# Student reasoning about neural communication in human anatomy and physiology


Melinda Richárd[1], Tara Slominski[2], Jenni Momsen[2]

[1]Department of Biological Sciences, Bethel University, St. Paul, Minnesota

[2]Department of Biological Sciences, North Dakota State University, Fargo, North Dakota


## A&P is a Difficult Course

- Physiology often more difficult than anatomy [1]
- Neurophysiology builds on many chemical properties and therefore is particularly challenging
- Many career paths require A&P, e.g., nursing, pharmacy, medicine
- Literature focuses on the cardiovascular system, not nervous [2]
- Prior research found that students seemed to believe neurons had to touch to communicate [3]
- Using data collected in 2014, we are exploring natural teleological misconceptions in the context of neural communication [3]

## How do Students Reason?

We evaluated how students enrolled in Human A&P interpreted intrinsic communication between neurons. We asked students to choose a drawing that best depicted neuron communication and then explain the reasoning for their decision.

**Research Questions**

1. What alternative ideas emerge from student reasoning about neuron communication?
2. What relationships exist between picture choice and overall course performance?

## Methods

### Course context

- Students (n=357) were enrolled in Human A&P during Fall 2014
- No course perquisites
- Most students were sophomores (Table 1), majoring in Pharmacy or Nursing (Table 2)

**Table 1.** Class Status

| Class | Totals |
|---|---|
| Freshman | 44 |
| Sophomore | 211 |
| Junior | 71 |
| Senior | 31 |

**Table 2.** Majors

| Majors | Totals |
|---|---|
| Pharmacy | 91 |
| Nursing | 76 |
| Health and Wellness | 60 |
| Other | 47 |
| Allied Sciences | 44 |
| Life Sciences | 29 |
| Other Stem | 10 |

### Assessment

- Students received two formative assessment drawing tasks (FA1, FA2) (Figure 1)
- Using an emergent coding process, we developed a rubric for student reasoning that captured what students believed about:
  - Spatial arrangement of neurons (interrelated agreement **92**%)
  - Signal type (interrelated agreement **92**%)
  - Signal movement (interrelated agreement **88**%)

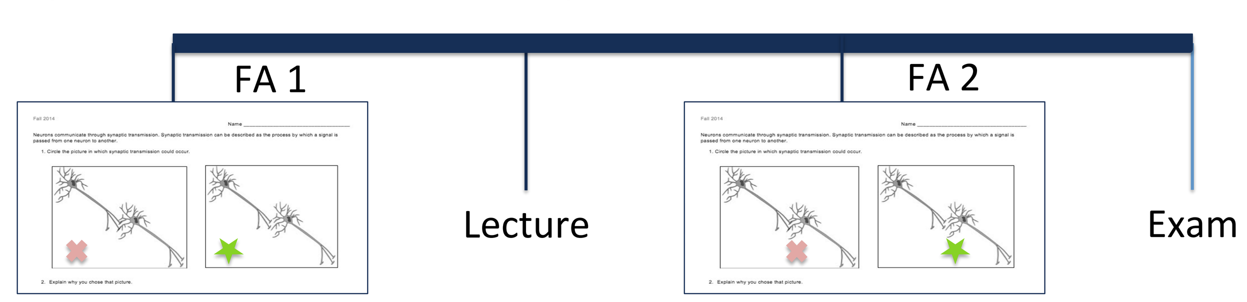



**Figure 1**. Course timeline

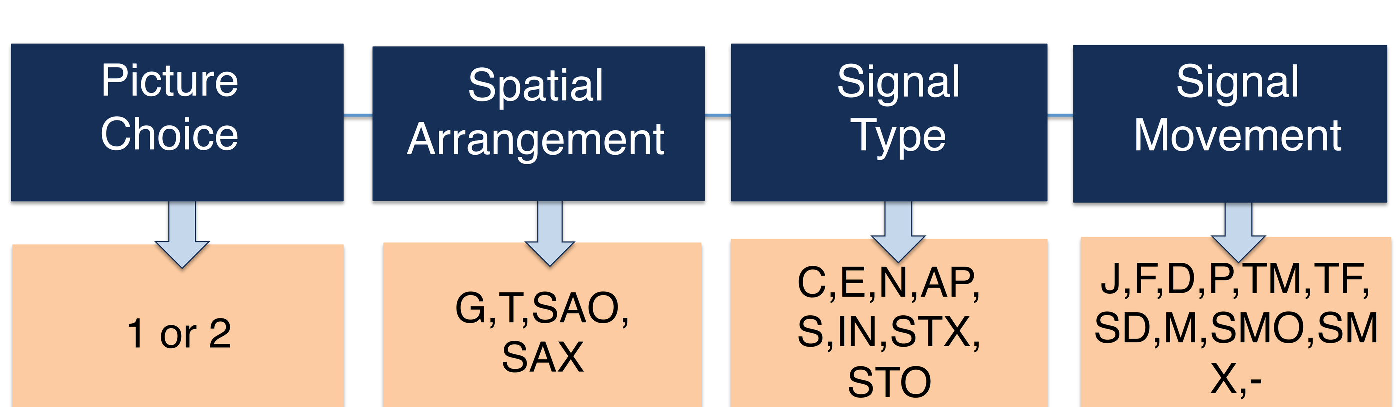


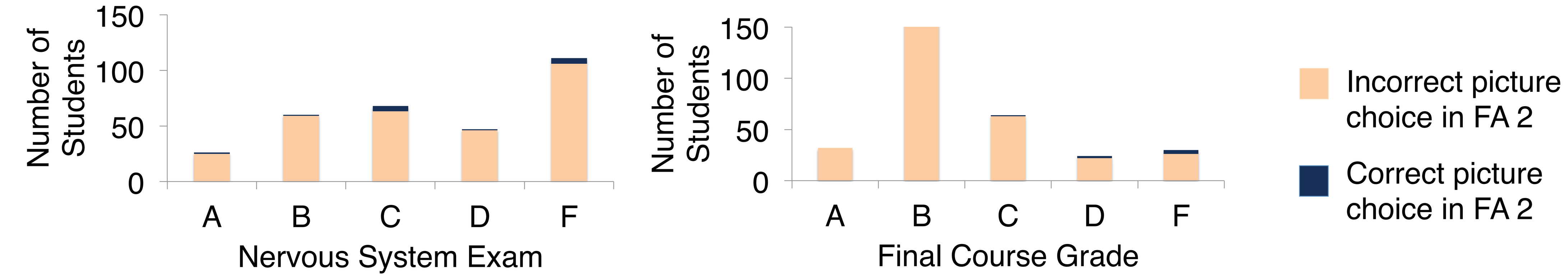

**Figure 2.** Rubric outline used to code assessments (see handout)

## Neurons Don't Need to Touch

| | FA 2 Correct | FA 2 Incorrect |
|---|---|---|
| FA 1 Correct | 205 | 1 |
| FA 1 Incorrect | 91 | 8 |

- The majority (n = 206) of students chose the correct picture on the first formative assessment, prior to any instruction.
- Following instruction, very few students chose the incorrect picture.
- 91 students changed from incorrect picture choice to correct picture choice.

## Picture Choice and Course Performance




- Most students chose the correct picture on FA 2
- Picture choice appears to have no relationship to exam or final course grade
- However, we predict that *student reasoning* may be related to exam and final course grade

## Coded Signal Type

- Through emergent coding, we identified 8 ways that students described signal type (Table 3)
- Prior to instruction, many students parroted back the question prompt, using the word 'signal'
- After instruction, students were
  - Less likely to describe the signal as chemical or electrical (Figure 2) and
  - More likely to describe the signal in terms of neurotransmitters

**Table 3**. Signal Type

| Code | Description |
|---|---|
| C | Chemical * |
| E | Electrical |
| N | Neurotransmitter * |
| AP | Action Potential |
| S | Signal |
| IN | Information |
| STX | Signal Type not mentioned |
| STO | Signal Type Other |

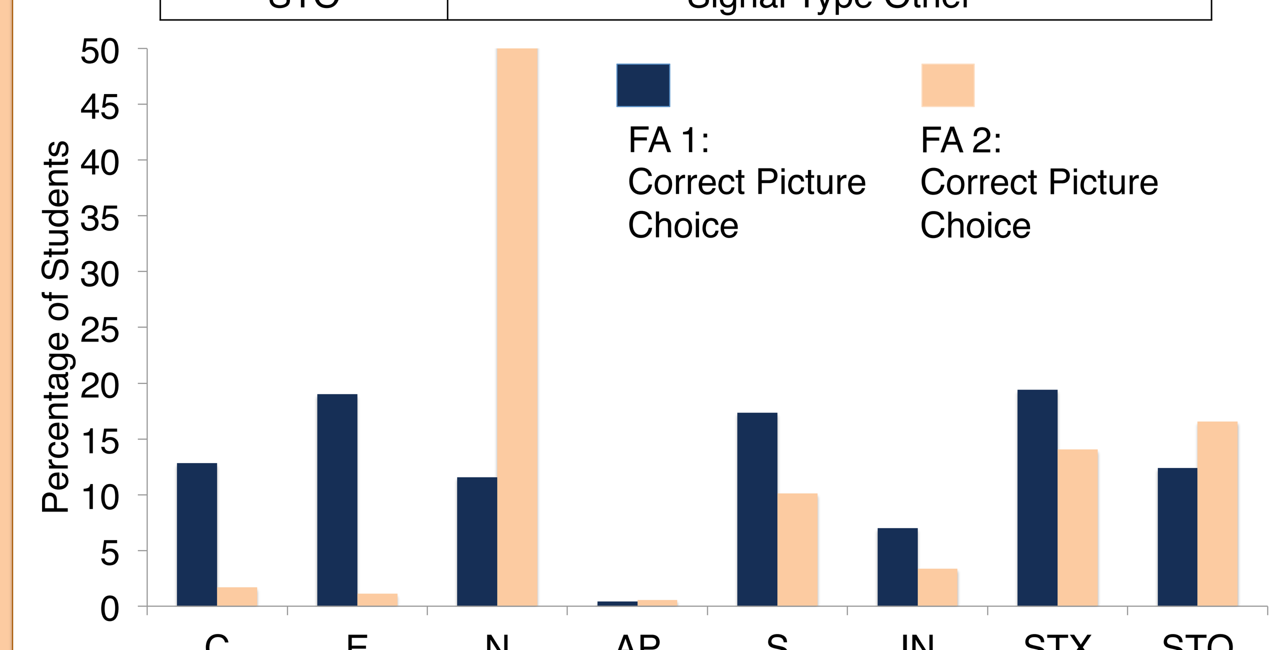



**Figure 2**. Coded Signal Type

## Student Reasoning

**Table 4**. Signal Movement

| Code | Description |
|---|---|
| J | Jump |
| F | Flow |
| D | Diffuse * |
| P | Pass |
| TM | Transmit |
| S | Signal |
| M | Move |
| SD | Send |
| SMX | Signal Movement not mentioned |
| - | No signal mentioned |
| SMO | Signal Movement Other |

- Through emergent coding, we identified 11 ways that students described signal movement (Table 4)
- Prior to instruction, students used words like jump, pass, and SD
- After instruction, students were
  - Less likely to use of the words jump, pass
  - More likely to describe movement in alternative ways (see SMO expansion)

**Formative Assessment One**

*"Neurotransmitters are released from the presynaptic neuron." n =15*

*"Chemicals travel from the presynaptic neuron to postsynaptic neuron." n = 14*

*"Electricity crosses over from presynaptic neuron to postsynaptic neuron" n = 12*

*"Signals are received by postsynaptic neuron" n = 6*

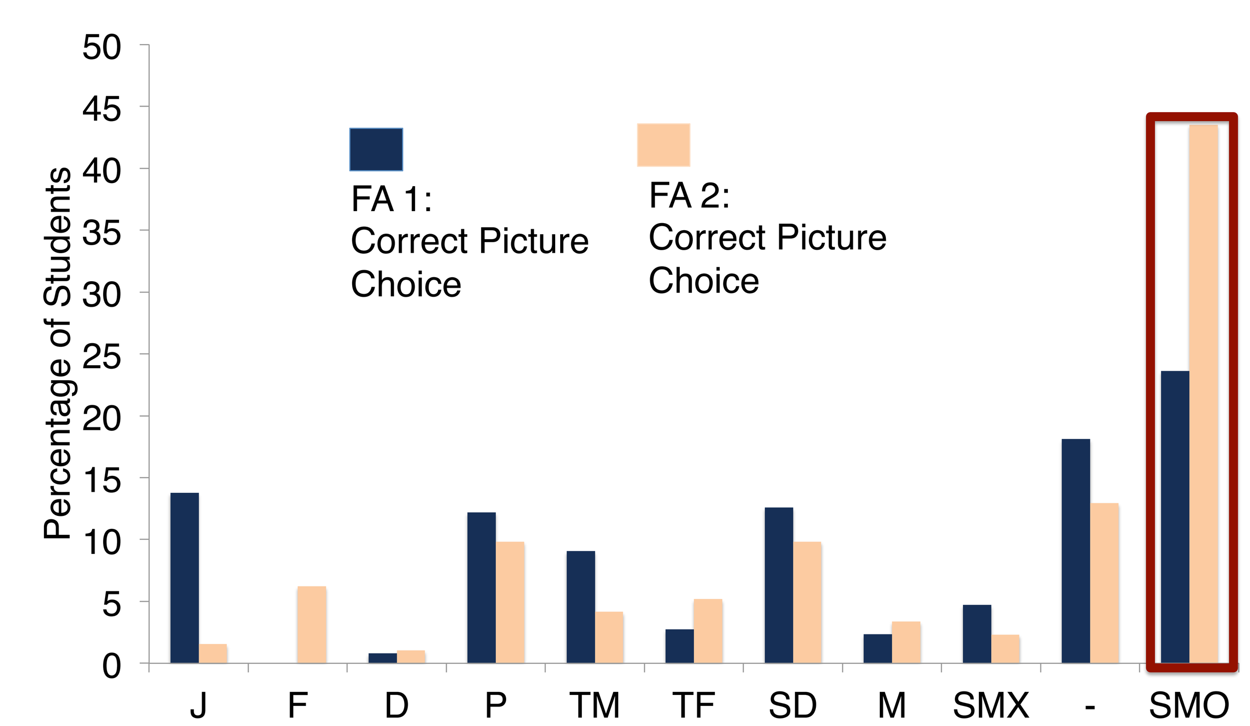



**Figure 3**. Coded Signal Movement

**Formative Assessment Two**

*"Neurotransmitters are released from the presynaptic neuron." n = 82*

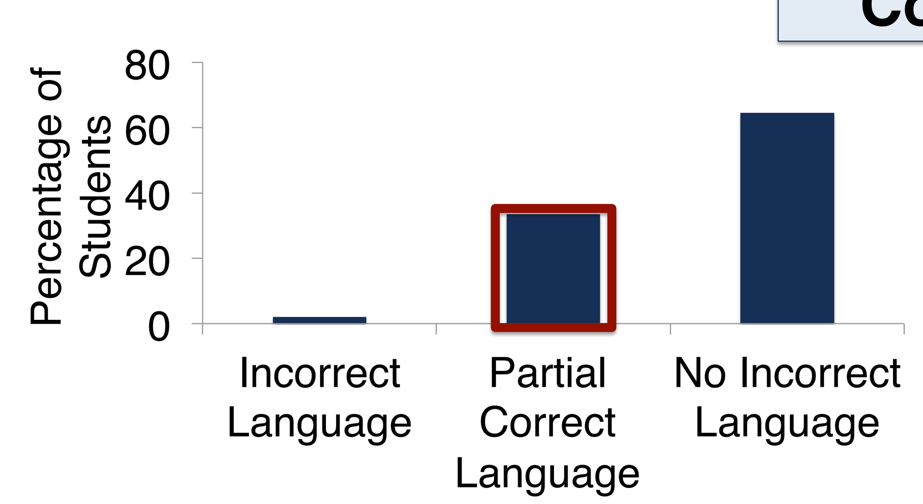
*"Neurotransmitters travel from the presynaptic neuron to postsynaptic neuron." n = 34*

*"Neurotransmitters bind to ligand gated channels on the postsynaptic neuron." n = 17*

*"Neurotransmitters are received by postsynaptic neurons." n = 13*

*"Neurotransmitters cross over from the presynaptic neuron to the postsynaptic neuron." n = 13*

## Correctness in Reasoning




Correctness of Written Reasoning FA 2

**Formative Assessment Two**

*"There has to be a space between them for the signal to travel. The neurotransmitters need to move through gap junctions to propagate the cell to create a synapse."*

*"Ion flow needs gaps for flow to occur. The synaptic cleft allows for the ions to flow from one to the next. The ion flow would cause an action potential that would allow neurotransmitters to flow from presynaptic to postsynaptic cell."*

## References


[1] Kurt et al. (2013). The most important concept of transport and circulatory systems: Turkish biology student teachers' cognitive structure. Ed. Res. Revs., 8(17), 1574–1593.

[2] Michael et al. (2002). Undergraduates' understanding of cardiovascular phenomena. Adv. in Phys. Ed., 26(2), 72–84

[3] Slominski, T. (2014). Drawing on student knowledge in human anatomy and physiology. North Dakota State University.


## Acknowledgements


Thanks to National Science Foundation and the NDSU REU program for this research opportunity. Special thanks to Dr. Warren Christensen, Rachel Salter, Ayla Parham for additional mentorship.

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation. Research supported in part by NSF REU, DUE #1156974