

PRESS RELEASE

## 3D Models Reveal Hidden Details of Zebrafish Behavior

May 16, 2017



A research team headed by Professor Maurizio Porfiri successfully developed the first successful 3D computer modeling of the motions of zebrafish, which are increasingly

BROOKLYN,

New

York

—

Zebrafish

have

become

increasingly

popular

model

animals

in

preclinical

and

neurobehavioral

research

due

to

...

genetic  
similarity  
to  
humans  
and  
rapid  
rate  
of  
reproduction.  
Studies  
of  
zebrafish  
behavior  
have  
shed  
light  
on  
social  
and  
biological  
phenomena  
ranging  
from  
the  
dynamics  
of  
collective  
animal  
behavior,  
such  
as  
shoaling  
and  
schooling,  
to  
anxiety,  
fear,  
and  
leadership.  
Borrowing  
from  
decades  
of  
work  
on  
mice  
and  
rats,  
most  
observations

of zebrafish are conducted using a two-dimensional approach, despite the fact that zebrafish swim in three-dimensional (3D) space.

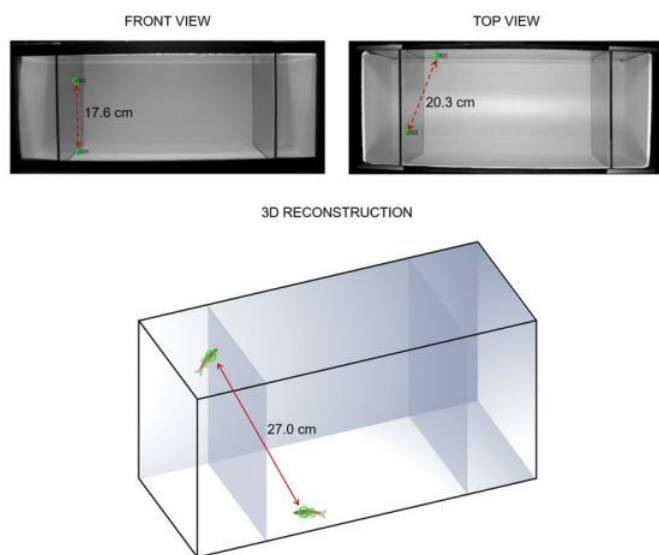
In a new paper published in *Scientific Reports*, a research team led by [Maurizio Porfiri](#), professor of mechanical and aerospace engineering at the New York University Tandon School of

compared  
2D  
and  
3D  
observational  
data  
in  
a  
series  
of  
behavioral  
experiments.  
Their  
results  
highlighted  
potential  
compromises  
in  
data  
integrity  
in  
2D-  
scored  
behaviors  
versus  
3D,  
with  
the  
former  
tending  
to  
under-  
estimate  
locomotion  
in  
zebrafish.  
Because  
interpretation  
of  
zebrafish  
behavior  
is  
entirely  
dependent  
on  
assessment  
of  
swimming  
patterns  
and

preference  
in  
response  
to  
various  
stimuli,  
such  
reporting  
errors  
can  
influence  
experimental  
outcomes.

Experiments  
also  
confirmed  
that  
3D  
approaches  
to  
analyze  
zebrafish  
behavior  
require  
less  
than  
half  
of  
the  
number  
of  
zebrafish  
used  
in  
2D  
approaches,  
with  
no  
compromise  
in  
validity.  
These  
findings  
may  
lead  
to  
a  
reduction  
in

number  
experimental  
animals.



In the first experiments of their kind, NYU Tandon researchers and their colleagues found significant discrepancies in data generated when tracking the social behavior of zebrafish in two dimensions as opposed to 3D.

The  
paper  
was  
co-  
authored  
by  
Simone  
Macrì  
of  
the  
Istituto  
Superiore  
di  
Sanità  
in  
Rome,  
Italy;  
Daniele  
Neri,  
Tommaso  
Ruberto,  
and  
Violet  
Mwaffo,  
all  
at  
NYU

in  
Porfiri's  
group;  
and  
Sachit  
Butail,  
an  
assistant  
professor  
of  
mechanical  
engineering  
at  
Northern  
Illinois  
University.

“Zebrafish  
are  
inherently  
social  
species  
who  
demonstrate  
a  
rich  
repertoire  
of  
swimming  
behaviors  
in  
response  
to  
various  
stimuli,”  
said  
Porfiri.  
“Two-  
dimensional  
scoring  
intrinsically  
misses  
a  
major  
dimension  
of  
swimming  
behaviors,  
leading  
to

false  
positives  
and  
false  
negatives.  
This  
is  
the  
first  
study  
to  
systematically  
quantify  
the  
degree  
to  
which  
data  
integrity  
may  
be  
compromised  
by  
this  
approach.”

Using  
data  
from  
previous  
zebrafish  
studies  
based  
on  
a  
3D  
tracking  
software  
developed  
by  
Porfiri’s  
group,  
the  
research  
team  
compared  
zebrafish  
behavior  
in  
response



stimuli  
including  
a  
live  
conspecific  
and  
live  
predator,  
3D-  
printed  
models  
of  
a  
conspecific  
and  
a  
predator,  
and  
a  
computer  
animated  
image  
of  
a  
predator.  
These  
experimental  
paradigms  
are  
commonly  
used  
to  
study  
anxiety,  
memory,  
fear,  
and  
general  
locomotion  
in  
zebrafish.  
Their  
results  
confirmed  
that  
2D  
tracking  
significantly  
underestimates

swimming  
behavior  
with  
respect  
to  
average  
speed,  
average  
peak  
speed,  
wall  
following,  
and  
other  
parameters.  
Additionally,  
2D  
tracking  
consistently  
overestimated  
spatial  
preference  
for  
stimuli,  
an  
important  
parameter  
for  
understanding  
fear,  
anxiety,  
and  
other  
social  
behaviors.  
For  
example,  
zebrafish  
have  
an  
innate  
aversion  
towards  
threatening  
stimuli;  
such  
aversion,  
clearly  
identifiable  
through

the  
3D  
approach,  
can  
be  
overlooked  
when  
data  
are  
scored  
in  
2D.

The  
researchers  
acknowledge  
that  
material  
costs  
and  
the  
burdens  
of  
analyzing  
3D  
data  
increased  
computational  
loads,  
which  
likely  
prohibit  
the  
replacement  
of  
2D  
approaches,  
but  
emphasize  
that  
3D  
tracking  
systems  
may  
be  
a  
valuable  
complement  
to  
zebrafish

analysis,  
particularly  
as  
a  
means  
to  
gain  
rich  
data  
sets  
with  
fewer  
numbers  
of  
experimental  
subjects.

*Three-  
Dimensional  
Scoring  
of  
Zebrafish  
Behavior  
Unveils  
Biological  
Phenomena  
Hidden  
by*

*Two-  
Dimensional  
Analysis*  
is  
available  
at  
[www.nature.com](http://www.nature.com).

The  
National  
Science  
Foundation  
and  
Mitsui  
USA  
Foundation  
supported  
the  
work.

Note:

Images  
available  
at

[http://dam.engineering.nyu.edu/?  
c=1952&k=97112efb75](http://dam.engineering.nyu.edu/?c=1952&k=97112efb75)


—

**About  
the  
New  
York**

Tandon  
School  
of  
Engineering  
*The  
NYU  
Tandon  
School  
of  
Engineering  
dates  
to  
1854,  
the  
founding  
date  
for  
both  
the  
New  
York  
University  
School  
of  
Civil  
Engineering  
and  
Architecture  
and  
the  
Brooklyn  
Collegiate  
and  
Polytechnic  
Institute  
(widely  
known  
as  
Brooklyn  
Poly).*  
A  
January  
2014  
merger  
created  
a  
comprehensive  
school  
of  
education

and  
research  
in  
engineering  
and  
applied  
sciences,  
rooted  
in  
a  
tradition  
of  
invention  
and  
entrepreneurship  
and  
dedicated  
to  
furthering  
technology  
in  
service  
to  
society.  
In  
addition  
to  
its  
main  
location  
in  
Brooklyn,  
NYU  
Tandon  
collaborates  
with  
other  
schools  
within  
NYU,  
the  
country's  
largest  
private  
research  
university,  
and  
is  
closely  
connected

to  
engineering  
programs  
at  
NYU  
Abu  
Dhabi  
and  
NYU  
Shanghai.  
It  
operates  
Future  
Labs  
focused  
on  
start-  
up  
businesses  
in  
downtown  
Manhattan  
and  
Brooklyn  
and  
an  
award-  
winning  
online  
graduate  
program.

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