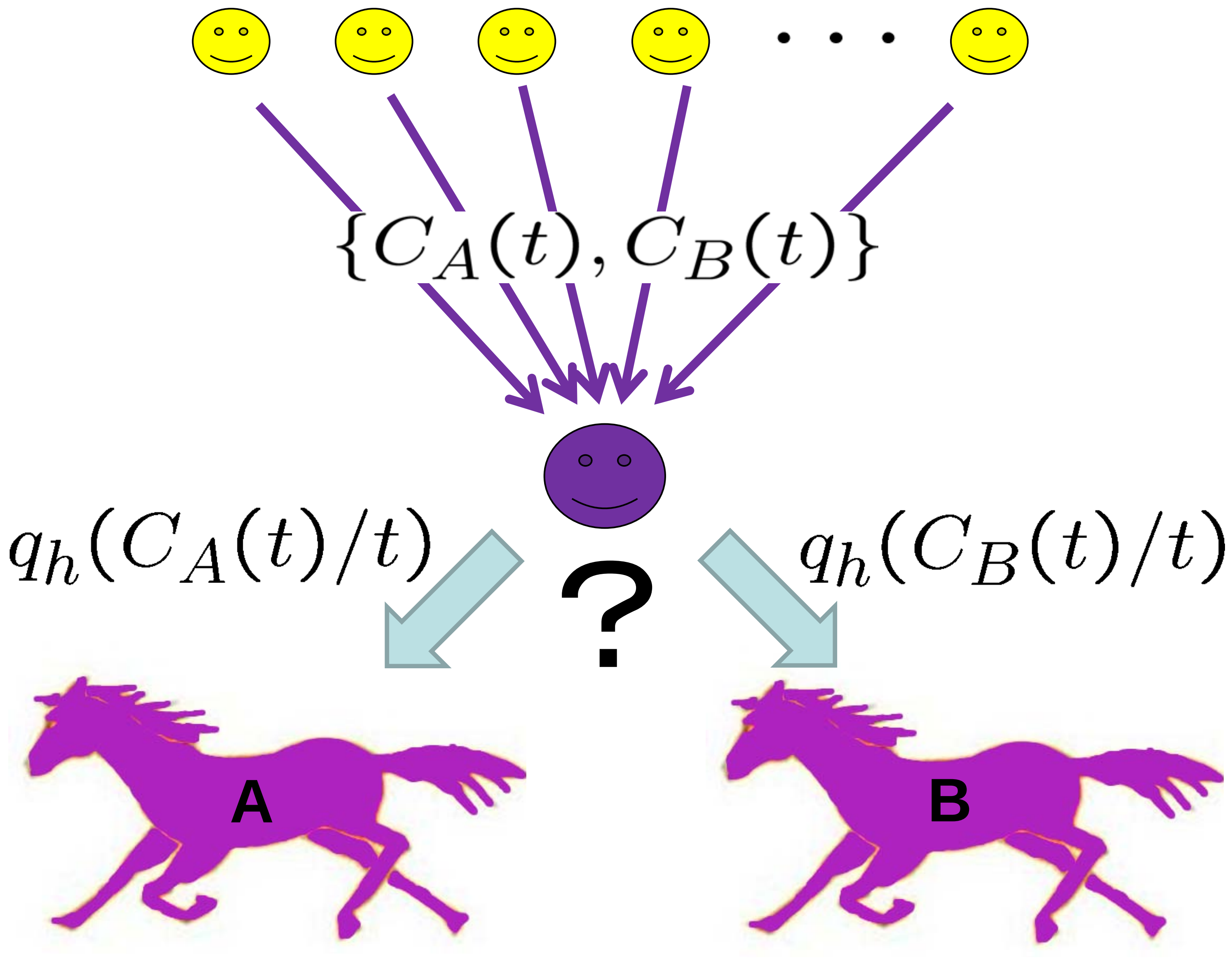
$$\Rightarrow\quad Z(T|\text{No Hint}) \geq \frac{1}{2},\ Z(T|\text{Hint}) \geq 1-p$$

We eliminate data which does not satisfy these conditions.



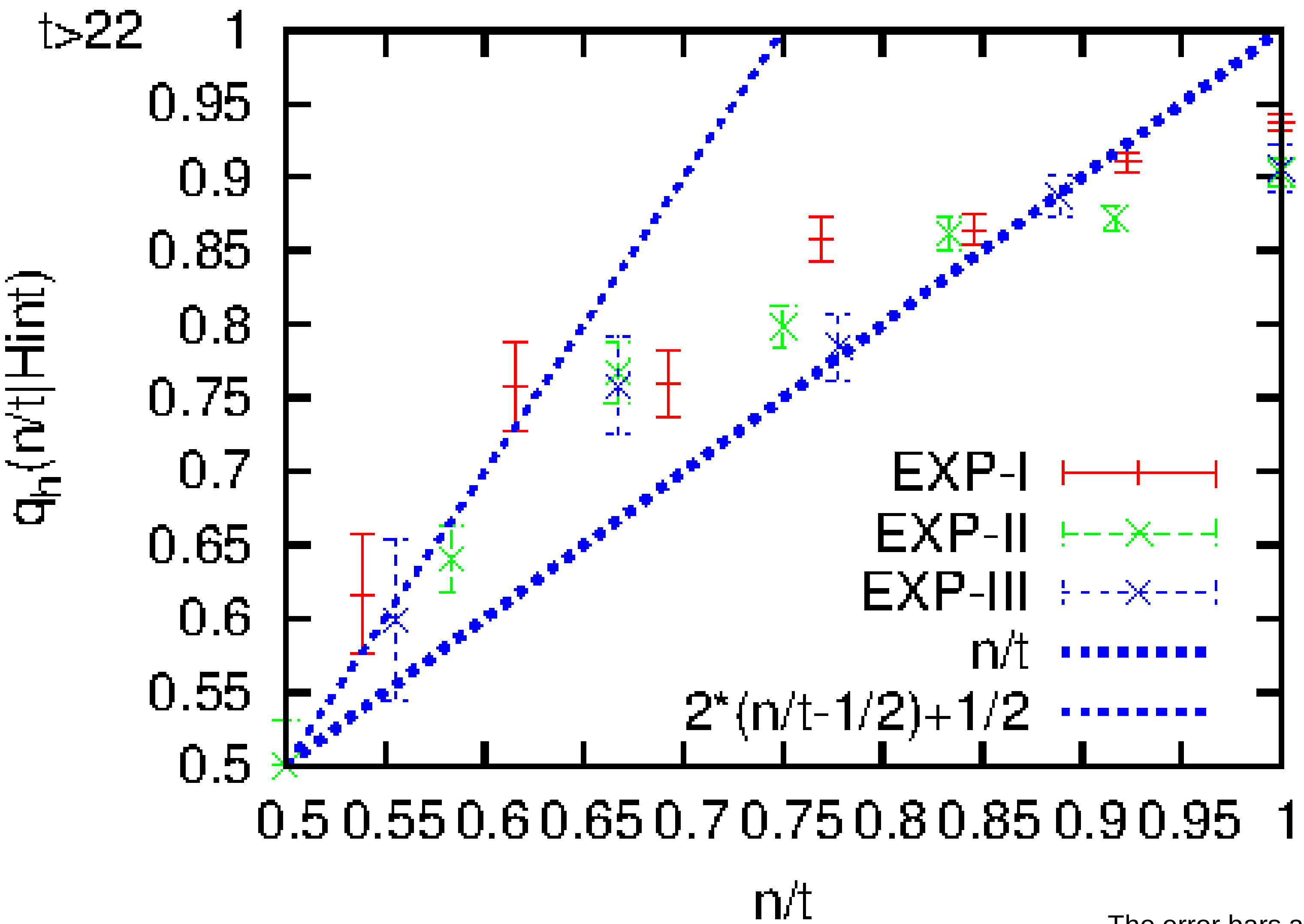
$Z(T|\text{No Hint}) \geq 0.45$
$Z(T|\text{Hint}) \geq 1 - p$
EXP-I
1
0.8
0.6
0.4
0.2
0
Z(T|Hint)
0
0.2
0.4
0.6
0.8
1
Z(T|No Hint)

Q. How he copies ?



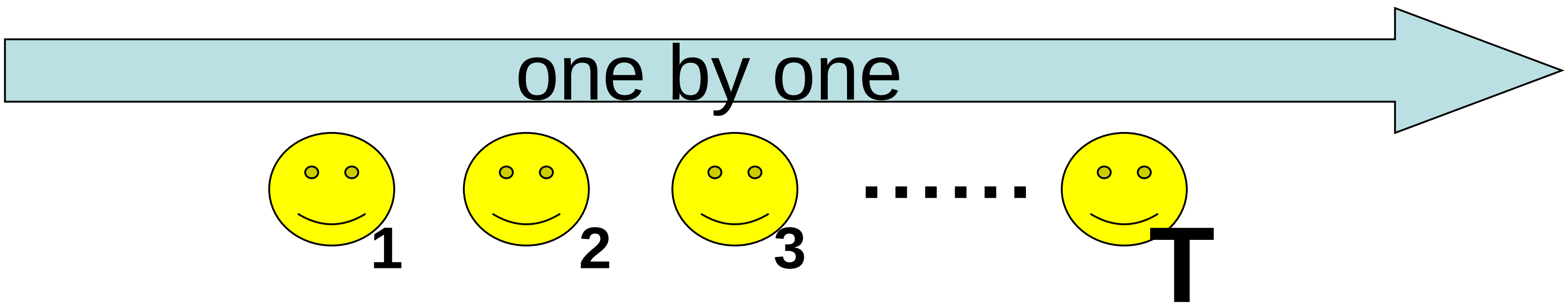
Herder's Response Function $q_h(n/t)$

$$q_h(n/t) = 1 - q_h(1 - n/t)$$



The error bars are SEM.

Q. What happens
at the macroscopic level ?

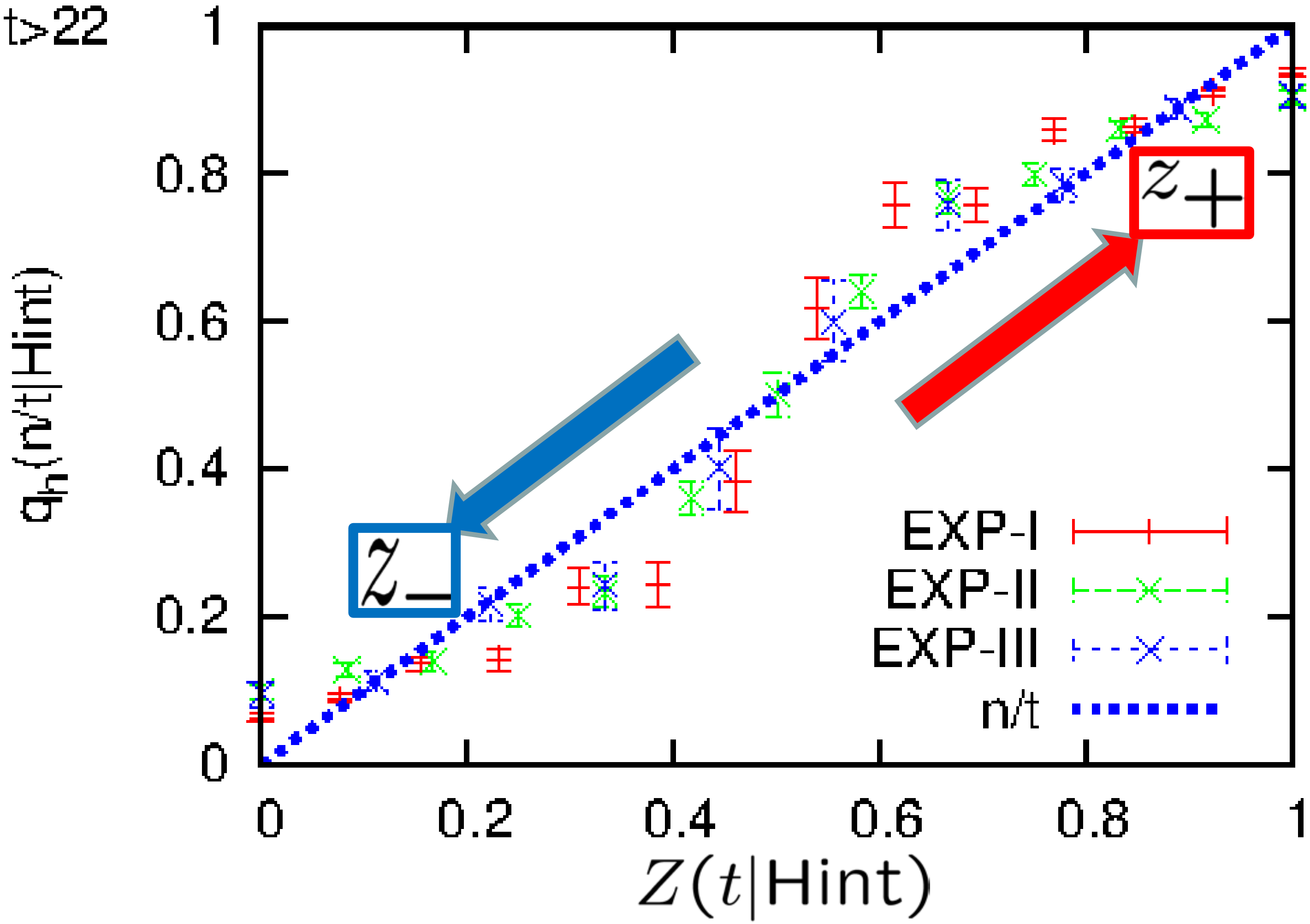


$$T \to \infty$$

$p = 100\%$


1
2
3
∞

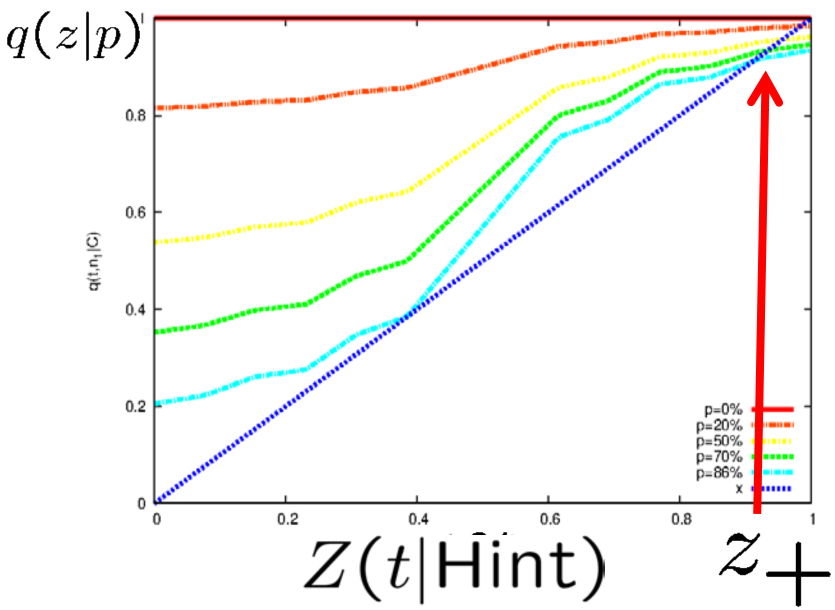
?


t>22
$q_h(n/t|\text{Hint})$
$Z(t|\text{Hint})$
z_+
z_-
EXP-I
EXP-II
EXP-III
n/t
0
0.2
0.4
0.6
0.8
1

Self-Consistent equation

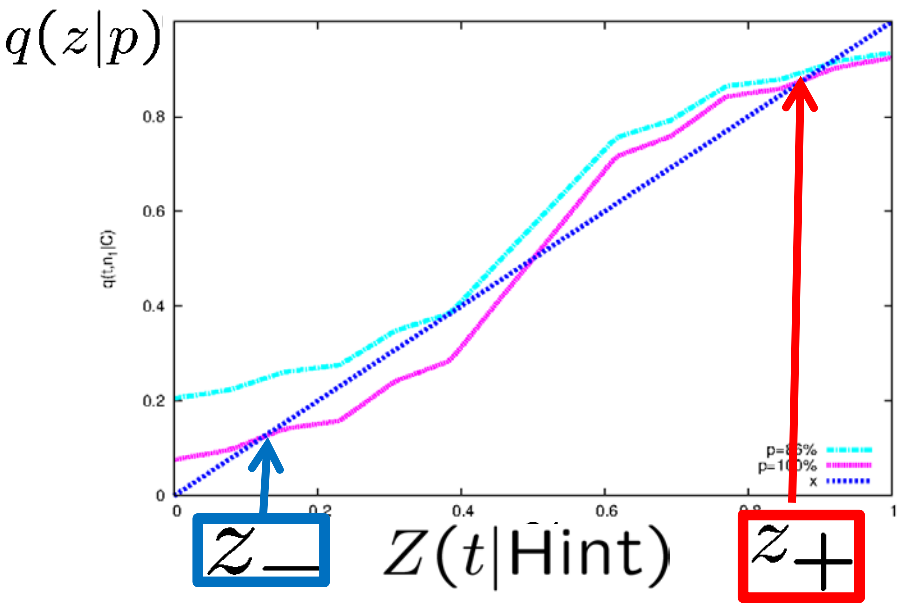
$$z = (1-p)\cdot 1 + p\cdot q_h(z) = q(z|p)$$

$p \le p_c = 86\%$



One-Peak Phase

$p \ge p_c = 86\%$

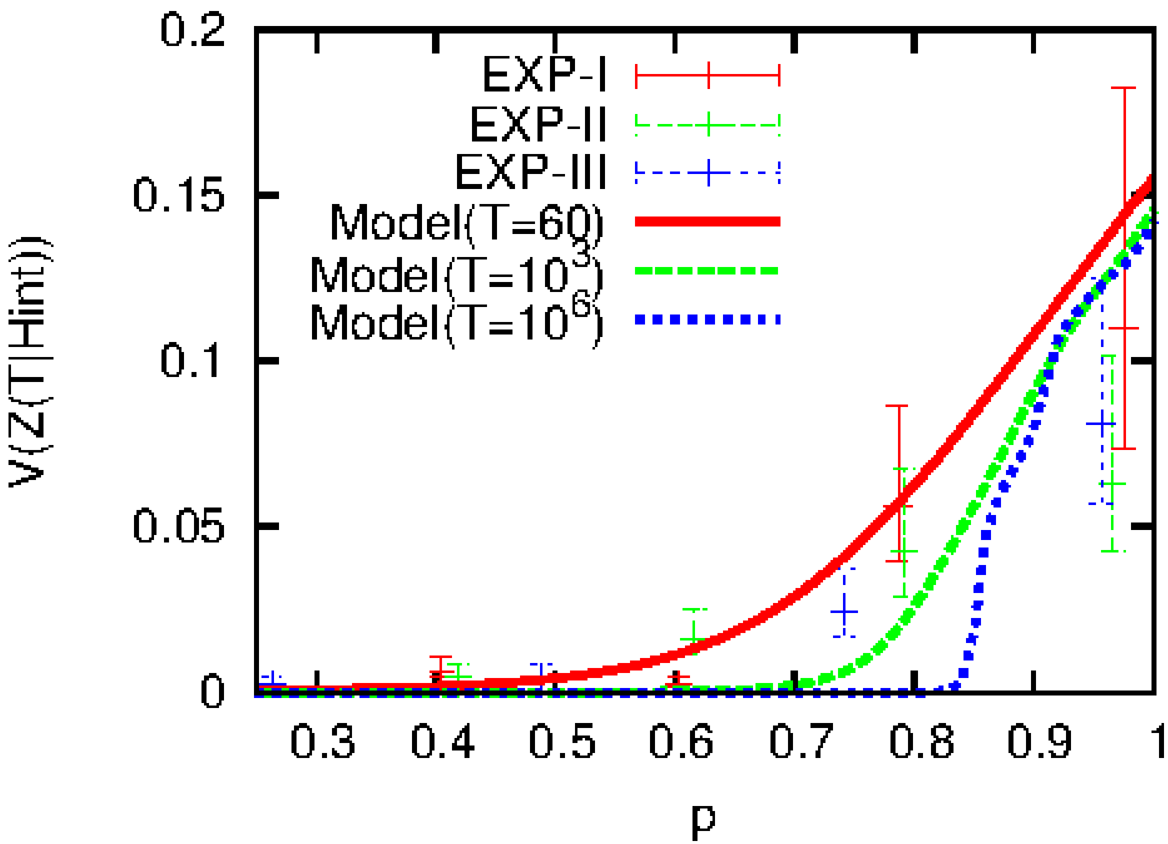


Two-Peak Phase

Information Cascade Phase transition

Order Parameter

$$\lim_{t\to\infty} \mathrm{Var}(Z(t|\mathrm{Hint})) \to \begin{cases} 0 & p \le p_c \quad \text{One-Peak Phase} \\ > 0 & p > p_c \quad \text{Two-Peak Phase} \end{cases}$$



Model

$$X(t) \in \{0,1\} \quad t \in \{1,2,\cdots\}$$

$$\mathrm{Prob}(X(t+1)=1|C_1(t)=n)=(1-p)\cdot 1+p\cdot q_h(n/t)$$

$$C_1(t)=\sum_{s=1}^{t} X(t)$$

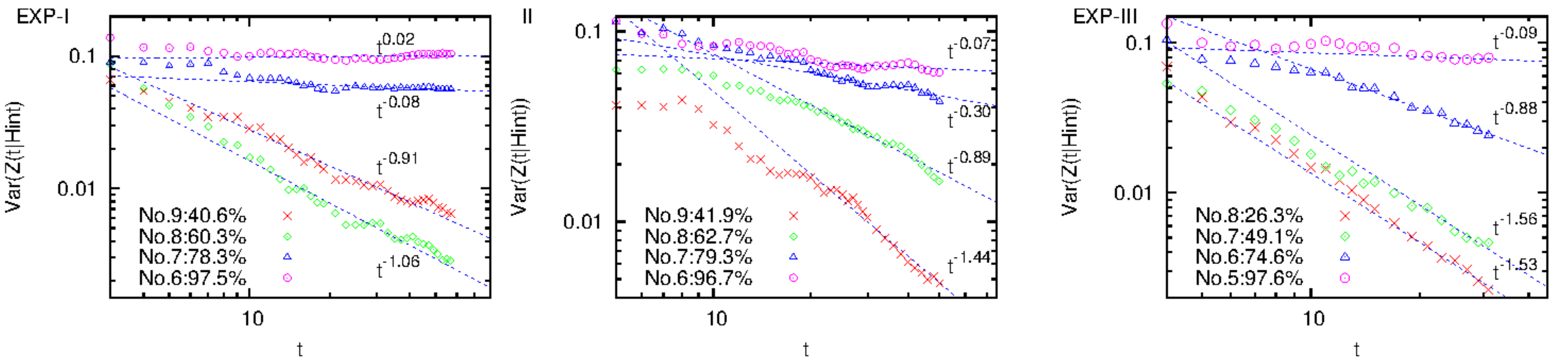
95%CL is estimated with the assumption of kai-squared dist. It is not sure in the two-peak phase.

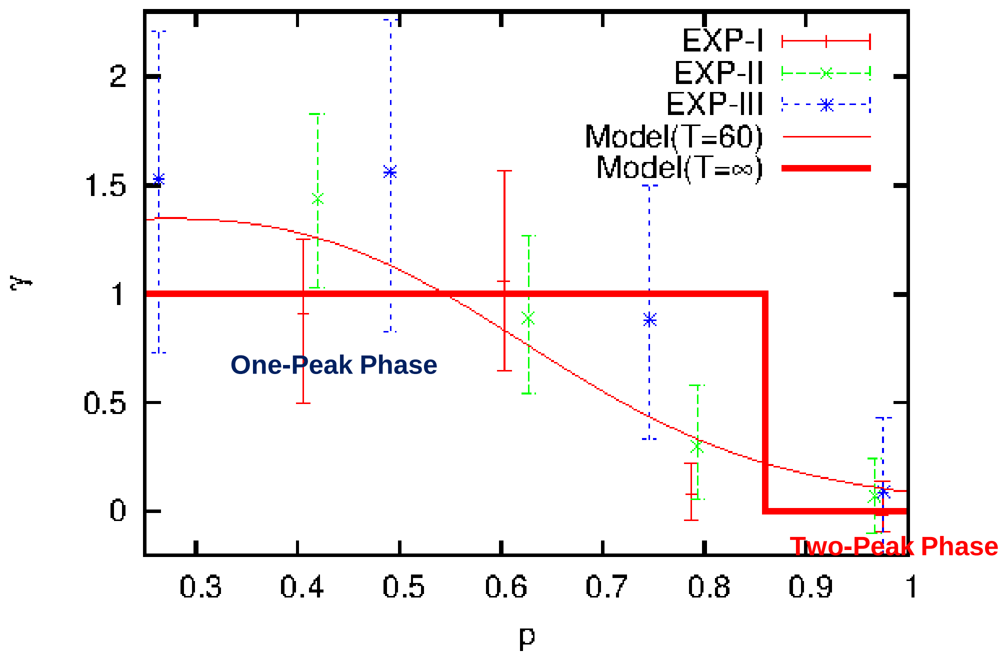
Asymptotic Behavior

$$\lim_{t\to\infty} \mathrm{Var}(Z(t|\mathrm{Hint})) \propto t^{-\gamma} \begin{cases} \gamma > 0 & p \le p_c \\ \gamma = 0 & p > p_c \end{cases}$$

One-Peak Phase

Two-Peak Phase

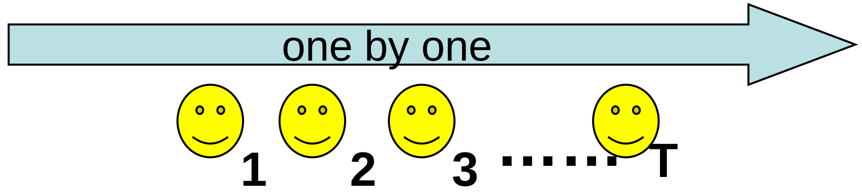


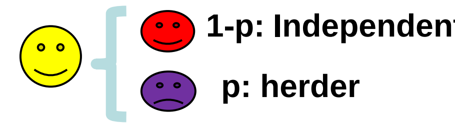


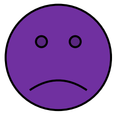
95%CL is estimated with the usage of **Model**.

Summary

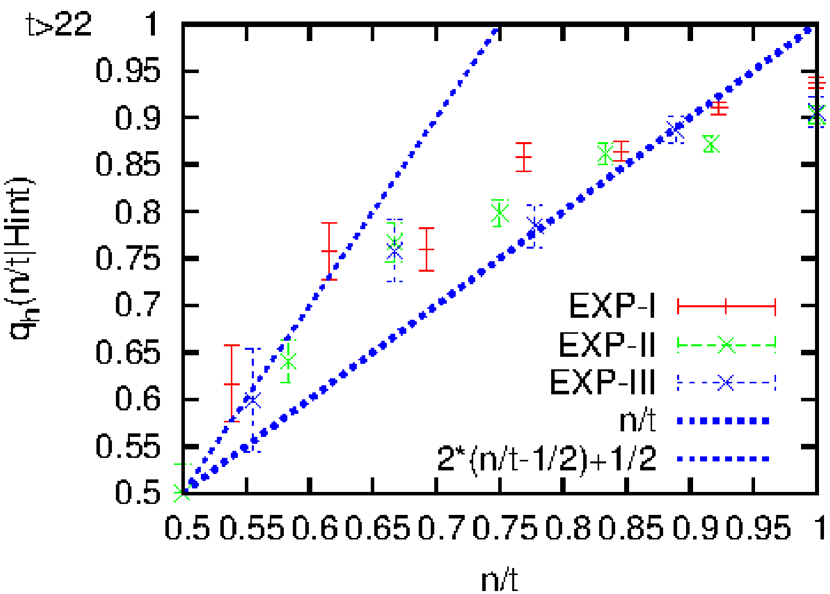
Quiz : A or B



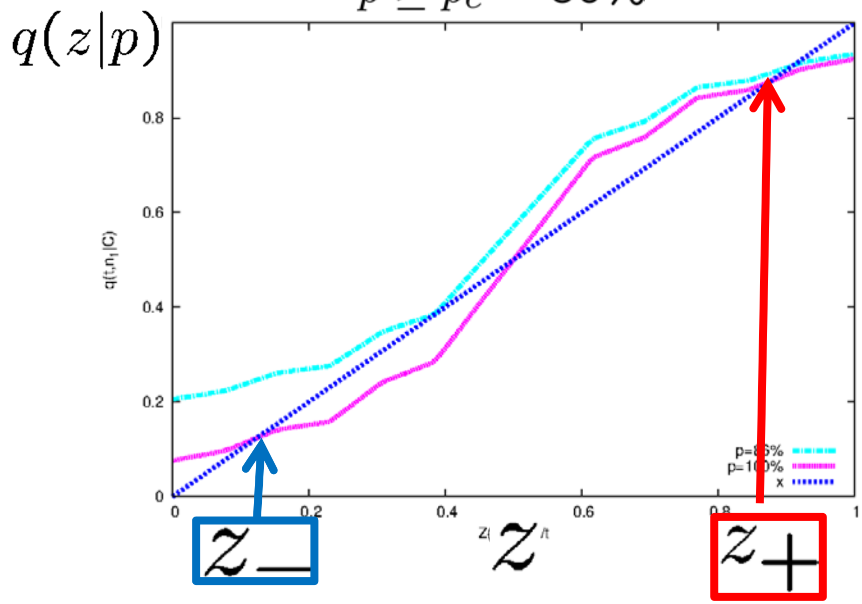


Q. How  herds ?

Q. What happens $T \to \infty$?



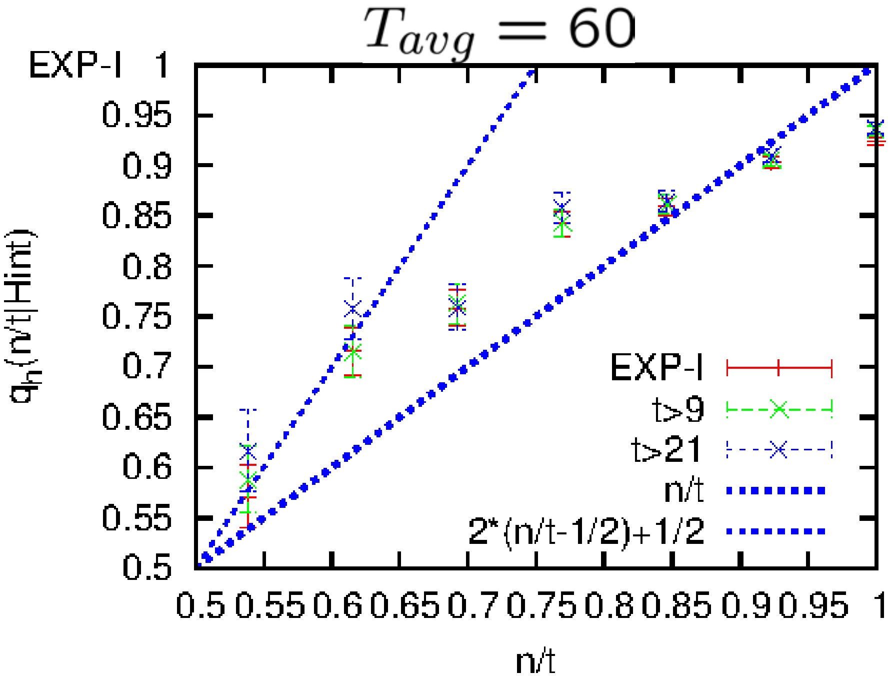
$p \geq p_c = 86\%$

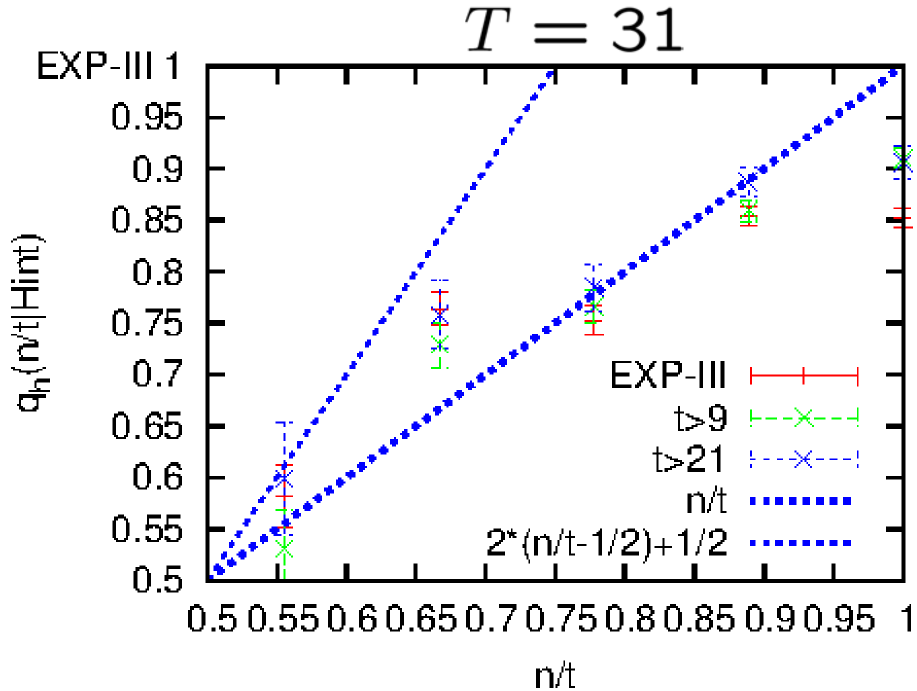


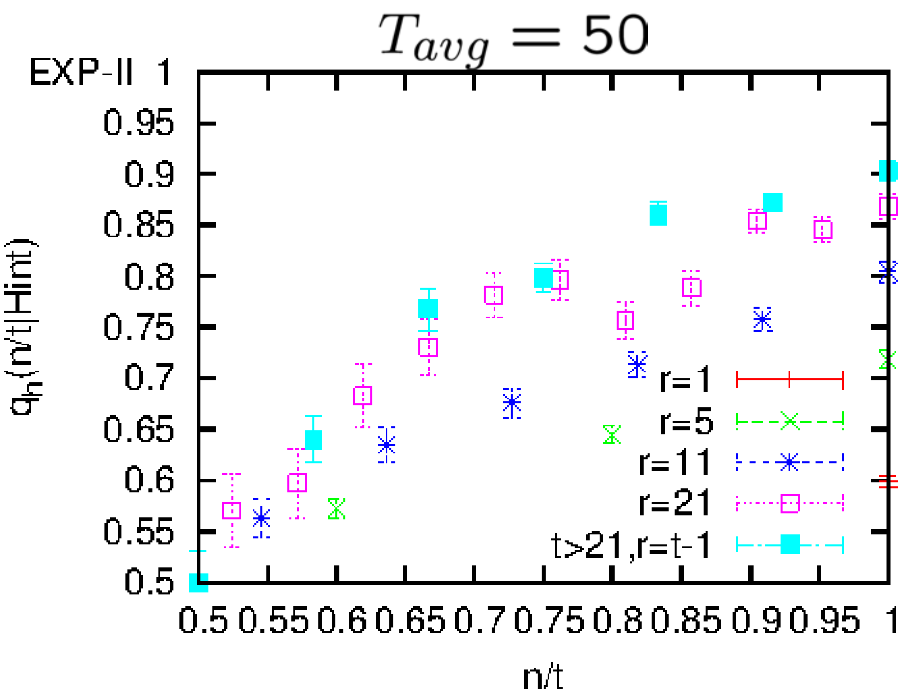
Reference

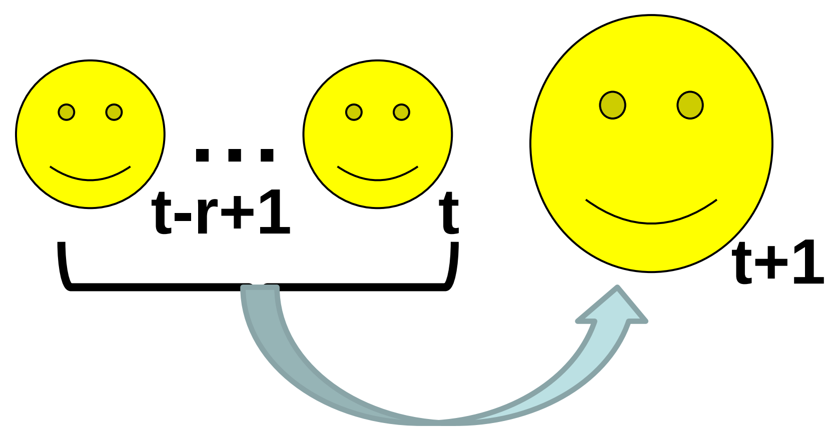
Phase transition to two-peaks phase in an information cascade voting experiment
S.Mori, M. Hisakado and T. Takahashi, Phys.Rev.E86(2012)026109.

Thank you


$T_{avg} = 60$
EXP-I
q_h(n/t|Hint)
n/t
EXP-I
t>9
t>21
n/t
2*(n/t-1/2)+1/2


$T = 31$
EXP-III
q_h(n/t|Hint)
n/t
EXP-III
t>9
t>21
n/t
2*(n/t-1/2)+1/2


$T_{avg} = 50$
EXP-II
q_h(n/t|Hint)
n/t
r=1
r=5
r=11
r=21
t>21,r=t-1


...
t-r+1
t
t+1

How to get $q_h(n/t)$

	# of Choices
Correct	N_1(No Hint)
Wrong	N_0(No Hint)
Total	N

Hint

$\{C_1, C_0\}$

$$\frac{n}{t} = \frac{C_1}{C_1 + C_0}$$

	# of Choices
Correct	N_1(Hint)
Wrong	N_0(Hint)
Total	N

$$\frac{N_1(\text{No Hint})}{N} = (1-p)\cdot 1 + p \cdot \frac{1}{2}$$

Estimate of p

$$\frac{N_1(\text{Hint})}{N} = (1-p)\cdot 1 + p \cdot q_h\left(\frac{C_1}{C_1 + C_0}\right)$$

Estimate of q_h