

Erikson Institute
Early Math Collaborative

Children are Born Mathematicians

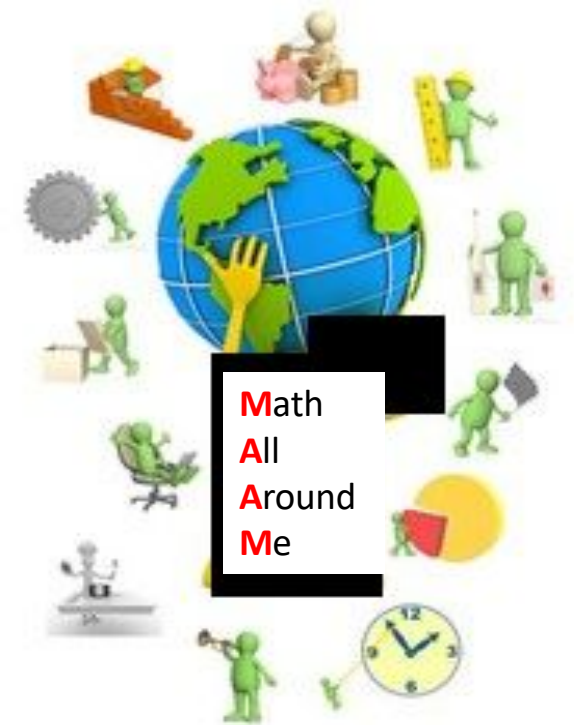
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0-3 Breakout Session, *Children as Mathematicians* PD Institute

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It Begins at the Beginning

Children are natural-born wonders!!



They are born hard-wired with capacities to ...

... walk & talk

... become life-long learners & problem-solvers

... become the most important persons in others' lives

But no child is born ...

... a professional athlete or dancer

... a poet or a musician

... an inventor or architect

... a mathematician or a scientist

*Every Adult needs to be supported from the earliest years
in order to become **competent & accomplished** !*

Case in Point

Turn and talk about the difference between the video showing a 6 day old child (born with a primate's capacity to walk & run & a typically developing 3 year old.

<https://www.youtube.com/watch?v=VkiOkboxzPo>

6 day old

<https://www.youtube.com/watch?v=LhzjY8icA0k>

3 year old

This instinctive capacity to walk/run when feet touch the surface is one of 7 physical responses that begin at birth but disappear at between 2 and 4 months.

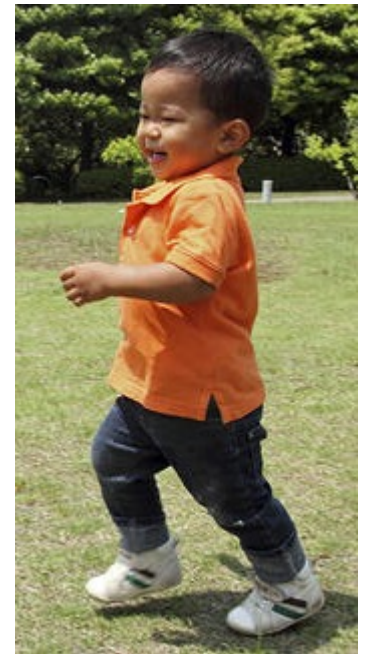


Babies are both with an instinctive reflex that is a **precursor** of the ability they will acquire to walk & run. The process takes place over the first 2-3 years.



Showing them flash cards or videos won't speed this achievement up.

Playful tummy time, providing clothing & experiences that invite movement, & delighting in their development **will!**



USE IT



OR LOSE IT

It's the same for math!

Beginning at birth, infants have innate mathematical capacities, including the capacity to *perceive*

quantity

magnitude & size

spatial & temporal relationships

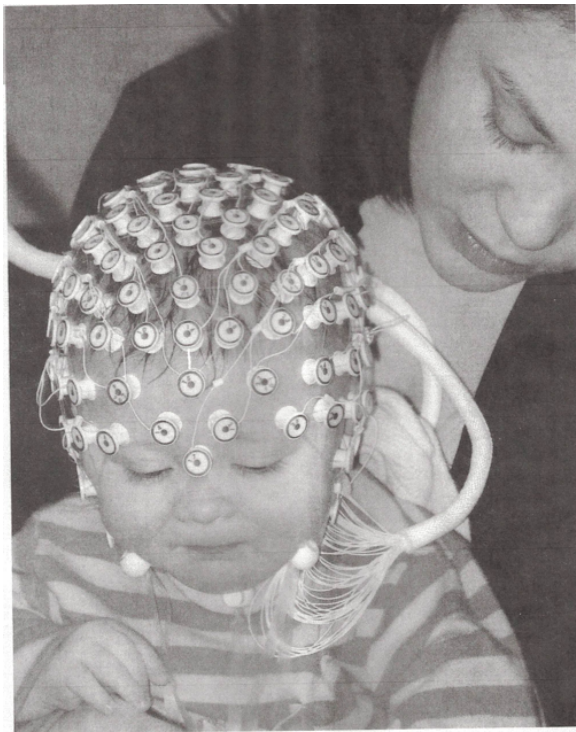
pattern & regularity

MATH ALL AROUND ME

is much more than rote counting & naming shapes

It's a
logical way of thinking
that allows for
increasing precision.

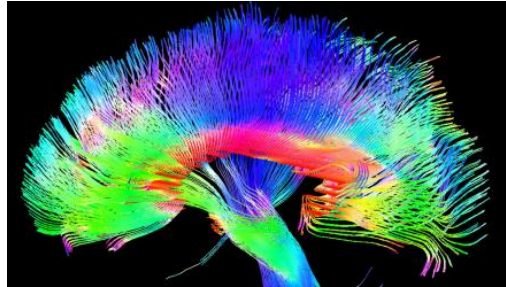
Brain imaging shows that thinking begins at the beginning, but it is not verbal



Before they are a year old, infants' **gaze**
non-verbal expressions
gestures
actions
brains
show active logical thinking &
problem-solving

It's the same for math!

Babies are born **hard-wired** with innate mathematical capacities that we call
Precursor Mathematical Concepts



PRECURSOR -- what comes before & prepares for or signals something

Red sky at night, sailors' delight.

Red sky at morning, sailors take warning.



When leaves turn red and fall,
we know winter is coming.



In mathematics, a PRECURSOR concept is
a concept that **underlies or prepares the ground** for a big idea

We have identified 4

Precursor Mathematical concepts

Attributes

Comparison

Patterns

Change

**Babies, toddlers & 2s thrive & grow into playful,
confident mathematical thinkers & problem-solvers
when caregivers use the **CAIR** Principle:**

Closely **A**ttend & **I**ntentionally **R**espond

***in ways that are appropriate for the child's age &
stage of development***

No matter how young or old we are, we learn best if learning/teaching happens in a way that makes us feel



Engaged

Safe

Valued

Competent

Research shows that from birth on, children need evidence that caregivers are **closely attending & intentionally responding** supportively & positively.

<https://www.youtube.com/watch?v=PWfHBn3W6Fc>

This video makes it clear how very sensitive young children are to picking up cues from adults.

<https://www.youtube.com/watch?v=7FC4qRD1vn8>

From birth on, learning is a **complex** process.

We have to notice before we can make sense of what is going around us.

We have to make some kind of sense of what is happening before we can explain or do.

We always need many chances to notice and to practice before we are good at doing.

No matter how young or old we are,
learning takes a similar path.

Receptive understanding comes first.

Long before we name or do, we **recognize.**



No matter how young or old we are,
productive understanding & skills take much longer.

We need many experiences before we can

- **match** or point out an attribute
- **name** people, objects, words, ideas
- **do/perform** a skill or task



The LANGUAGE OF MATH is embedded in every mother's tongue.



Every language includes expressions of

- **quantity**
- **magnitude & size**
- **spatial & temporal relationships**
- **pattern**

Talk the *MAAM* Talk

ATTRIBUTE words include adjectives

quantity

all cardinal numbers, *generic terms* such as only, a lot, many, pair, dozen, gazillion....

magnitude & size

big, huge, gigantic, little, teeny-weeny, long, short, tall ...

sensory perception: touch/physical sensations

cold, hot, prickly, cozy, soft, smooth ...

sensory perception: visible appearance including texture & color

red, magenta, pink, green, emerald,; smooth, wrinkly, bumpy, twisted ...

sensory perception: *sound*

soft, loud, quiet, exploding, clattering ...

sensory perception: *taste/smell*

yummy, yucky, smelly, fragrant, sweet, salty, spicy ...

descriptive terms indicating time

soon, right now, after a while, today, long ago ...

spatial & positional ideas expressed in *prepositions* & *adjectives* related to location

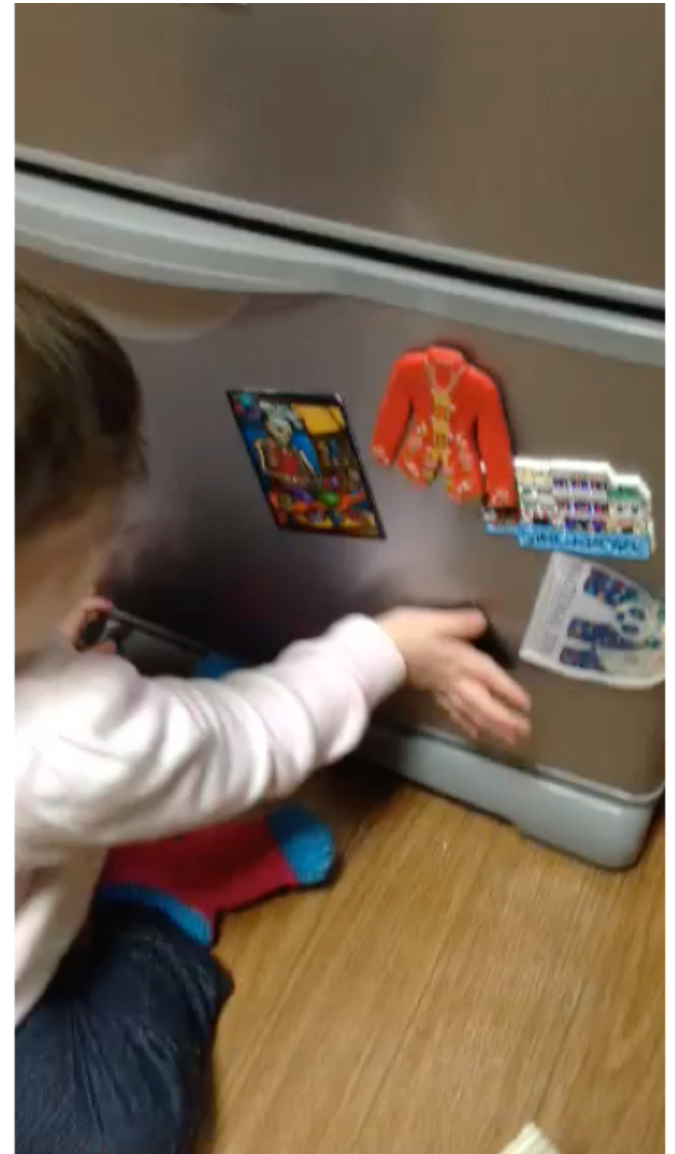
here, there, in, on, over under, above, below, next to, beside, behind, close, far, left, right...

•
Newborns don't run and they don't count!



**BUT THEY CAN THINK—
even if they can't put their thoughts into
words.**

*What evidence do you see
that this 11 month old is
thinking logically about
magnets?*

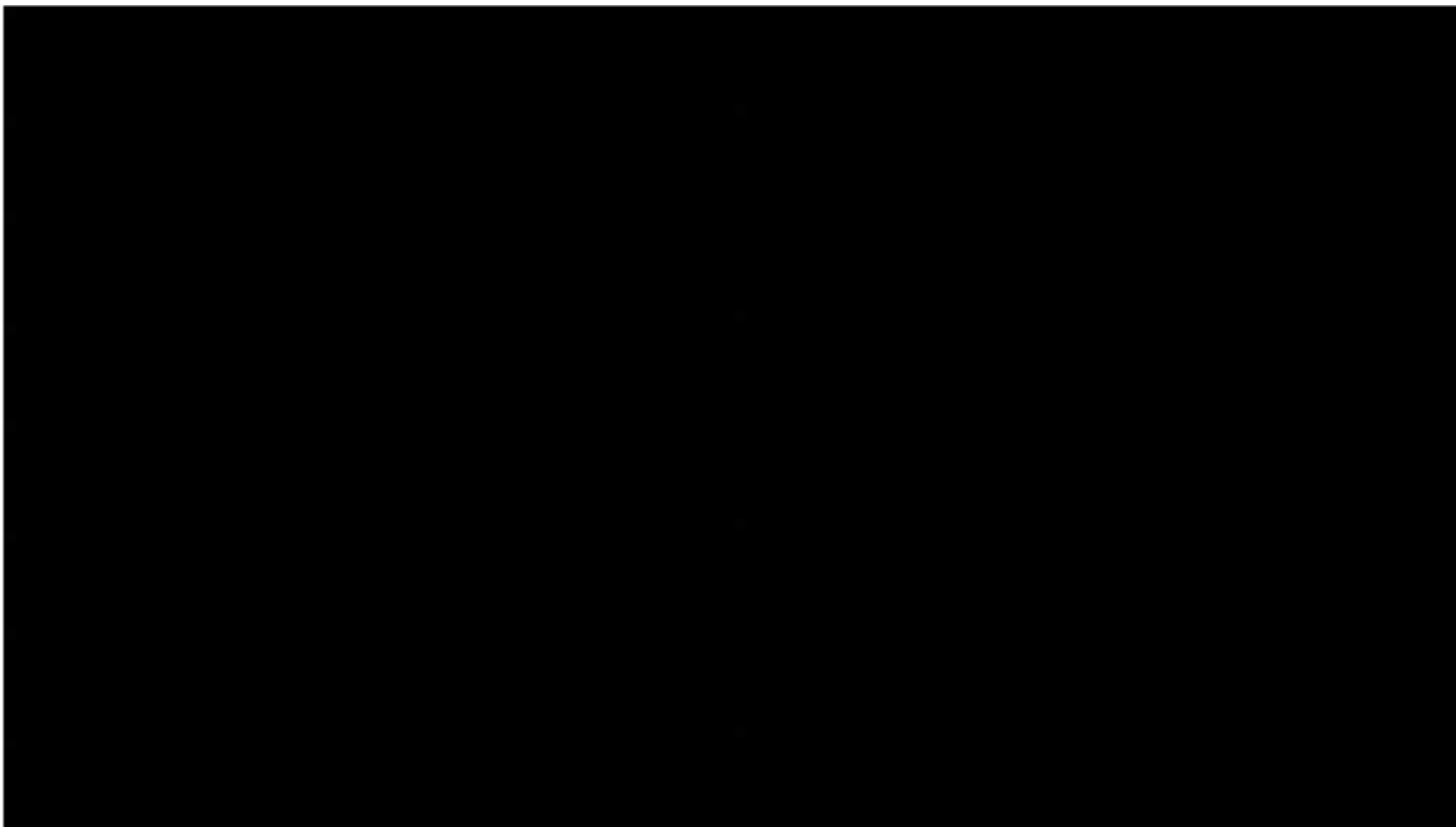


Newborns don't run and they don't count!

**But they do have an innate capacity for
perceiving **attribute**,
comparing,
noting **pattern & change****

**0-3s DEMONSTRATE increasing capacity
even though they don't NAME it**

Watch this child noticing attributes of an avocado.



**Watch this child
recognizing the pattern
in the finger play.**



Newborns don't run and they don't count!

But they do have an innate capacity

for perceiving

quantity & magnitude

Let's begin at the beginning ...

From the first weeks, brain imaging shows infants can

SUBITIZE

(register changes in the number of images being flashed on the screen)



Subitizing happens
only with very small quantities: 1,2,3
(Newborns don't run and they don't count!)



The innate capacity for **perceiving**
quantity & magnitude
is not the same as
knowing how to count
(name quantity with precision).



Crows, elephants, and monkeys
Have the same innate ability as
infants & toddlers
to *subitize*.



Brain imaging shows none of them are counting—
They are registering **CHANGE** in quantity.

Only at 12-18 months do humans recognize that 3 is *more* than 2.

Counting means being able to name **HOW MANY?** in a precise way.



Elephants and crows **NEVER** develop the ability to **NAME** quantity.
Only humans do.

But it is only at 2 -3 years that humans' cognitive capacity has developed enough so they are able to accurately name *How Many?* up to 3.

The latest research strongly indicates that
counting is a human invention
It allows us to name quantity with precision
not just beyond 3 but up to infinity!

(Dehaene, Lakoff, Everett)

**Different cultures have different needs to
make sense of & name numbers precisely!**

It's not just counting!

Mathematics is a complex, socially-developed set of ideas that must be taught to be learned.

Multiplication & Division developed in the West after 1400.

Analytic Geometry was “invented” by Rene Descartes (d 1650)

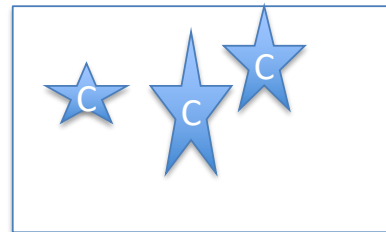
Calculus by Isaac Newton 50 years later

CASE IN POINT –Subitizing

We don't **teach** children how to *subitize*—they are born instinctively **perceiving differences in quantity**.

By about 12 months, they seem to register that 3 is more than 2 or 1, but they still don't have any **names** for these amounts.

Mapping the ties among the word “*three*,”
the symbol 3 and the quantity
is complex

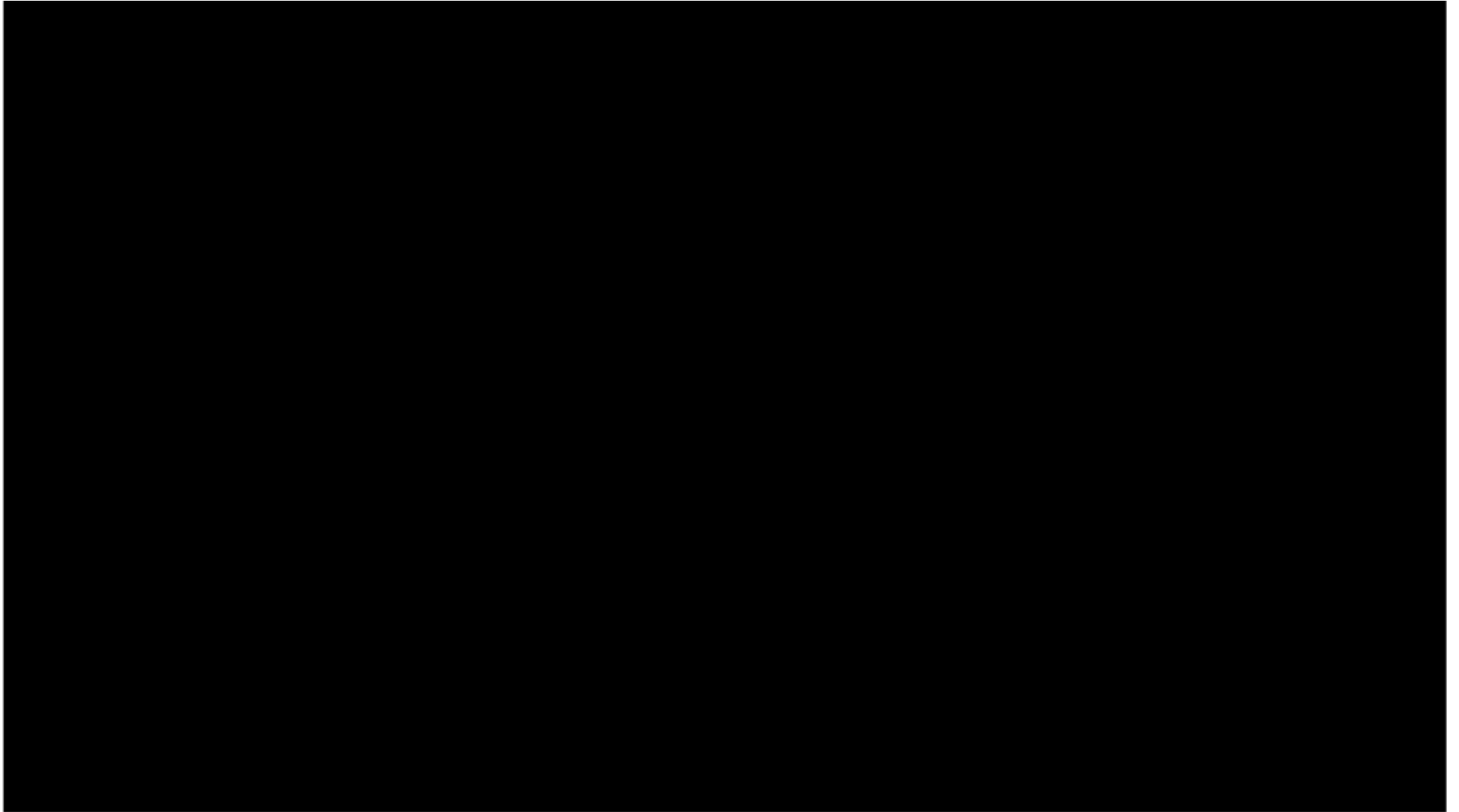


Naming **1,2, 3** precisely doesn't really begin to emerge
sometime around 3 years old!!

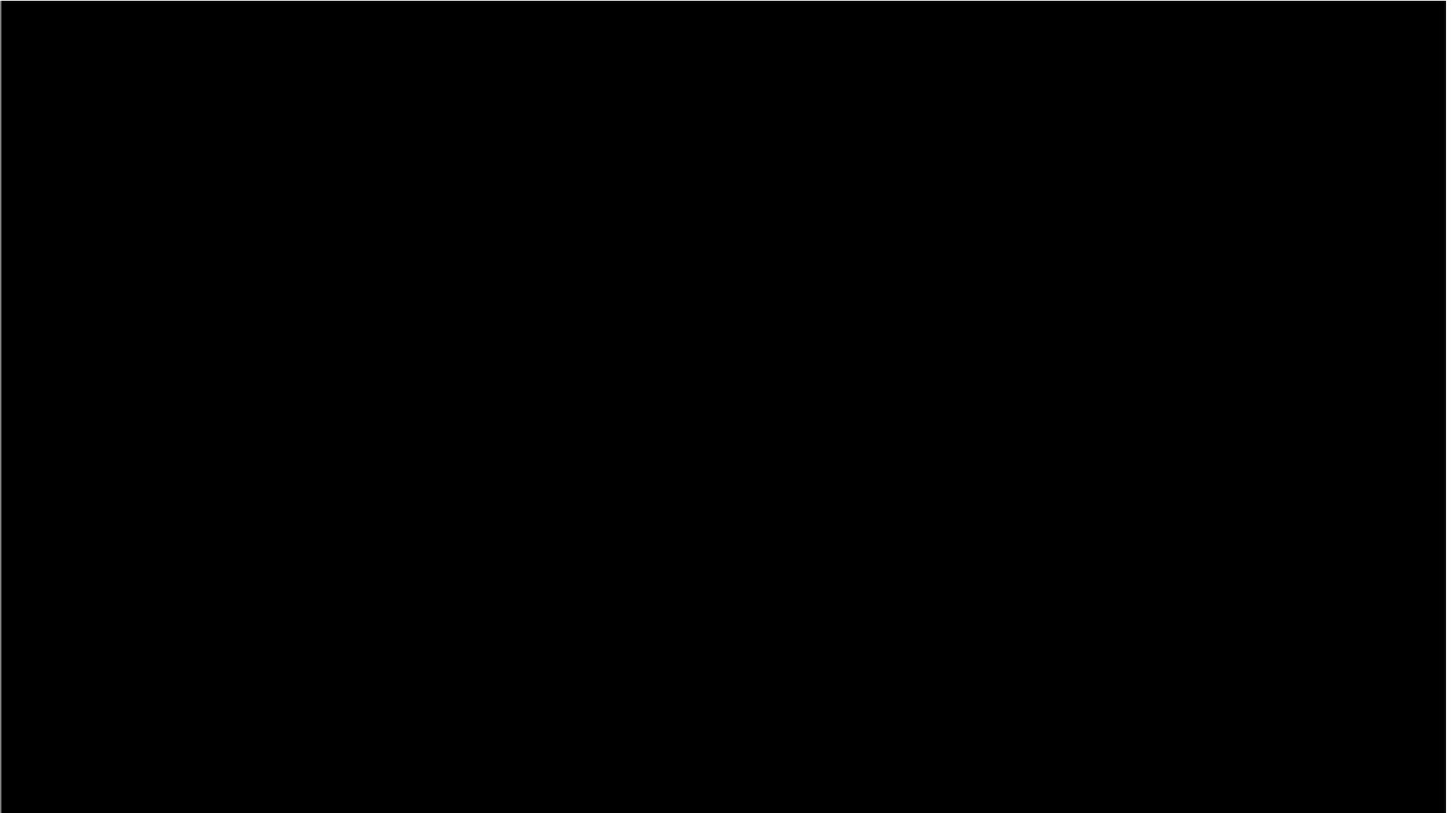
Many children are close 3 years old before they make the *conceptual shift* to becoming 2-knowers or 3-knowers
That is they can not just recognize but accurately do a give me 3 task (count out 3 things from a larger collection).

What does it look like for children to be entering preschool primed to make sense of numbers?

Feast for 10 part 1

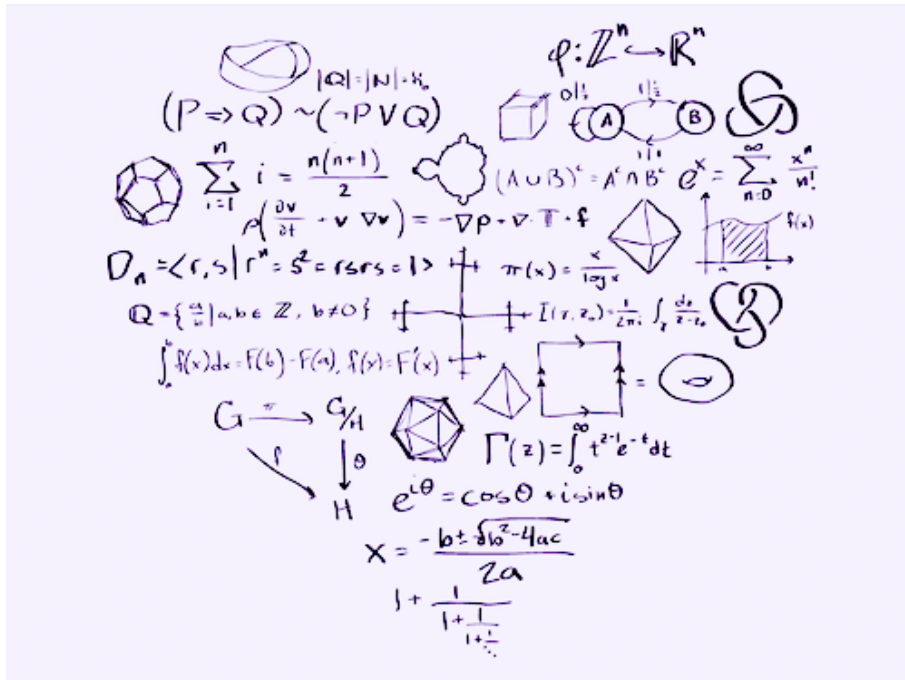


Feast for 10 part 2



It takes most of the preschool years for normally developing children to develop precise number sense for quantities from 4-10.

One of the best ways to help them is continually play with visual number sense & subitizing, using dot cards & 10 frames.



Questions & Comments ?
Noticing & Wondering ?
What does it take for
ALL children to love math?
Beginning at the beginning!!